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PROCEEDINGS
CONFERENCE ON
CONSTRUCTION OF URBAN RAIL TRANSIT SYSTEMS
THE CHALLENGE OF MORE COST EFFECTIVE CONSTRUCTION

WILLIAMSBURG, VIRGINIA
DECEMBER 7-8, 1978

PACIFIC CONSULTANTS
47 WINTER STREET
BOSTON, MASSACHUSETTS 02108



SEPTEMBER 1979
CONFERENCE PROCEEDINGS

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16. Abstract <p>The Conference on Construction of Urban Transit Systems was sponsored by the Urban Mass Transportation Administration (UMTA) to present a number of candidate changes in the UMTA urban rail development process. The goal of the conference was to seek input from the construction community on improving the use of public funds and insight into identifying new ways to control and reduce cost of construction of urban rail transit systems in the United States.</p> <p>These proceedings include remarks by eminent representatives of the construction community directed to the proposed candidate changes of the UMTA project development and management process and comments of conference participants and panel members made during the discussion periods.</p>					
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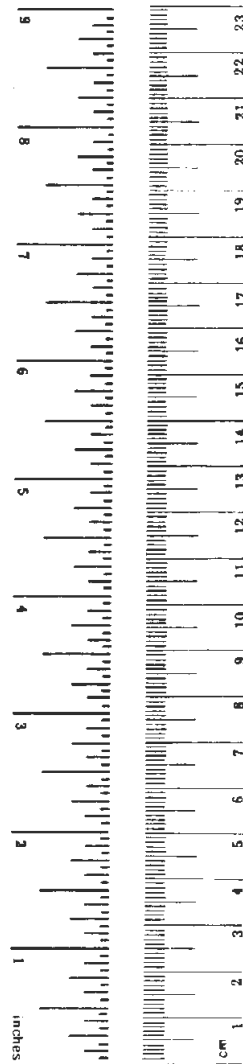
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Approximate Conversions to Metric Measures

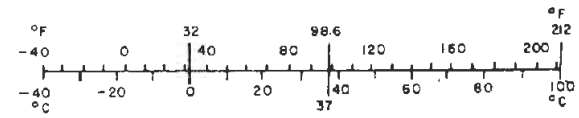
Symbol	When You Know	Multiply by	To Find	Symbol
LENGTH				
in	inches	2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
AREA				
in ²	square inches	6.5	square centimeters	cm ²
ft ²	square feet	0.09	square meters	m ²
yd ²	square yards	0.8	square meters	m ²
mi ²	square miles	2.6	square kilometers	km ²
	acres	0.4	hectares	ha
MASS (weight)				
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
VOLUME				
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft ³	cubic feet	0.03	cubic meters	m ³
yd ³	cubic yards	0.76	cubic meters	m ³
TEMPERATURE (exact)				
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

* 1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price \$2.75, SO Catalog No. C13.10.286.



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
LENGTH				
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
AREA				
cm ²	square centimeters	0.16	square inches	in ²
m ²	square meters	1.2	square yards	yd ²
km ²	square kilometers	0.4	square miles	mi ²
ha	hectares (10,000 m ²)	2.5	acres	
MASS (weight)				
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
VOLUME				
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m ³	cubic meters	35	cubic feet	ft ³
m ³	cubic meters	1.3	cubic yards	yd ³
TEMPERATURE (exact)				
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



PREFACE

The Urban Mass Transportation Administration has become a major source of public funded construction. To ensure the most efficient expenditure of these funds, UMTA needs industry input in identifying how greater cost effectiveness could be achieved, resulting in improved use of public funds. To this end, the Conference on Construction of Urban Rail Transit Systems was held, bringing together UMTA policy makers and industry representatives. The proceedings contain the remarks and comments from this meeting and serve as a starting point for achieving more cost effective construction.

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RUSSEL McFARLAND
OFFICE OF CAPITAL GRANTS
UMTA

MODERATOR

ARTHUR J. FOX
EDITOR
ENGINEERING NEWS RECORD

KEYNOTE ADDRESS

JOHN J. FEARNSIDES
DEPUTY UNDER SECRETARY OF
TRANSPORTATION

TRANSPORTATION OVERVIEW

JOHN K. TAYLOR
ASSOCIATE ADMINISTRATOR FOR
TRANSIT ASSISTANCE

TRANSIT ASSISTANCE PROGRAM

GEORGE J. PASTOR
ASSOCIATE ADMINISTRATOR FOR
TECHNOLOGY DEVELOPMENT
AND DEPLOYMENT

TECHNOLOGY DEVELOPMENT
AND DEPLOYMENT

RICHARD S. PAGE
ADMINISTRATOR
URBAN MASS TRANSPORTATION
ADMINISTRATION

POLICY ADDRESS

QUESTION AND ANSWER SESSION

ARTHUR J. FOX

MR. MCFARLAND: Gentlemen, it is my pleasure to welcome you this morning. Those of you I haven't had the pleasure of meeting, I am Russ McFarland and I welcome you to this, our Fourth DOT Conference on Construction; this conference on the Challenge of Building More Cost Effective Urban Rail Transit Systems. We have, I think, a very interesting morning. Our keynoter this morning will be Mr. Arthur Fox, Editor of Engineering News Record. For those of you that don't know Art, let me give you a bit of his background. Art has been editor of the Engineering News Record since August of 1974. He's a Fellow of the American Society of Civil Engineers, Chairman, ASCE Committee on Engineering-Education, '66-'67, Chairman, National Conference on Civil Engineering-Education, 1974, National Director of the American Society of Civil Engineers, '68 to '71 and the President from '75 to '76. There are many other things that I could tell you about Art's background but I think what I've said is sufficient. With that, I would like to introduce Art and let him kick off this meeting with the keynote address.

MR. FOX: Thank you, Russ and good morning ladies and gentlemen. I have an Engineering News Record story to read to you. It hasn't run yet. It won't run for a while, in fact. It may run in December, 1982. It's datelined Los Angeles, Mr. Gallagher, and that's why I smiled when I met you this morning and here it is:

"Another low bid came in as good news last week for the Southern California Rapid Transit District, SCRTD. Kumagai Gumi Company, Ltd., of Tokyo, bid two hundred and fifty million on a 4.8 mile underground length that includes three stations. The official SCRTD estimate, released at the bid opening, was two hundred and seventy-five million.

Kumagai Gumi, as sponsor of the combine with the low bid, is in line for its second contract in the U.S. The Japanese general contractor earlier was in joint venture with Perini Corporation of Framingham, in successful bidding on a section of Boston subway construction.

Kumagai Gumi's sole joint venture partner last week was Korean Overseas Construction Corporation KOCC, the Seoul based consortium that formed in 1975 to compete for the big money contracts in the Mideast. Since 1975 and beyond the Mideast, KOCC has done construction in Africa, Latin America and off the Atlantic Coast of the U.S. for American oil companies. The L.A. subway job is the first project the Koreans will build on U.S. soil.

KOCC competes only outside Korea and it competed unsuccessfully against Kumagai Gumi for a piece of the

Hong Kong subway back in the '70's. But individual members of KOCC, notably Hyundai and Daelim built several large parts of Seoul's new subway extension. Miryung, another KOCC member is building a piece of the Caracas system.

Second low bidder at two hundred and sixty-five million in Los Angeles last week was the Italian-French combine with Impresit of Milan its sponsor. Third low at two hundred and sixty-nine million was Skaska of Stockholm, leading a joint venture including Schiavone Construction Company and Grow Tunneling Corporation both of New York.

A spokesman for SCRTD expressed pleasure with the bids and the way the three low bidders clustered. He noted that the only U.S. sponsored bid from SoCal Subway Builders, a team of Chicago and West Coast Contractors was clearly out of the running at three hundred and forty million dollars.

Motoo Otsuka, general manager of Kumagai Gumi told ENR that the cost per mile estimates that went into his joint venture's bid are based on productivity achieved by his company on past jobs in Tokyo, Osaka, Hong Kong, Tehran and Caracas. "We Japanese have a reputation for copying others' processes and products," said Otsuka. "In Los Angeles we will use our improved version of every labor saving, money saving, technique ever used anywhere in the world. It will be Japanese equipment and technology. Our latest version of everything that has worked well elsewhere in the world. On top of that," Otsuka said, "Our Korean partners will assume responsibility for all field construction from membership on our management committee down through project management to the level of field supervision. For many years, and particularly in the Mideast, Koreans and Americans have worked well together," said Otsuka. "This time, of course, it will be Americans who are in effect labor only subcontractors. KOCC will assign the project to Hyundai for execution and Hyundai plans to subcontract to Brown and Root which it has known for years in Mideast work and which has a reputation for employing and training productive workers here in the U.S."

In Tokyo, Jiro Wakabayashi, Executive Director of the Overseas Contractors Association of Japan, Incorporated commented on the Kumagai Gumi bid. For the past several years Europeans have had a place in U.S. and subway construction as members of joint ventures in the late '70's and as sponsors more recently. Now it will be shown that the high technology of the Japanese, combined with the ability and high productivity of the Koreans, can give Americans much more subway than they were getting for their dollars before they quit building their own.

Urban Mass Transportation Administrator, Russell X. Sage, said, "From the time DOT approved purchase of the first Japanese bullet train it has been obvious that

we would soon approve Japanese subway construction for U.S. cities.”

Burt Beatty, Executive Vice President of the Associated General Contractors of America had no comment on this latest in the series of low bids by foreign contractors on mass transit contracts across the U.S.

Robert Georgine, President of the AFL-CIO Building and Construction Trades Department, said, “We couldn’t care less. Our union contractors have been out of the subway market for years.”

“It’s impossible isn’t it. Preposterous but not very funny if you are a contractor. Perhaps only the designers and owners were laughing. But we might have built such a piece of fiction as well around American designers to show them losing out to Czechconsult, the organization of brilliant but long repressed professionals from Czechoslovakia, who learned from the Russians all the wrong ways to build their Prague system. Or perhaps from Helsinki might come the cost cutting Finnconsult which brought the simple utility that gives all Finnish design its distinction to the Helsinki mass transit system. And, if there is fun to be made of others in construction, the owners cannot escape as contributing to costs of construction through their specification, regulations, stipulations, complications. But we’ve made fun enough, and perhaps a few serious points.

Let’s be serious now, as we consider the purpose and the importance of this Fourth Annual Conference on Construction Technology sponsored by the Urban Mass Transportation of the U.S. Department of Transportation. UMTA has billions to spend in capital grants to cities needing new or improved mass transit facilities. A major portion of those dollars will go to rail transit systems. How those dollars are to be spent is the question that keeps UMTA rewriting, refining, its policy statements and properly so. You will hear this morning and we will discuss here today and tomorrow, further elaboration of what UMTA believes it must do to see that its billions, the taxpayer’s billions, are spent effectively.

Another way of stating the question before the house is, what will UMTA’s billions buy? What, when supplemented by the twenty percent local contribution, will UMTA’s eighty percent grant money buy? How many miles of product, product is double track urban rail transit complete with stations. How many miles will the billions buy? How many millions of dollars must we spend here in the U.S. for a single mile of modern rail transit system. It’s the likes of you here in this room who hold the answers to these questions.

We are into a potentially emotional discussion here, with our subject, “The Challenge of Building More Cost Effective Urban Rail Transit Systems.” Two years ago, Gene Dallaire, Associate Editor of Civil Engineering, titled the same subject, and I quote, “Desperate Need to Slash Construction Costs of New Subways,”

and he brought forth some rebuttal that was somewhat emotional.

It just happens that Russell McFarland, this morning’s moderator and one of the DOT staffers responsible for bringing me here to keynote this conference, was a prime source for Gene Dallaire in his article that claimed U.S. subways cost too much. I am amused by the realization that McFarland is using us journalists, using us to keep the heat on the owners, designers and builders of subways. If this is a fair statement, and if this is what he he doing, let me quickly state that I admire him and I admire his judgment. For I believe that it is the job of the journalist to express ideals, to deplore the status, define and report the better ways, to encourage their use, to commend the users and, generally, to provide information that can be acted upon and possibly stimulate his readers to act.

If we construction journalists do our jobs, we are reporting cost effective ways of producing miles of subway, or of road, or bridge, or pipeline. We are, or we should be, reporting better cheaper ways of producing things constructed. And we truly succeed when we can claim to have been accelerators of change. When communication leads to progress we accomplish our purpose. When, despite communication, progress is slow, when our industry appears reluctant to accept change, when our industry everywhere is not planning, designing or building in the very best ways it somewhere has learned to plan, design and build, then the editor can become very unhappy, and, as an observer, a reporter, a critic of those who must actually do the work, produce the mile of subway, he can assume the temerity even to come to a conference like this and keynote it.

Construction surely does suffer a communications gap. The very best information on the ways to do things is seldom in the hands of those who must do them. The time lags between invention and application, between proof and acceptance, between acceptance and general acceptance remain too great.

In winding up his affairs this fall as the construction industry specialist in the National Center for Productivity and the Quality of Working Life, Louis E. Alfeld called poor communication in the fragmented construction industry its greatest drag on productivity. I would argue that the industry has been relatively quick at adopting computers, CPM’s and the like, but I concede that, generally, it is too slow at capitalizing on tools and methods.

In 1974 as we probed the future in ENR’s centennial issue, we concluded that in the areas of technological development change will come fastest. It will come more slowly in clearing the social and political constraints. In a 1976 conference on productivity, we in the American Society of Civil Engineers looked at improving the management, the planning and the design processes of construction and deplored the effect of

regulation, political and social. We also deplored and should continue to deplore the construction industry's institutions and traditions that so resist change.

Challenged with the need to cut cost of subway construction, U.S. owners, designers and builders blame the system. The following are some quotes from rebuttals that ran in *Civil Engineering* magazine in April, 1977, rebuttals to the Gene Dallaire article cited above, and I quote, "The greatest costs are institutional rather than technological. Badly needed is a reduction of adversary relationships among engineers, owners and contractors. Bidders must be given ample time to review geotechnical data before bidding. There should be full disclosure of all geo-technical data and consulting engineering interpretation. The proper sharing of risks is probably the best way to achieve both better contracting practices and better climate for introducing new technology. Assumption of liability by the federal government would foster more innovative approaches by designers. A board of engineering consultants could be useful on a national basis to assure current accepted experience was being applied. A hindrance to adopting new technology is lack of contractor experience." Aud, finally, and not much more self-damning than the foregoing, "It's ridiculous to compare subway projects in European cities with those in the U.S. Differing contracting practices alone make such a comparison absurd. In most European public works contracting procedures, contractors have a vested interest in making the design succeed." Of course, they do. How outrageously absurd it is that U.S. practice would have it otherwise. The comparison of U.S. and European practice is not absurd. The comparison is, admittedly, odious. But it would appear to be that certain U.S. practice is absurd. What's so sacrosanct about the way we've always done it? When inflation showed building costs out of control some years ago, the General Services Administration found a way to fast track the design and construction process and to interpose a new professional, a construction manager, between the owner and his AE's and contractors.

Super projects require special organization, perhaps more special than the organizations of the BART's and the WMATA's. Perhaps there's something to be learned from the management and construction support contracts being awarded at cost plus award fees and the packaging of AE assignments and fixed fee construction contracts on such Saudi Arabian super projects as the multi-billion dollar industrial and military complexes, the universities, the airports.

Next month in Scottsdale, Arizona, ASCE will sponsor and DOT, UMTA, DOE, EPA, and others will co-sponsor, a conference on sharing risks and liabilities in construction. The purpose of that conference, to be keyed by Grow Tunneling Corporation's President

George, no relation, Fox, is to carry forward the search of the U.S. National Committee on Tunneling Technology of the National Academy of Science, a search for better contracting methods for underground construction. Let's leave the question of who pays for the unexpected to that conference with a plea that there should be not so much unknown, not so much unexpected. But let's not leave the matter of new technology to next spring's Fourth Rapid Excavation and Tunneling Conference. It's time to stop talking and begin letting actions answer such questions as put forth by researchers Boyd Paulson, John Fondahl and Henry Parker. They ask, why must costs of major urban transportation structures in the U.S. run from two to ten times more than they do in other economically advanced countries? Is the industry right in placing primary blame on regulators, the labor unions, consumer activists and lawyers or is a share of the blame rooted in the construction industry's own institutional structure, organizational inertia, and conservatism. The renowned Ralph Peck warns of over-conservatism in geotechnical problems and, particularly, in underpinning. He urges resistance to, "The compounding of conservatism, injecting slightly conservative interpretations at each step of a multistage problem." Before I leave Paulson, et al, I want to refute here the researchers syndrome that shows itself at Stanford, at M.I.T. and, perhaps, other places. It is this mistaken conception of the construction industry as a service industry, I've argued against it earlier in correspondence with researchers who struggle under the misconception and I'd like to refute it here publicly.

Construction is no more a service industry than is manufacturing a service industry. Is the Ford assembly line worker who tightens those twelve bolts providing a service? Of course not, he's involved in the manufacture of a product, an automobile. And, just as manufacturing produces autos and T.V.'s and textiles and steel shapes, the construction industry produces houses and office buildings and bridges and dams, constructed products. Of course, there are many such professional services as planning, engineering, architecture, market analysis, public relations, and law that go into the process of delivering the product but on the bottom line there is a product at a cost and let's not forget that. Maybe with the mistaken notion that construction is just a marshalling of services of designers, constructors and labor, we have lost sight of the real world in which home builders set out to build a house. They don't start out to provide a service. They set out to build a house or a whole community of houses to sell at a given price per copy, in a given market, at a given time, just as surely as automakers set out to produce a medium priced auto of a given year's model, or garment manufacturers, I'm told, start with the selling price of a dress and work

back from there in their quantities and their materials, their design, their marketing.

Do you remember the story of the two bricklayers who were asked what they were doing? The first said he was laying bricks. The second said he was building a cathedral. If ours were a service industry in which everybody is laying bricks, who is building the cathedrals? We know who's building the subways, you are. And, the bottom line for this conference, for all of you who are assembled here, is the cost of your product, a given mile of transit system produced in the U.S. in 1978 and the years ahead. The project costs money because the delivery process is complex and costly. There are many costs in the delivery process that do not result in increased quality or economy in the finished product and, these costs particularly should be identified and pruned.

But the ways of constructing must also change. T. D. O'Rourke's new study of European construction practices in tunneling for urban transportation concludes a review of techniques with costs per mile that range from ten and fifteen million dollars per mile in London to 30.5 million dollars per mile in Brussels for tunnels in soil and costs of twenty-five and thirty million dollars per mile in Stockholm and Helsinki for tunnels in rock. O'Rourke describes all the variables such as depth, cross section, station dimensions and spacing, approximate geology. Next to those European figures he puts the downtown section, a downtown section of Washington, D.C. subway at almost sixty million dollars per mile and a piece of Baltimore's at almost seventy million dollars per mile. O'Rourke recommends such possibilities as reassessing the scale of U.S. metro structures, that is, a cross section and station lengths. Elimination of redundant support, temporary structures that might rather be permanent. Evaluation of materials and performance specs such as, precast liners and waterproofing requirements, adoption of specialty methods and equipment, consolidation of services and reduction of layers of authority, pre-qualification of contractors and improved control of disputes.

Is the U.S. construction industry capable of such changes or will subway lines simply go the way of New York City's Second Avenue line? It has been priced to death as construction underway badly outran available money. Its completion, reportedly, is estimated to cost over one hundred and forty million dollars per mile, 14.3 miles for two to three billion dollars. Or will foreign subway builders move in and take over the construction of U.S. urban rail transit systems as reported to you in that December, 1982, ENR story I read at the outset? Just in case the 1982 story pans out here's an editorial for the back page of that week's issue.

Last week's bidding on a section of Southern California Rapid Transit District subway line probably marks the end of U.S. rail mass transit construction by U.S.

contractors. SCRTD surely will award the contract to Kumagai Gumi, Company, Limited of Tokyo and its Korean joint venture partner. Whether this trend toward foreign take over of subway construction was inevitable is a moot point today. Four years ago, the U.S. Department of Transportation and its Urban Mass Transportation Administration was trying desperately to find ways to control costs of U.S. built transit systems. Through a series of conferences, policy changes, research projects, urging and cajoling of system owners, designers and builders, UMTA searched for the delivery system that could produce cost effective projects.

At a DOT sponsored conference precisely four years ago, the editor of this magazine in a keynote speech said, "The industry everywhere is not planning, designing or building in the very best ways it somewhere has learned to plan, design and build." He said, communication gaps produced costly time lags in application of new tools and methods. He said, it was time to act in response to charges of inertia and conservatism. Thank you.

MR. MCFARLAND: Thank you, Art. I think that set the stage beautifully for these two days.

JOHN J. FEARNSIDES

MR. MCFARLAND: I would like, now, to introduce to you some of our people at DOT. As you know, the Department of Transportation is an organization made up of a number of administrations; Highway UMTA, FAA and others. Some of you, many of you, look at our organizations, our acronyms and wonder what they mean. What I'd like to do this morning is introduce you to some of the people that run this organization, that make it work, and the last presentation this morning will be a policy statement by our administrator of UMTA.

Now, DOT is run by the Secretary of Transportation and his staff. Under DOT are the Administrations. Each Administration run by an Administrator has its staff. We have with us this morning Dr. Fearnside,

Deputy Under Secretary of Transportation. Dr. Fearnside has been in the Office of the Secretary since November of 1972 and is currently Deputy Under Secretary. In this capacity, Dr. Fearnside serves as Deputy to the Deputy Secretary, assisting the latter in the overall management of the Department of Transportation. The Deputy Under Secretary title also includes the function of Chief Scientist. Dr. Fearnside.

DR. FEARNSIDES: Thank you, Russ and good morning ladies and gentlemen. It's nice to see all of you here and I bring to you the greetings of Secretary Adams and Deputy Secretary Butchman and my presence here is an indication to you that they are keenly interested in this whole matter of construction costs and productivity in the construction industry. As a matter of fact, the Secretary, shortly after taking office started worrying about this problem and started worrying about how we could get public transportation systems built in a more efficient way. Shortly after he began worrying about this, he got a note from someone named Carter who had a similar interest. So, I think you can see that from an overall policy viewpoint, the notion of cutting construction costs and improving productivity in the construction industry gets to reasonably high levels. As a matter of fact, in my various roles that Russ outlined to you before introducing me, I was thinking that in the job as both Deputy Under Secretary and as Chief Scientist I seem to get myself more and more into questions that relate to productivity and anti-inflation. And, more and more they are getting me involved in such matters as innovation and balance of trade. It's remarkable the number of projects throughout the department where we can make a really meaningful contribution to the inflation program. We certainly build enough, have a substantial enough budget, and influence a substantial enough part of the economy. I was very taken by Mr. Fox's opening remarks. As a matter of fact, on the way down I was reading Mr. Alfeld's editorial in the Engineering News Record which says the construction industry is the nation's largest. It accounts for nearly two hundred billion dollars of our GNP and employs some 5.4 million people. That strikes me as a target of opportunity in the anti-inflation program. The Secretary went up to Detroit on Tuesday and told the automakers that it was time to have a summit conference on getting together and deciding what the automobile of the future was. One of the principal concerns that he has in that regard is not just the fuel crisis, which is certainly a major contribution to the balance of payments problem, but also the shrinking dominance, if you will, of U.S. auto manufacturing in the world market. Once again, Mr. Fox's opening remarks gave us an indication that there is a good deal of similarity existing between the automotive and the construction industry. We have a case where it's a big part of our economy, with tremendous

employment implications, very seriously affected by some of the social and environmental concerns that have been raised over the last several years, and properly so. I think that the question of buying back our environment is a crucial question but we have to assess that against the cost of what it means to inflation and what it means to our productivity. In this regard, as you know, the President has established a regulations council to look at the cost of health, safety, environmental regulations and to try to optimize, if you will, the social benefits of these things, given the physical constraints of what it is actually costing us. One of the other interesting things I am doing in the administration is representing the department on an inter-agency committee that is headed by the President's Science Advisor. It's the President's program to stimulate industrial innovation and the Department of Transportation is taking a very, very, close look at this. For all of our wide and diverse interests, we have organized, I think, rather well, to address this problem and two of the major candidates that we will be considering in the President's anti-inflation program and industrial innovation program, are going to be the construction industry and the automobile industry.

I smile because I was giving a speech yesterday on computers and improving productivity and the like, and I said, that we, in the government we're doing our best, but instead of saying to stimulate innovation I said, "To stimulate inflation," and pretty nearly everybody agreed with me. But the cost of urban transportation is a serious concern to us, as I mentioned. It's a serious concern to Dick Page who is going to talk to you later. We've been talking a great deal about this in the two years that Secretary Adams has been in office.

Now, I know that many of you have been at these conferences before and, as a matter of fact, I have been at one or two before, and you get the feeling that you spend your time talking to each other and that the policy people never get involved. Well, as I look around the room and see the kind of people that UMTA has brought today and, as I say, my being here as a representative of the Secretary, ought to give you the idea that, in fact, we are interested and we are listening.

Over the last decade the government and the Congress have turned more and more to private engineering construction for planning, design and management of public construction. We can see a vast difference between the federal involvement in engineering and construction by comparing Highway, who organized in the mid-fifties, to the way UMTA currently handles the projects. We are looking very strongly to Dick Page, Chuck Bingman, John Taylor and others to organize an office of construction management in the capital grants of UMTA to get the kind of responsibility, to get the kind of focus, to tie in the capital grants money that we put out, in a way that Mr. Fox suggested in his opening statement. With an overall construction management

process that enables us to try to get the productivity, to provide incentives, and to put rewards into the system so we can get back and be competitive. So, we feel that this is a step that shows you that we care as well. We've been asking the construction industry now for four or five years to get their act together, to get more productive, to get the costs down, and yet it has been rhetoric. We fully plan to get the kind of government responsibility behind this by setting up this management office right in the capital grant's office and encouraging capital cost reduction and construction management efficiency.

Now, Mr. Butchman, the Deputy Secretary, has had the opportunity to visit Europe and observe metro construction in London, Stockholm, Brussels and Helsinki, some of the places that Mr. Fox also had mentioned in his opening speech.

Now, I know, you are all saying here we go again comparing London with their beautiful blue clays or Stockholm with their magnificent rock to the miserable geology we have in the United States. However, when we see three and one half miles of subway built in the extension to Heathrow in London for less than fifty million dollars and when we see the urban rapid transit systems being built in Brussels, Helsinki and Stockholm at costs of less than thirty-five million per system mile, I'd say we'd have a great opportunity here to enter into a concerted effort to improve our government-industry cooperation. Once again, government-industry cooperation is essential. When Brock Adams went to Detroit the other day, he scared the life out of them by talking about government-industry cooperation. Nobody showed up without their anti-trust lawyers but we're going to be talking to them about how we can work together to get the productivity, to get the kind of product out that people will buy and will make the U.S. auto industry dominant in the world markets again. So, the bottom line, of course, is that we think that we have a great opportunity to offer the public a better return on the investment of public funds. An opportunity to renew the public's faith in the ability of this industry with DOT to provide more cost effective public transportation.

Some time ago I was shown a plot of the U.S. construction industry's piece of the GNP. In real dollars over the last decade, this piece of the U.S. economy has been shrinking. I believe this symposium offers one means of slowing this trend. For want of another expression, the no build trend.

In last week's *Engineering News Record* there was an article on the sixteen billion dollar Canadian James Bay Hydro-Electric Project. This undertaking, one of the world's biggest construction projects is being completed on schedule, under original cost estimates. I believe this is an excellent example to drive the U.S. industry to seek improved performance and to quiet these critics of this industry who have been very vocal in saying we no

longer have the means for effectively implementing the mega-dollar projects. So, I ask you all to give serious consideration to this. I want you to know that we will be working very hard in the government to try to help this and to try to use our influence to make it happen. I thank you very much for your attention.

JOHN K. TAYLOR

MR. MCFARLAND: Within the Urban Mass Transportation Administration are the Administrator and the second level, the Associate Administrators. Two of the Associate Administrators are with us here this morning. I'd like to introduce Mr. John Taylor, our Associate Administrator for Transit Assistance. As Associate Administrator, Mr. Taylor is responsible for the Urban Mass Transportation Administration Capital and Operating Assistance Programs, including the acquisition, construction, and improvement of the facilities and equipment for Mass Transportation services in urban areas. John.

MR. TAYLOR: First of all, I am very pleased to be here this morning and I want to welcome all of you. This is my first attendance at this meeting, which I think maybe tells you something. There are a lot of other UMTA people here. We are glad that they are here. We are a little concerned, and it is kind of an insider joke, but we hope that Jack Anderson, the Washington columnist is not around somewhere. I think it's very important that all of us be here together. We have an immensely important subject. Today, and I'm sure you're all aware if my arithmetic is correct anyway, is the thirty-seventh anniversary of Pearl Harbor and I think that is significant because for the United States anyway, Pearl Harbor was a day in history that really broke a chain of events that had begun a decade or so before of, more or less, constant depression and recession and economic problems in all sectors of the economy, including the construction industry. It also initiated a period of great destruction that continued for a good many years and, as a result of that destruction, all over the world a good deal of construction resulted from that destruction and, in fact, in Europe and some places and perhaps that is part of our problem,

it was a great urban renewal effort and they have some very efficient plants and equipment that some of our manufacturers find very difficult to deal with at this point in time. It was a period that began a prosperity that all of us would agree has continued to today. This country is still prosperous but I think all of us realize that we are in a good deal of difficulty at this point in time. We are not as competitive as we used to be. We have a hard time thinking up what we are going to be doing and financing those things and constructing them. My feeling is that the public has pretty much lost confidence in most of us. Those of us in the federal government hear every day and in every way about this and we are very concerned about it and we want to change it.

I believe at this point it is clear we are simply going to have to do something and I think that's why we are all here. This is my first opportunity really, as Associate Administrator, to come to a conference like this. I want you to know the seriousness with which we take this conference. In a way, we are using this as a kick-off for something that we are all going to have to do together.

As a bureaucrat, a career bureaucrat, perhaps it is appropriate for me to comment a bit on President Carter's anti-inflation efforts. I've been with the federal government now for nine years and this man is the only man I know of who sits over on Pennsylvania Avenue, who writes us notes constantly telling us that we aren't doing the job and that we are spending too much money and who has gotten the federal bureaucracy together in a large meeting and told them they've got to do better and has followed up in every way to be sure that we, in the federal government, understand that he means what he says and I think anybody who thinks otherwise is in for a big surprise. So, you'd all better be listening, not just to what we have to say here, but you'd better be listening to what he has to say because that's what is going to happen. We are going to have to make the appropriate adjustments and I believe that the President knows what he is talking about, that he is reading the mood of the country and that the people want us to make some changes and we'd better make those changes or we're all going to be out of business. I don't think any of us want to go back to the kinds of problems that we had during the thirties but the seeds are there and it's up to us to recognize that. We have our opportunities. I believe that the people that are in this room are the people, at least in our part of the business, who will run and who will develop and who will construct rapid transit systems and make other improvements to public transportation.

As you all know, I think you all know, I am responsible for the Section 5 Program, which is mainly operating assistance. We'd like to see a lot more of it used for construction. That's a slightly different problem and we'll be working on that but that's not the primary source. The Section 3 Program is the primary

source and this year we have one billion two hundred and twenty-five million dollars available for construction and rail improvements and bus acquisitions, et cetera, around the country. Now, that's one hundred and seventy-five million dollars less than we had last year and next year there is absolutely no reason to believe that there will be a lot more money available. There may be some more money available but certainly not a lot more money available and there is no reason to believe that the year after that there's going to be a lot more money available or the year after that. We are going to have to all learn to live within a budget that I think we can all reasonably, in our own minds, predict and be sure that we bring our costs, bring our dreams, in effect, into accord with that availability of funds because, if we don't, that article in Engineering News Record won't occur. The Japanese won't be the low bidder because there won't be any bids. There won't be any subway system in Los Angeles. Nothing is going to happen.

Now, I've been involved in the construction part of this business for about seven years. I was involved in the Second Avenue subway. One of my great disappointments is that that project has gone, in effect, down the tube. We started out with a notion that that was going to cost, oh, on the order of maybe a half a billion dollars. I think that estimate was probably pretty phony but the fact is that the costs are probably, I believe, the greatest change and there is no way we can undertake that project, nor the City of New York, not for the foreseeable future and, yet, I personally believe that it is extremely important to New York City that that project be progressed. It's very important to the project that we're building up there, the Sixty-Third Street Project. I may not be the last word in DOT by a long shot as to what is going to be done or what isn't going to be done, but I'm the first word and I think most of you know that, and I'm the guy when the going gets tough and we begin to talk about real dollars, that you start talking with and I've developed a habit of being a great nay sayer. I don't particularly like that role, and if you can come to us with sharp pencils, with projects that have both been conceived with the notion that costs must be kept under control and then designed and engineered and then hopefully constructed in that fashion, I think we can move forward. Thank you.

MR. MCFARLAND: Thank you, John. As mentioned earlier, this is our fourth conference. The previous three conferences have always been held in the framework of R & D review, R & D program review and it's only in this last year that we've grown beyond R & D and tried to bring other factors into this effort.

GEORGE J. PASTOR

MR. MCFARLAND: We have with us this morning the Associate Administrator for Technology Development and Deployment, George Pastor, who over the last several years, has been the prime mover in conducting all research, development, deployment, implementation efforts in the Urban Mass Transportation Administration. George.

MR. PASTOR: Good morning. Russ, you said this is the fourth conference on construction. I think it is the first because, indeed, we had several in Chicago and New Jersey and Atlanta and we always talked about delivery systems, using the results of R & D. It's the first conference where we are sitting down with you together, where we are going to address how to, indeed, do something about it. As a matter of fact, I even wondered why was I on the program and I thought about three reasons why. One, indeed, frequently the technologists, the researchers, are sort of the stimulants and we cause all the trouble. The second reason that I think I was put on the program is because Williamsburg is a hell of a lot nicer place than Buzzard's Point. The third, and most important reason that I am on the program is because I'm footing the bill. However, for four and one half years I'd like to say I've been a student of this process; how to get the results of R & D. R & D by everybody, not only the federal government, but R & D abroad. Knowledge, how to get the results of knowledge into deployment.

As I was driving down here yesterday, with my wife, I was thinking about I have to give a speech here and a very old story occurred to me from the old country. The story goes like this; there is a long train ride and in a small compartment there is a Jew and a Gentile riding together and they strike up a conversation and they find out about each other's religion and the Gentile says, "You know, I've heard an awful lot about the Talmud but I really don't know what it is. Could you explain it to me?" And, the Jew says, "Come on, the Talmud is a very complicated analysis study of philosophies about the Old Testament and Jews spend a lifetime studying it and still don't understand it. How do you expect me to explain it to you on a short train ride?" He says, "Well, could you give me an idea about it?" He says, "Well, let me try." He says, "Imagine that there are two chimney sweeps climbing out of a smoke stack. One is completely covered by soot. He's dirty, filthy. The other is immaculately clean. Which one will wash himself?" So, the Gentile says, "Well, obviously the one that is dirty." He says, "No because as they climb out they look at each other. The clean one sees that the other one is dirty so he thinks he is dirty, too, and goes home and washes himself. The dirty sees that the other one is clean and thinks that he would be

clean, too, and forgets about washing himself." So, the Gentile says, "I see, that's what you mean about the Talmud that you can explain or rationalize almost anything." He says, "No, you don't get it, yet, because the Talmud also said, let's say there are two chimney sweeps, one filthy, the other clean, which one will wash himself?" He says, "Well, you just proved it to me that my logic is wrong." He says, "No, the Talmud says that you are, indeed, wrong because they both go home, look in the mirror, the dirty one sees that he is dirty and he will wash himself. The clean one sees that he is not dirty so he will not wash himself." So, the Gentile smiles and he says, "Now, I get it. You are really proving that you can explain it one way, explain it the opposite way, and both can be rational, true." He says, "Well, you know you Gentiles, you don't really understand because, first of all, have you ever seen a clean chimney sweep crawl out of a smoke stack."

Well, I sort of feel about R & D policy, delivery systems, deployment, that I am a Gentile. Perhaps, I will never understand it but with whatever understanding we have I'm delighted to see this conference take place because, indeed, I've been saying this for years. If we keep spending research and development monies, sending people abroad, sponsoring people to come here, disseminating knowledge, and, if we don't use that knowledge in deployment, in operations, then it ain't worth spending another nickel of the taxpayers money for federally sponsored R & D.

Now, we have spent about six million dollars in the past four years in tunneling and construction oriented R & D. We have made a lot of progress but we need a hell of a lot more. About half of that money was spent on knowledge, reports, new techniques and R & D in its broadest sense, socio-economics, economic impact, insurance studies et cetera. It's not all technology. The other half was spent on the delivery system. I'm very proud to say that we are, with R & D funds, present in just about every major construction, subway construction, around the country. New York City exempted but we are talking with Jack Hoban about participation there very shortly. But we are there in Baltimore with the concrete tunnel liners. We are in Atlanta with shotcrete rock tunnel instrumentation. In WMATA with chemical grouting and muck utilization. These are all seed monies. We are trying to preach the gospel. We are trying to show ourselves what can be done. Not necessarily new technology, proven technology which needs to be used, put to use by you people. We have established a good partnership in UMTA because we recognize that UMTA is or can be the delivery system. Our capital assistance program is really the ultimate user of the products, of the technology development in R & D and that's why we are here all together. Particularly in construction the problems are very difficult because there is no laboratory to truly test out new techniques, new methods. It must be done at the con-

struction site. We must have guts. In order to have guts we have to share the risk. In order to share the risk we have to put up sometimes money. We are willing to do that. We have participated with money and the new Act, which I consider is a major victory for all of us who pushed it, even recognizes that the utilization of capital assistance funds shall be used for the introduction of new technologies, new methods, when they are proven for reducing costs of our construction equipment et cetera. It's an explicitly stated objective. Now, I don't want to oversell that because John Taylor has enough headaches already, how to meet all the obligations we have with capital assistance dollars so there is no big magic kitty that we can all draw upon but when there are good causes that objective will be met by UMTA to, indeed, introduce new technologies.

Let me cite to you, many of you know about this, but I think it is a classic example of what we can do together. What currently is happening in Miami. It was a few months ago that we were approached by Miami, where they were planning their elevated rail rapid line construction and, internally, the idea came up that, gee, we could use double "T" girders instead of box girders. We could save, perhaps, six to ten million dollars on construction. But, quite rightly, the agency and its consultant were split. Some of them said, let's go. Others said, now, wait a minute, double "T" girders have never been used in this country for rail rapid construction. We don't know. There are highways built by them but we don't know how they would react to the dynamics of the subway trains. How they would last. So, they came to me. We have a problem. What should we do? I talked to John Taylor and we came up with a solution where we said, okay, I felt double "T" guideways have been built by Otis, for example, at Duke University for a people mover. Strangely enough the second phase Morgantown guideway is built by double "T" but that's also for a people mover. So, I felt both sides had good arguments. So, we assigned about two hundred thousand or so dollars to actually build a section of the double "T" guideway that would fit the Miami requirements. Go through an accelerated, environmental shaking, vibrating, dynamic loading, testing program and tell Miami that they prepare their design package and their procurement package both ways so that they can accept bids either for double "T" or for box girders. They had to do this because of their schedule. John agreed that, since Miami is under a full funding arrangement with UMTA that the the extra cost of the double design packages, double "T" and box girder, if the bids turn out to be lower for the box girder, in which case all this exercising was for naught, we would pick up and compensate Miami for the extra cost out of capital grant money. On the other hand, if the test results on the double "T" segment confirmed that they can do the job as well as a box girder and if the bids, indeed, come in significantly or lower than

the box girder bids, then Miami just saved money. So, we had this agreement between John and I; Dick and Chuck blessed it immediately as the sensible thing to do. I called John Dyer and I said, "I have a proposition for you which you can't resist." After I described it to him he said, "George, I agree, we'll go." We are now in the process, the unit has been built. It goes into testing and I'm convinced that it will prove to be a satisfactory alternative.

I went into this detail for two reasons. One, it shows what can be done if we just talk to each other. Second, it raises some very interesting problems that we all struggle with in the federal government. Suppose we proved to ourselves unequivocally that a double "T" segment can do the same job cheaper than a box girder. Should, from that moment on, UMTA insist in every construction job that you build it with double "T"? There will be jillions of reasons why somebody will argue, should the federal government mandate, should we twist arms, should we jaw bone? What we prefer is to hold conferences like this and agree. That's what it is all about and I hope we maintain this dialogue. We will put up our money where our mouth is. We hope to work with you but we also hope you have the determination and the commitment and the desire to save yourself. Thank you.

RICHARD S. PAGE

MR. MCFARLAND: I would like now, to get to our policy address by the Administrator, Urban Mass Transportation Administration, Richard S. Page. Dr. Page became Administrator of Urban Mass Transportation Administration on July 11, 1977. In this position Dr. Page directs the federal government's program of financial and technical assistance in support of Urban Mass Transportation. Prior to his UMTA appointment, Dr. Page was Executive Director of the municipality of metropolitan Seattle. Seattle Metro, which operates Seattle's transit and water pollution control system. From '72 to '74 he served as director of that agency's Department of Public Services. Before his Seattle service Dr. Page held a number of positions in and out of government. He was a Special Assistant to Senator

Henry M. Jackson, in '71-'72, Special Assistant for federal-state programs and Deputy Mayor of Seattle in 1970-71. An assistant professor and Assistant Dean of the University of Washington's Graduate School of Public Affairs, 1968-69. Dr. Page holds a Master's Degree in Public Administration from Princeton University's Woodrow Wilson School of Public and International Affairs and Master of Arts and PhD Degrees in Politics, also from Princeton. Dr. Page.

DR. PAGE: Thank you, Russell. I want to thank Art Fox for setting the stage for us this morning. I also want to thank Jack Fearnside for making a personal appearance to convey the Secretary's direct interest in this subject and I also want to say that I have already learned something this morning. I have not heard John Taylor say those kinds of things before and I hope you listened as well as I did because John had a very important message for us this morning. And, George, I always enjoy listening to George.

Art Fox reminded us that the goal is building a cathedral but maybe it's not who's building the cathedral but how we are building the cathedral. Before launching again into this rather heavy subject, I owe you a joke. This is called Page's six rules for life. Guaranteed to bring anyone to a happy old age. Only they are from Satchel Page not Richard Page.

First, is to avoid fried foods which anger the blood. Second, if your stomach disputes you passify it with cool thoughts. Three, keep the juices flowing by jangling around gently as you move. Four, go very lightly on the vices, such as carrying on in society as the social ramble ain't restful. Five, avoid running at all times and six, don't look back, something might be gaining on you. That's intended to be a joke and not advice for us this morning because we have to look back in this business as well as look forward.

The President signed the Bill the day before the election and that new law, Public Law 95-599, authorizes some more billions, as Art put it, for UMTA. Seven and one half billion dollars in Section 3 over the next five years, with another billion and one half in bus money in Section 5. Today, I appreciate your coming to this two day forum where we hope to gain your cooperation, your counsel, and your advice in identifying new ways to control and reduce the cost of urban rail transit construction. All of us recognize the problem; it has been the subject of previous Administrators' speeches, OMB questions, congressional comments, and handwritten presidential memos, but this is the first formal attempt by UMTA to focus such a discussion with the several parts of the industry. I mentioned this concern in Toronto in September as well as our growing interest in transit operating performance. Next month we start a series of five workshops on transit productivity. Today, we want to focus on rail construction costs.

In a sense this gathering may be too little and too late. For the problem is so severe that rail construction

for many and varied reasons may have reached the point where, in most areas, it can no longer be considered as a serious alternative. The problem is not confined to transit. FHWA announced that its highway construction cost index for the second and third quarters of this year reflected the two highest quarterly cost increases on record, 17.6 percent and 14.7. The Secretary has ordered FHWA to re-examine projects where the low bid exceeds the estimate by seven percent and to consider alternative designs and contract clauses. I'm tempted to say that, we, in UMTA should not approve any transit bids that exceed the engineering estimate by seven percent. That's not policy, yet, but we certainly have that kind of idea under construction.

We do not have an urban transportation construction cost index to indicate our productivity with respect to the whole economy. However, when we look at neighbors in Toronto and Edmonton, as well as in Europe, it's plain to see that we have a real opportunity to offer our cities a range of urban rail transit systems at costs far less than we are currently experiencing. I believe we can lower our costs by examining the manner in which we conceive, develop, and implement urban rail systems. Success in such an effort cannot be achieved by UMTA fiat. It depends on the best efforts of all parties represented here. Let me summarize, quickly, the current development process and then make some suggestions for your review and comment, now or later, about how we ought to change that process.

There are now roughly four stages. I know some of you think there is an infinite number of stages but there are currently four stages in the urban rail development process: systems planning, alternatives analysis, preliminary engineering, and final engineering and construction. Each successive stage is a more serious assessment of a prospective rail project and as a project proceeds from one step to the next it becomes a more serious candidate for local and federal investment. That process was laid out a little over two years ago in September, 1976, in UMTA's policy on major transportation investments and further elaborated on last March in the statement on rail transit signed by Secretary Adams and myself. After systems planning, alternatives analysis phase one, a more rigorous planning analysis of a limited set of regional alternatives, including an EIS, and after preliminary engineering, a project funding decision is made. Then final engineering begins, following which, bids are solicited and construction begun. You can see from this process that a project is subject to a series of local and federal appraisals and decisions as it progresses. The two previous policy statements, '76 and '78, define several useful principles, including area-wide planning, incremental development, local financial commitments as well as other governmental actions to support transit and the full funding commitments. These policies were a big step forward. However, in examining them I am struck

by the fact that we have not really addressed the problem of cost. We have concentrated on controlling expenditures. We have tried to hold expenditures by limiting the application of rail transit systems. For those systems we have approved, I find a lack of guidance or incentives on our part and the grantee's part, to encourage cost effective engineering, design and construction. There are several reasons for this. Let me list a few and I'm sure you can think of others.

The need to adapt to NEPA requirements has had a significant influence on our process as well as highways and EPA's. The philosophy that limits UMTA's role to concentrating on grant development, leaving major decisions to local authorities is another factor. Other factors include the local authorities' desire to design first class, even fancy, systems plus the normal ambition to design for optimistic future growth.

Still another major reason for escalating costs is the painful subject of liability and litigation expenses familiar to the public in medicine but not, until recent years, in the engineering and construction industry. I'm not quite sure when this began to change significantly but let's use BART as a rough point of demarcation. Prior to BART, significant public works and construction management in the United States was performed by public agencies, local and state governments, the Bureau of Public Roads, the Corps of Engineers, the Bureau of Reclamation. Engineering criteria and their attendant risks were assumed by these public agencies on behalf of the public to provide prudently designed, well engineered end products. With BART, public works construction turned a corner when we and UMTA were not involved, but I say "we" collectively, asked private engineering firms to provide criteria, conduct designs, and manage construction on behalf of the public. But little thought was given to the assumption of liability or risk management.

In the mid seventies the magnitude of this risk management question has become much more apparent. This year, the National Academy of Sciences noted that the total value of insurance premiums paid by U.S. business in 1975 was twenty-five billion dollars and it is probably twice that in 1978 as the same magnitude as total corporate profits and corporate taxes in the United States. "In 1975 the insurance industry had an underwriting loss of 4.9 billion and in 1976 the loss was 2.2 billion." Professional liability premiums currently run twenty-five percent of insurance coverage. Yet, we in UMTA have no guidelines or policy on providing extraordinary coverage for general engineering consultants and designers. Little wonder we have trouble adopting new practices or technology or avoiding overly conservative designs. That's a subject for which I do not propose to offer a solution this morning but it is a subject which, I think, we should acknowledge officially and

on which we should invite your comment about how UMTA can be helpful.

An additional major factor in the general problem of increasing costs is thrusting private engineering and consulting firms into the political area of special and local interests without providing some means of open and public review of technical decisions and countering these pressures in the decision making process. The old Bureau of Public Roads or the Corps of Engineers never had to worry about future business when disagreeing with local authorities where local and national interests did not coincide. This situation is one many of you have had to deal with without getting much help from UMTA.

Let me outline a number of candidate changes to the process that I've described. We do not now require sufficiently detailed cost estimates during alternatives analysis. In my brief tenure at UMTA I've already encountered more than one project which we had listed on our internal worksheets as a couple of hundred million, maybe four hundred and fifty million and then we make a site visit and then we meet with the grantee and the engineers and we find that a couple of hundred million is now four hundred and twenty and four hundred and fifty is now seven hundred and thirty million dollars. We do not now require sufficiently detailed cost estimates during alternatives analysis. In the absence of engineering data, many assumptions must be made which are documented in the EIS and then become gospel during the preliminary engineering phase. Based on experience, we recognize that more detailed investigations of alternatives are necessary during the analysis stage in order to define projects definitively enough to permit modal decisions, realistic estimates of project costs and an adequate assessment of environmental impacts. In effect, we need to investigate alternatives from an engineering perspective during engineering analysis, to ensure that the decisions resulting from the analysis and which shape preliminary engineering are valid. There is one obvious solution to this which I didn't put in this speech, and that is to tell you that we are going to require two alternatives analysis. In fact, we may have to do that in certain cases but as a first step in controlling costs we do intend to require the use of more rigorous costing methodologies during the alternatives analysis. But the problem is even if we insist upon more rigorous cost estimates in alternatives analysis, projects may still be subject to change in scope during preliminary because of new information.

Two weeks ago, the Council on Environmental Quality issued revised regulations about handling EIS's. They now spell out federal agency responsibilities for NEPA compliance and they recognize that projects can change complexion as new information becomes available. These regulations call for a tiering approach.

That's not causing you to cry. That's suggesting that there may be a second tier. A tiering approach to address this issue. The tiering process envisions a comprehensive EIS at the outside and should the need arise a so-called, second tier EIS which focuses more narrowly on selected matters of concern during the later stages of the project development process. The CEQ regulations further state that tiering is appropriate when the sequence of statements is from an EIS on a specific action at an early state, such as, need and site selection, to a subsequent statement of a later state, such as, design detail and environmental impact mitigation. Incidentally, those new regs also allow us to limit the number of pages in an EIS. I'm sure you join the UMTA staff in welcoming that change.

As a second step, we propose to introduce the concept of an upset cost into the project development process. More specifically, at the end of alternatives analysis, if the preferred mode is rail, then it seems to us that the grantee and UMTA can determine and define an upset cost for this rail mode. By upset I mean, a rail system unit cost that, if exceeded in subsequent engineering and design, negates the conclusions of the alternatives analysis and forces a re-examination of the assumptions which led to the rail option as a preferred mode. I can give you examples of where I might choose to do that if we'd had that policy in effect.

As a third step, we propose that specific cost control incentives be built into the rail system definition process. One is the upset cost idea. Another is the development of an applicant's management plan. So, we intend to use the upset cost idea and the management plan as the primary criteria for the selection of successful applicants for capital funding. By management plan, I mean simply that the applicant will be expected, as we suggested in the March rail policy statement, to define how each phase of the process will be managed and delivered, including systems operation. This is simply a page from the basic management principles. The applicant should be able to tell us how its decisions are to be made. How consultant services are obtained. What incentives will be used. How criteria will be developed. How design and construction will be managed. How accountability will be assured and how risks will be managed. The Department of Energy calls this a project management plan.

I suggest that many problems with new as well as existing systems could be avoided if UMTA, the industry, and the public is told how effective judgment will be exercised in the use of public funds. This requirement is not intended to, and we do not think it will, add an additional burden to the applicant. We believe it could provide needed incentives to contractors as well as to other applicants. For example, the MARTA system has already put into effect an award fee type contract with its general engineering consultant. Buffalo is currently examining risk management techniques developed at M.I.T. to deal with insurance problems.

Jack Fearnside referred earlier to another step that we are taking and that is to organize within John Taylor's office a program management office, not so UMTA can manage projects, but so we can, through a technically developed and technically oriented office, develop a closer association between the applicant, the industry and UMTA, particularly during the early engineering system definition and cost development phase. We should jointly develop guidelines and recommended practices, allowing us to enter into a full funding commitment with reasonable levels of confidence that the commitments are real and can be met and that the system is prudently defined and engineered.

Finally, I propose involving this industry in the planning, engineering, design and construction processes leading to the development of operational rail segments. How do we do this is a question I put to you for this conference. One experience will be described tomorrow by Jack Rhett, of the Environmental Protection Agency, where they have involved their industry in design and construction review. Cost reductions can be brought about by the use of prudent incentives and design review techniques. Perhaps we can profit by EPA's experiences.

Those are three or four or five suggestions which are not published in the federal registry. Some of the staff hadn't even heard about them until this morning. I throw them out as candidate changes to the way we conduct our business and we invite your comment, this morning, this afternoon or tonight, tomorrow, next week but we are not only concerned enough to have senior people at what has been a construction research oriented conference but we are concerned enough to start shaking the tree a little bit in order to change our own procedures and to work more closely with grantees and with industry to see if we can't get a better handle on this problem that is threatening our industry.

Within the United States the public, especially elected local officials and members of Congress, is developing a perception that rapid transit systems are too costly. This perception is supported by construction cost escalations far in excess of overall national inflation rates and by apparent excesses in the systems we are currently implementing.

I believe we are at a point where we have two courses of action. We can stumble on and end up in a no-build option, based on increasing costs we are experiencing or, through a concerted effort by all of us, we can improve the process through the development of less costly, more efficient practices, designs and implementation techniques, through the development of incentives and a better allocation of risks associated with improved design and construction practices. If the rail construction industry is to have a future in this country it must respond to the real and perceived issues of cost. It must be able to change methods to be able to assure the public that the public is getting the best

bargain from public funds. I must admit to a little bit of amusement in what I am going to say because in writing this speech I came across another speech by Jim McDonough, immediate past chairman of the American Public Transit Association, and we have some differences between how APTA views our program and how UMTA views our program. I want to read you a quote of Jim McDonough's speech of last April, and he said, much better, what I am trying to say to you.

"I hope as we make our plans and design new services and projects that we examine all alternatives. Let us make a commitment to be cost conscious. Our expansive rail projects can be less expensive. Our designs can be more moderate. Our decisions can be more realistic. We cannot sell the public more than it demands."

Currently there are fifty-six operating rapid transit systems outside the United States and seventy-four others under design or development, many at costs far less than in the United States. I think this represents a challenge to our industry. I welcome your counsel and urge your commitment to solving this challenge. Thank you very much.

MR. MCFARLAND: Thank you, Dick. Gentlemen, I'd like to throw open the meetings to questions. We, of the government, are at an end in terms of our presentations. From this point on, it is you and members of your industry that will be speaking. I would like to now, for the next half hour, to see if you have questions for this mornings' speakers from the Urban Mass Transportation Administration.

QUESTION AND ANSWER PERIOD

MR. LUCZAK: Ron Luczak, Chicago Transit Authority. In conjunction with the proposal, are we also going to see a review and perhaps a moderation of federal regulations, EPA, E&H, the other ones, Trans Bus, driving the costs way up?

DR. PAGE: That's a fair question, Ron, and I think the honest answer is yes and no. I don't expect to revisit Trans Bus. I think that I would disagree with you. I don't think that a federal mandated design is the reason

bus costs are going up. I suggest to you that the change in UMTA administrators and policy about buses and the confusion in the bus industry, some of which is self-generated as well as federally caused, has been responsible for that. My honest hope is, and only time will prove us wrong or right, that a standardized design should stabilize the bus industry and enable manufacturers and grantees to count on a predictable, reliable, market. We haven't been meeting that market anywhere near in the last two or three years. I do not expect to revisit Trans Bus. E&H is clearly a serious factor, in general. Under 504, that is under active consideration by the Department right now, you know that we've got to balance several different factors there, including what the law says, what the regulation from HEW says, what we heard in the hearing and, clearly, the cost factor, not only capital but also operating costs. We're going to do our best job to make a reasonable judgment about all those factors but the tenor of my speech on the other parts is very definitely yes. We are prepared to reconsider, environmental, planning, bidding, and construction procedures to the extent that you suggest them to us and to the extent that, you know, human beings can identify them. Some of them may be doable, some of them may be within our power to change, some of them may rest with EPA or the CEQ, but we are, clearly, ready to work ourselves and work with you to do battle wherever it is necessary. Some of them may rest with the Department of Labor and the labor unions and that's not a subject that we can't talk about, can't sit down and start communicating about, either with the Department of Labor or with the construction unions.

MR. MCFARLAND: Do we have other questions?

DR. LEVITT: Raymond Levitt, M.I.T. Department of Engineering. I've been involved in some of the risk analysis work that Administrator Page referred to and I'd like to make some comments and pose a question here. There are several agencies both in the private sector, that is, electric utilities, oil companies and other major buyers in construction as well as federal agencies, such as, the Bureau of Reclamation and Corps of Engineers, who have construction contracts that are of the form where the owner accepts much more risk than those that are typically in effect with local transit authorities, whether they are regional transit authorities, or agencies of the State Department of Transportation. My question here is, whether UMTA is willing to use the muscle that they have, in terms of the golden rule, they have the gold, and dictate to the local authorities who are, for all kinds of reasons, not anxious to assume risk, that they, in fact, *do* assume more risks, perhaps even more than some of those that are assumed on highways and dams and power plants. Let's face it, tunneling is a very risky project and to build a tunnel on what amounts to a fixed price contract, which is the way we build them, in a situation where there are

economies that make us adhere to large projects since you can't subdivide a tunnel into twenty little sections if it's only a mile long, when these risks are so large, is UMTA willing to try and really put the pressure on these authorities to change their construction contracts?

MR. MCFARLAND: I haven't had the opportunity to introduce our Deputy Administrator in the Urban Mass Transit Administration, Chuck Bingham, who will answer that question.

MR. BINGHAM: Maybe and then again maybe we won't. Art Fox used an expression this morning which, I think, is very relevant to that kind of question. He talked about a compounding of conservatism and I do see it as one of UMTA's obligations, not only to deal with transit authorities and with architect engineers and construction firms, but to begin pressing this same dialogue with political leadership and with transit authorities in their role as public bodies, recognizing that it is probably true that much of the conservatism that is built into this sequence of events is political conservatism and, if you are going to break the circle, that is probably a key point at which that break will occur. I would like to follow up this conference with some of the thinking that I expect to emerge from it, with some serious meetings with the political leadership that I'm talking about, where we can begin to say to them, you must now convey your public policy direction in a way that urges the system to produce what I call the best public bargain and I think that is an obligation where our golden leverage can be exerted.

MR. MCFARLAND: Thank you, Chuck.

DR. PAULSON: My name is Boyd Paulson, Stanford University. One preliminary comment, I think I am the one that raised hell last year about this group coming together here and talking to themselves, I specifically asked why Dr. Page was not here and I'm very happy to see Dr. Page here this morning. Thank you for coming. Let me address the question, though, to this group. I think some of what you have said this morning and, also I think I read in a draft of UMTA policy, where it talks about this in-house Office of Program Management, UMTA Management, as a way by which UMTA might begin assuming some of the responsibility beyond just the grant process stage, which I think even the industry people, many of them I've talked to, have been calling for. The government can spend the billions of dollars, they do owe it to the taxpayer to at least monitor and see how that money is spent. I'm still very vague though, it's not very clear to me how this new office is going to work. What I see right now, as a major lack in UMTA, is sufficient in-house technical expertise to really begin to process most of these alternative review documents coming in. I personally, don't think Gil Butler and Russ McFarland, by themselves, can do it all and they, certainly, are very dedicated people who have the competence. They have a very small staff but, by in large, UMTA is not staffed

by such engineering people or people with this kind of experience. The draft that I read did refer to, at least vaguely, some things about involving industry. Somehow, perhaps, as consulting panels or something of this kind. At least, at this stage it is unclear to me how the government actually does intend to involve industry.

MR. TAYLOR: Well, first of all, I don't know that I have the perfect answer but I believe we have given thought to the very issue that you are raising. First of all, we do have a staff on board, not only in George Pastor's office but under Wilbur Hare in my office, and I think a good many of you know him, who have been reviewing engineering plans. I think if we quadrupled and then quadrupled that and et cetera, we still wouldn't be able to review plans to the depth that would guarantee anything that we talked about today and that is not going to be our approach. We want to work with the industry and the contractors and we want to work back up stream. We want to become involved and, importantly involved, when projects are conceived, when the design criteria is established, when the engineering criteria is established. We believe that's the time when important cost considerations are developed and we have not been a part of that process. We are realistically not going to have a cast of thousands. We don't think we need a cast of thousands but we do believe that if we can all work together, to involve all of ourselves with the notion that we simply, and I was trying to communicate that this morning, we have to bring these projects under cost control. We simply have to do that and we have to make the public believe that we are accomplishing that. We have to do it all together and do it beginning on the day we think we are actually going to do something. We think we can do that. We have, not a perfect plan, but we have in mind hiring additional staff, as many as we can get, highly technical professionals who will work with you, again, at the earliest possible stage. If that doesn't work, we are going to be in trouble, but I think we believe, that it will work. I think all of you probably believe that, too. Thank you.

MR. ZIEGLER: George Ziegler, New York City Transit Authority. As part of this procedure would you, or do you intend to have any sort of time schedule for this entire process? In other words, an alternative analysis, a certain number of days or months. Will UMTA review a certain number of days or months? As I look at the draft, I can easily see two and one half, three years, from the time start to the letter of intent. I was just wondering what your ideas on that are.

MR. TAYLOR: No, I don't think we have in mind some rigid time schedule that all of this would be done on. I think each project would obviously vary. I sense some concern on your part, George, that we are going to take a project that is in mid-stream somehow and go back to ground zero and establish some new process. I think if you're concerned about that, that's not our

intent but it would be our intent to work with you to insure as rapidly as possible, without incurring unreasonable delays, that this process be applied as practically as possible, to projects which are in process. Alternatives analysis could be a very, very, short process, depending on the nature of the project or it could be a rather prolonged one. A major new rapid transit system in a new city is a very large, very significant, undertaking and it's going to take time to look at that kind of issue. The design of it is going to take time but I don't think there is any rigid schedule. I don't think we would want to propose a rigid schedule as to how all of these processes would be carried through. There are certain sub-sects, like doing an environmental impact analysis, that I think all of us would feel we ought to try to put some time constraints on it. I'm sure there are others and I would hope we can all work together to do that. I think environmental analysis has come up a number of times. I know that we are all concerned about it. I personally think that it has gotten to be rather overblown and that we can work together to bring it back to accomplish what the Congress really had in mind when they passed the National Environmental Policy Act in the first place.

MR. SWEDE: George Swede. Dick, I'd like to put a question to you concerning your remarks about the proposals that you are planning to implement, particularly in the area of the upset cost limit and the possible rejection of the conclusion that a rail system might be a preferred, if during PE those cost estimates are exceeded. As someone who has been struggling with the question of what is an upset cost in Detroit, let me say, I'm pleased to hear that this is going to be clarified for all of us but, more particularly, I get the sense that within the spirit of the President's urban initiatives, decisions regarding rail transit systems are clearly going to be made not based solely upon cost per mile, cost per passenger, such as that. They are also going to be made upon issues of developing, I get the sense that, in fact, those kinds of parameters, the economic development potentials of rail systems could in fact be the overriding decision parameter that dictates the choice of a rail system as a preferred mode. I guess then, I need a clarification on the rejection of the conclusion if, during ordinary engineering, upset cost estimates are exceeded, how would that be reconciled with the decision, perhaps, being initially made on economic development potential?

DR. PAGE: It's a fair question, George, and I won't be able to give you a clear answer. Clearly, we are interested in a number of factors. Partly because of the President's urban policy but also, in fairness, I would say the decision in Buffalo that the previous administration made, very definitely had urban policy employment revitalization objectives as well as mass transit objectives. Maybe I can put it this way, the first thing we are interested in is transit merit. The other objectives

or the other benefits that may happen or accrue to a meritorious transit project are good. They ought to be assessed. They certainly count as benefits but I don't think that these concepts are mutually exclusive. If it's a bad transit project, it won't become a lot better just by adding on a whole bunch of rhetoric about other factors. Now, the task, as you know better than anybody, is to try to sort out whether there are other tangible benefits and not just a lot of rhetoric about development and about other social and economic and environmental objectives. One more comment and that goes back to the budget. The President's urban policy is the first and best document of its kind. It did not increase the UMTA budget. We've still got a very constrained budget for this fiscal year and the next five fiscal years. There is a little more money in the authorization bill but that's still subject to annual appropriations. So, the primary justification and the primary cost figure, which is what I was addressing in my remarks about an upset cost, has to do with the transit merit of the proposal and what our budget can tolerate over several years through the letter of intent and the Section 3 dollar amount.

MR. DYER: John Dyer, Miami. I've got about two or three kinds of comments and questions related to one another. It seems to me the first thing that really needs to be examined and talked about are costs. It gets down to the basic decision that UMTA has permitted the locals to deal with primarily. That is, whether the guideway systems are going to be tunnel type systems or aerial type systems. That basic decision, once made, in most cases, is made in favor of subways at about five times per mile of cost, whatever you build. I think we would conclude that. It seems to me there ought to be much more consideration given to the construction industry as well as the architectural design capacity to this country as well as to UMTA. Looking at the alternatives above the ground first, we happen to be building an aerial system in Miami, for a variety of reasons. We could have built a subway. It would have cost a lot more to do it but the example of the double "T" girder that works out is going to probably add aesthetic quality, not detract from it. I recall a rail conference of a couple of years ago where a number of people were saying, the major reasons for subways in the United States, the world, were eliminated a few years ago with the advance technology. We don't have noise problems and other things. The basic question really needs to go back to, why subways? It seems we are talking about costs and getting more dollars. The second major area it seems to me to be addressed by UMTA and, it's essentially an institutional one that can be dealt with, is this whole business of streamlining procedures. You've certainly come a long way in the last six months. You're obviously going to move even further but the context of that ought to be in the final analysis, the locals get all the risks because they've got all the responsibility anyway. In the final analysis, the system is going to be

operated for better or worse at the local level. You're moving in the direction, throwing the risk down, we understand that. At the same time there ought to be, instead of compounding an institutional conservatism, the reverse of that or doing away with the institutional conservatism. I think you are moving in the direction of that, but getting around to my specific example, our experience, working with Section 6 grant on the double "T" and getting that contracting process as opposed to the Section 3 process, there is no comparison. Six is three times as easy as Section 3. I don't know exactly but I don't think necessarily R & D funds ought to be easier to get the contracting process passed and approved than Section funds. I can't understand that, in fact, I think you demonstrated it's very easy today and I think that that needs to be examined. My third comment is, that if we're talking about trying in part to reduce costs, there are so many legal and institutional barriers which UMTA can't really deal with as administration in DOT but that the people in the audience can deal with through their interest groups, their organizations. It seems to me we ought to be talking about what are the difficulties, conflicts, those under the UMTA Law, I3c, 3E and union agreements on one side. What about the complexity about the other things in legislation, EPA, as you suggested. Those types of things it seems to me ought to be issues of policy that this group here ought to be worrying about and maybe you folks ought to be stimulating them some but we've got three types of things going. The basic decisions that are local, institutional procedures to be dealt with within UMTA and the policy things that are not, by any means, within your framework exclusively. I'd be interested in your comments on the first two at least.

MR. TAYLOR: I came over here to really answer the first one. I really couldn't agree with you more. I don't know that anybody other than you and I, John, agreed but my feeling is, and to the degree that I can, I'm going to take the position that transit ought to be built on the surface at grade and if that for some reason is legitimate, a legitimate reason, is unacceptable then it ought to be built elevated and if it can't be built elevated then maybe in cut and cover and if it can't be built in cut and cover as a last possible thing we would do, we would build it in tunnel. Frankly, we've all got to take that approach. You're going to have to prove that some other way of attacking this problem is what you have to do. Now, there are legitimate reasons. There are legitimate environmental reasons why you might want to do something else. There are legitimate problems concerned with the impact on other transportation, other facilities that may not be entirely environmental but are real practical reasons. We understand all that but I do think what's happening right now is, we are starting with the presumption that we don't disturb traffic and we don't have problems with the utilities, et cetera, et cetera, so we tunnel. Well, we're tunneling ourselves

out of existence. We won't be doing any tunnels because we won't be building anything. I said that earlier and I'll say it again and you've got to believe me and that's going to be our approach. We want to do that together, however. We want you to understand we will do our best to work together but we're going to take a hard eyed approach on that subject. As far as changes in procedures, we're working on those. Section 6, I disagree with you, John. Section 6 is at least twenty-five times easier than Section 3.

Section 3 is difficult for a major reason. It is the bulk of the money and it, therefore, is the money that the Congress has put the most strings on. It's where 13C applies. It's where all the planning process apply. It's where everything is applied and we would agree with you. We would like to eliminate some of that. We can all work together on that. We have to have politicians understand when they write something into the Act relating to E&H that there is a cost associated with that. It's nice to do these things but it costs money to do these things and I don't think that frequently as legislative changes are made that the cost implications of those legislative changes are really assessed. I know that it's awfully easy to recognize that and I would think that probably a congressman could stand up here and say the same thing and probably would but it's going to take all of us working together, believing together and the public believing that. I'm not sure the public sees the cause and effect relationship and when they do then we will get different kinds of legislation.

Local institutional hears, sure we recognize that. That's where the bulk of the problem is. We have problems through our legislation but, frequently your local institutional problems aren't mutually exclusive with our problems. We'll work with you to change what we require and we'll help you to the degree that we can to change whatever needs to be changed at the local level, to try and convince people. If it can't be changed we'll do our best to recognize that as being a reality. It might affect the cost of the project but we were talking about upset cost figures. We know when we get into estimating that that's a real situation. At least, if we did our work, and we do, that's got to be a part of estimating an upset cost figure. The goals of the project have to be a part of that estimate. There's no reason why we should estimate a project and then find out there are a whole slew of things we didn't think of that are going to materially affect the cost of that project.

MR. KUESEL: Tom Kucsel, Parsons, Brinckerhoff. First an illustration, the BART project, that is very little recognized but a great accomplishment of the BART project, was not the complicated subways and tunnels that were built, but that routes were found for one-third of the route mileage where construction at the surface was acceptable and could be sold to the community, and for another one third of the system on aerial structures. If these routes had not been found and it

had been necessary to build more than one-third of the system underground, there would never have been enough money to build the project and it would not have been built. So, it can be done but at a very early stage one has to investigate these opportunities. I'd like to comment more about something that a number of speakers this morning sharpened my perceptions on, a common problem that we all share. Government agencies cannot build transit systems alone nor can property owner agencies, nor can engineers, nor can research organizations, nor even construction contractors alone. We must all work together and we do not work together very well at the present. Our relations have become defensive. They are characterized by excessive concern for liability exposure, censure, contract obligations. The characteristic relationship among the parties is hot. There's the culprit, off with his head. I submit that the work will be accomplished slowly at a great expense so long as each of the workers has to use one arm to carry a shield to defend himself against attacks by his fellow workers. The American experience, historically, has been incentives are much more productive than punishment and we have, not only in the construction industry and the nation as a whole, become excessively preoccupied in recent years, with punishment of transgressors. We've lost sight of the opportunity the nation has always had, realized from incentives, reward and performance. I think we need somehow to change that focus.

MR. MCFARLAND: Thank you, Tom. The gentleman next to Tom.

MR. HARDY: My name is Ted Hardy from Pittsburgh, Pennsylvania. First of all, Administrator Page asked for our cooperation. Indeed, he will get it. There is nobody here today that would not cooperate with you and UMTA in bringing these policies to bear. We're here because we're very much interested and we do want to cooperate. The question that I wish to ask is, if you are searching for ways in which to reduce costs and now that you are suggesting that you wish, at the federal level, to be more involved locally, it appears to me we are returning to those early days, in the early 70's when, indeed, the policy was in the opposite direction. That is, it was a local decision, bring those local issues up to UMTA and we, in turn, will decide. Now, you wish to reverse that policy. Maybe it's good but let us remember, all of us, that if we're going to play the game of the environmental impact statement, it must be played fair. If you are inviting citizen participation to work out with groups and what have you, in going from A to B, we must be prepared, all of us. We're responsible to that. It's not utilities that were going underground and it's not through neighborhoods but, indeed, we're involved with people's lives. I believe that, if indeed, they end up, the people, asking for subways, we're probably going to construct them. Perhaps, the federal response will be, ah ha, it costs too much.

Therefore, local citizen you are not going to get it. You, UMTA, must be prepared for that response. I hope we don't get into that confrontation.

My third point is that if you are going to get more involved early, at the local level, I think that you have one opportunity recently which should be exploited in terms of staff. That is, and I will now use a word very rarely used in transit, I'll call it trust. I suggest that you have a way of doing this through your regional offices and, indeed, I hope you in D.C. at the headquarters will begin to place some trust, maybe more trust and more responsibility at the regional level so that we can work on this one-to-one opportunity. In my judgment, the local property is now going to enter in partnership in a much greater way than we've ever done before in bringing you, the federal level, along with us as we review very clearly and carefully the cost estimates and the reasons for the multi-years decisions that have been taken prior to many of you being in the places that you are today. I've only been in transit for seven years and I have seen five administrators. I think that our point simply is that you're on the right track at the regional level. I don't know what the jointure with the federal highway administration means. It sounds to me like we're not only trying to wash our own laundry but we're also going to be educating some highway people in the very near future and that's going to be an interesting situation as UMTA becomes absorbed in that. So, my question, first of all, strengthen your regional offices and are you going to do it? And, secondly, how do we do it with your pending merger of the highway department?

DR. PAGE: It only took half an hour to get to that, Ted. That's a good statement and I appreciate it. Before I deal with the question let me just comment on the impression. I don't think we want to get deeper involved in local issues. Maybe that's what you heard some of us say, but I don't think that's the message you should carry away. I think what we want to do is communicate better, trust you to a greater extent and go to work on federal procedures and federal methods of decision making. If it takes too long with Section 3 or if EPA is a problem or DOL, those are federal issues we can deal with, but I wouldn't describe it as reversing our policy of saying that the primary focus of decision making is at the local level, but you're still going to have to live with our judgments about our budget.

We've got four regional directors here out of ten and, so I could say, that we were going to add staff to the other six regions instead of these four but I won't because we don't have authority to add any staff anywhere. There is a presidential freeze on federal employment. We are authorized and appropriated for six hundred and two positions in this fiscal year and we only have authority to fill five hundred and fifty-seven which was last fiscal year's ceiling. Five hundred and fifty-seven people are on board today. We are up to

what we are authorized to have. About one hundred and sixty-five of them are in the regional offices. These four and their six colleagues constantly batter us for more people. They need more people. Frankly, that's our first priority for what additional positions we may get this fiscal year out of the OMB and Secretary's Office allotments. I think you have a good point. We can, and should, and will do some of this work out of the regional offices. Right now, we've got a little bit of a headquarters problem. We've got to sort out this program management office, know exactly what we are doing and then have regional directors and regional engineers and regional attorneys help do it. We're going to do that as fast as we can and that's a this fiscal year effort, not the next three years.

You mentioned trust and its extremely important, and the previous speaker did, and I don't quite have any solutions for getting there quickly except maybe, more open conferences like this. It reminded me, before you mentioned merger with STA, it reminded me of something else that is called the Trust Fund. The more we work at defining what this Surface Transportation Administration is and the differences between highway methods and UMTA, the more I come back to two subjects. One is the existence of a trust fund to pay for those projects which we do not have in the transit industry and the second is field staff. I'm jealous. You know, senior officials in the federal highway administration go home at 4:30 in a car pool and we, because their program is delegated, the procedures are established, the staff is at work in the division level offices and the regional level offices. The merger is, for those of you who haven't heard about it, a proposal by Secretary Adams to recommend to the Congress in 1979 the creation of a Surface Transportation Administration. It would merge the two administrations into a single line of authority, with a single administrator, approximately five thousand employees, ten regional offices, fifty division level offices. The present levels of authority and the present ways of doing business would not change on day one. UMTA transit decisions would still be made in the regional offices. The planning process and the programming process and the grant approvals would be much as they are today. But, clearly, this would create a structure that would lead to change. Some of it I think is good for the transit program. We would acquire the use of some people who are more skilled at construction management and at engineering and at technical issues, and more experienced at it than UMTA has been.

Another advantage would be the creation, not on day one, but soon, of a single planning process and the review by one federal agency of the Highway I05 annual program of projects and the TIP. One system of paper work, one system of accounting, one system of reimbursement and so forth. But, clearly, it is going to be unsettling to some of our grantees and some of our

people that do business with us and to our employees and we still have quite a long way to go to define those details as to exactly how that merger will work. But the intent is to send up a presidential reorganization plan at some point during 1979. Any merger like this requires Congressional approval, either by a reorganization plan or by a piece of legislation. I don't know whether I answered your questions but I did make a few more comments.

MR. BINGHAM: I almost hate to break the mood by striking a hopeful note. I want to link the word trust with the word courage and say to you take a sort of panoramic view of rail transit in the last ten years. We have, after all, somehow managed to evolve rail rapid transit systems, starts or extensions, in Boston, in the red line and orange line. In New York in the 63rd Street project. In Buffalo, Baltimore, Philadelphia, Washington, D.C., Atlanta, Miami, Chicago, O'Hare, and we have a working agenda of further activities and extensions in Baltimore, Frankfurt El consideration in Philadelphia, Atlanta, Phase Two and so on and so forth and I think that perhaps, this is an extraordinary pattern. I think, the most courage that has probably been shown in the transit industry is that stemming from political leadership. After all, the politicians have had to go to bat for this assumption of public responsibility for mass transit, the buy-out of failing private operations, the development of public authorities to steward transit operations and going into the political arena to get the appropriations of tough, hard money, in order to be able to fund this kind of continuing construction program. Part of the message we are saying to you is, we have a substantial wave of construction activity here in which the politicians have done their part. Perhaps, more thoroughly than the rest of us in this room have done our part and I don't want to see it come to the point where, having fronted for the politics of these construction programs and, in fact, having trusted to the transit operation and to the construction industry, now, somehow, to provide that high order of professional management and that deliverance of the best public bargain for transit construction, they find themselves, in effect repudiated by the quality by which that implementation is delivered. I think politicians are bold in playing their role. They are conservative in asking you to play your role. They are not technical people. They don't know how to answer the question of where the best technology is. They cannot, themselves, generate the ideas by which this best public bargain can be produced. I think they may be a more receptive audience for proposals from you. I think you can take the initiative to identify ways in which you believe this cost effectiveness can be achieved and advance those proposals to the political leadership. We may surprise ourselves as to the kind of response we get.

MR. MCFARLAND: Our time is running short. Let us close with one more question and resume this afternoon.

MR. RUBIN: My name is Bob Rubin. I'm an attorney in private practice often representing contractors suing your grantee. I direct the question to Mr. Pastor. Through the work of sub-committee number four of the U.S. Committee on Tunneling Technology and GRAB, it has been concluded that adverse contracting practices and the unreasonable allocation of risks have contributed, substantially, to the increased cost of construction. I wonder, Mr. Pastor, what evidence you had that the consensus method that you described at the end of your remarks, is going to be effective at remedying these problems.

MR. PASTOR: Well, first of all, my reaction is, where is my lawyer. Probably one of the most difficult subjects is when there are technological alternatives and each one represents different risk. I'm not sure if I'm addressing the specific issue that you raised. However, I think you cannot escape to make subjective judgments whenever you make technological choices and there is no better known method to arrive at lasting technological decisions than the consensus method. Now, I don't know whether in legal interpretation this always holds up but I think the principle of expert testimony, for example, or the principle of adequate testing, or the principle of adequate look-see of those alternatives, the reasonableness of the decision, these are all principles that are recognized by the legal profession and I think we can't go much beyond that. There are practices which are rule-of-thumb practices that exist for decades, which says, let's provide a margin of safety or a margin of loading a factor of ten, a factor of five, a factor of three. Various industries, various constituencies, have developed various rules-of-thumb. I think just by getting them together and recognizing that a factor of three might be far more adequate than what the given application would ever call for. It is inconceivable to rational, reasoning, human minds that you can exceed that factor of three safety margin and bring about a consensus that that is adequate and that can represent a significant cost saving than sticking to the factor of five or to the factor of ten. I think these are the things I'm talking about when we are talking about consensus. Now this brings me to another thought I had. I think we have built in the past two years somewhat of a model that I would like to throw out. Some of you are participating in it on the DPM program. On the DPM program, we have reached a government, industry and local partnership which is probably unparalleled in the department. I sometimes feel sheepish by asking our local colleagues to come every month or every two weeks to a workshop but, nevertheless, I don't believe anywhere in the nation there has been as intensive an examination of everything that was done that relates to the future implementation of DPM's that might be relevant. We let down our hair. We had, in Morgantown, three series of workshops. We asked everybody who was in trouble,

BART, Boston LRV, WMATA, Morgantown, AIR TRANS, come and tell us what went wrong; soul searching. I don't think this exists exactly to the same intensity but I don't hear anybody looking at, let's get down honestly and say, why did WMATA move from two and one half billion to six billion, other than rhetoric. You know, the stretching of the time scale escalation, which is all true. But, I don't see anybody saying, let's see, if we had a chance to do it again, how could we save thirty percent. We are doing that on DPM. We are doing it with the consultants, with the locals, constantly and we are letting our hair down. It is impossible publicly, politically, to admit that we screwed up but many times, we are all human, we screwed up. Why don't we look at it? Where did we screw up? How could we do it better the next time? So, that's what I'm talking about when I talk about consensus, that there is a professional judgment called peer committee. We hear that all the time. Looking at our own thoughts so that we can come in court and support you with expert testimony. That's the best answer I can give you.

**CHARLES SCHAFFNER
VICE PRESIDENT
SYSKA & HENNESSEY
ENGINEERING**

MODERATOR

**ALAN F. KIEPPER
GENERAL MANAGER
MARTA**

OWNERS' POINT OF VIEW

**DAVID G. HAMMOND
VICE PRESIDENT
DANIEL, MANN, JOHNSON, AND
MENDENHALL**

DESIGNERS' POINT OF VIEW

**THOMAS TRAYLOR
VICE PRESIDENT
TRAYLOR BROTHERS
CONSTRUCTION COMPANY**

CONTRACTORS' POINT OF VIEW

QUESTION AND ANSWER SESSION

MR. MCFARLAND: There is a good session coming up this afternoon where we will be hearing the designers, owners, and contractors point of view in the question of reducing costs. The session this afternoon will be moderated by Mr. Charles Schaffner, Vice President, Syska and Hennessey Engineering. Mr. Schaffner.

MR. SCHAFFNER: It's good to be here with you. I think and the reason I say, "I think" goes back to when Ray Levitt and then Russ McFarland called me to describe this conference and try to get me to take on this responsibility. I very carefully explained to them that, after all, I had no experience in tunnel construction since I had spent most of my life in other areas in civil engineering and the more I told them how little I knew the more they told me that this is exactly what they needed which was the first time I ever heard anybody tell somebody that what they needed was ignorance to run a panel session. About the only other reason I would think they might want to have me here, and I hope George Ziegler will forgive me, and that is, I come from a town that successfully sold a subway twice and has been unsuccessful in building it once. Now, instead of the boy talking about the emperor having no clothes, the emperor himself has told you that he has no clothes, we'll get on with the session.

What the panelists and Russ McFarland and I would like to do is to spend as much time with you and having you discuss, ask questions and get answers to your questions. As Russ said, you're going to hear, theoretically, three different points of view but I would not be a bit surprised if they would jibe in many different ways in this whole process of the construction of rail facilities.

ALAN F. KIEPPER

The first speaker is Alan Kiepper who is the general manager of the Metropolitan Atlanta Rapid Transit Authority and, as such, is responsible for operating a fleet of almost eight hundred buses and building a sixty mile rapid transit system, the first fourteen miles of which are now under construction. Mr. Kiepper came to MARTA as general manager in 1972, which says that he's no neophyte at this, after having had an

experience in a number of municipalities, primarily in Richmond, in terms of management of towns, the last five years as City Manager of Richmond. He's a graduate of the University of New Hampshire with a B.A. in government and he also has a Master's Degree in public administration from Wayne State. He's a member of the board of directors of the American Public Transit Association and the Transit Development Corporation and he's received, of course, a number of awards for his public service, including the first annual award for distinguished local government service in Atlanta. Mr. Kiepper.

MR. KIEPPER: Thank you, Charles, and good afternoon. UMTA and MARTA have had a partnership that goes back really to prior to UMTA's existence, going back to the middle 60's when we received the first grants from the then transportation office in the Department of Housing and Urban Development for some early planning of the MARTA system. We have had, what I consider to be, an excellent relationship. As Charles points out, I've had a number of years of service in local government and have dealt with many federal agencies and the thing that has consistently impressed me about UMTA has been its unbureaucratic qualities. We've had consistent cooperation and support over the years and I think what we have accomplished can be attributed, largely, to that partnership.

I'm glad to be participating in this meeting today. I think we are at a significant juncture in the development of urban mass transportation systems and it is time that we took a look at the criteria that we need and I certainly salute UMTA for being willing to open itself to meetings of this type and to tap what knowledge we have acquired in the furnaces of every day life.

I wanted to start by showing just a few slides of the MARTA rapid rail system and its construction. I guess, first, to do a little bragging. Since I'm the only owner on the program there aren't any competitive slides that anybody will be showing you and, secondly, to establish credibility. We do have some experience in building a mass transit system and what I have to say this afternoon is based on that experience.

We are working on a sixty-three mile system which involves fifty-three miles of rapid rail construction and thirty-nine stations. We are building it on an incremental basis as is suggested by the new policy and, as a matter of fact, has been our policy and UMTA's as far as MARTA is concerned for some time. What we have under construction is the portion in green which is the core of the system, 13.7 miles and seventeen stations. (Figure 1) We have only one major contract left on that segment of the system, the Garnett Station, which is the southern most station on the system and we hope to award that before the end of this year. In yellow is an additional eight miles and seven stations for which we have design funds only and we are in design on all of that segment of the system. We have a budget of one

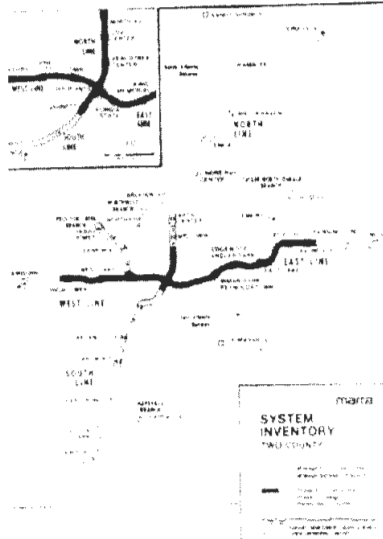


Figure 1

billion seventeen million dollars. As I'll point out later, MARTA was the first of the systems in the country to get a full funding commitment of eight hundred million dollars from UMTA for the construction of this system.

We plan to put this fourteen miles in service in three segments. The first seven miles in July of next year, another five miles in December of next year and the final two miles, which is the subway portion down Peachtree Street into the heart of downtown Atlanta, in April of 1981. I was interested in the comments this morning about the design or the concept of a system and the fact that the emphasis ought to be on at grade portions. My comment is that that is a little overly simplistic. The first thing that a rapid transit system must do is to realistically serve the transportation needs of the community and in most urban centers that's going to involve some amount of subway in order to get people where they want to go—into the dense urban centers, into the commercial centers of the community. I'm happy to say that we have less subway than any other major city in the country that's designing a system, to the best of my knowledge, with the possible exception of Miami. We have only ten miles out of the fifty-three miles. In this first section we have four and one half miles of subway, 3.6 miles aerial, and 5.6 miles at grade.

Ninety-five percent of our budget is new committed. Eighty-six percent of it is now under contract and sixty-four percent of it has already been paid out in cash to designers, contractors and others. We also have received all of the grants necessary to supply the federal funds. Again, because our program was accelerated and we actually exceeded our schedule and requirement for funds, UMTA actually speeded up the granting of funds to us so that we would not have to slow down.

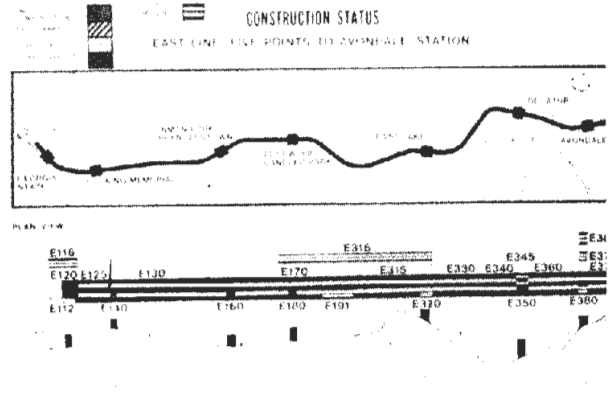


Figure 2

Figure 2 is a sketch of the East Line. The first seven miles showing the status of construction. Green means under construction and the horizontal line means completed contracts. As you can see, this total line is now about ninety-seven percent complete with just finishing actions underway. The West Line, Figure 3, radiates

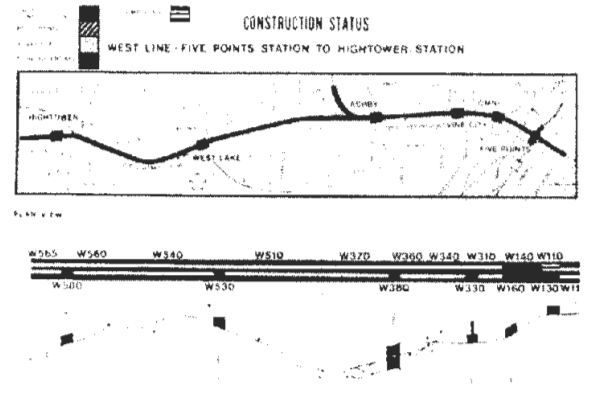


Figure 3

out from the west of downtown Atlanta. Because most of it is at grade, it actually shows a higher percentage of completion, although the station—the final finish in the stations—is not completed.

The most difficult part of our work is the North-South Line, Figure 4, in downtown Atlanta which involves about two miles of tunnel, about half of that is deep rock tunnel. The rest is mixed face and soft

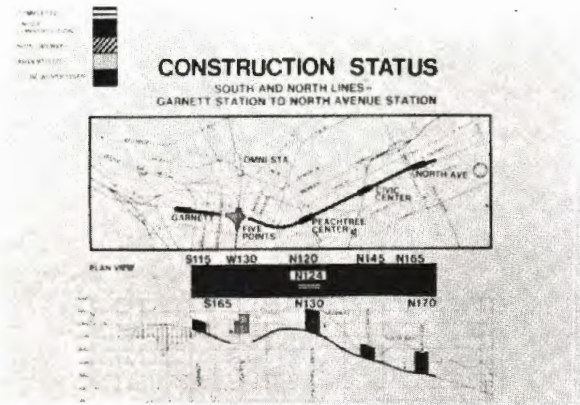


Figure 4

ground tunnel. The hard rock tunnel is currently underway. At its deepest point it will be about one hundred and fifteen feet below Peachtree Street. One of the by-products of rapid transit construction which is of interest, and particularly to the political forces in the community, is the surge of money that it puts into a community and we've been tracking very carefully the number of full time construction workers. We peaked at about twenty-six hundred last summer. We will now begin to taper off. (Figure 5) One of the real benefits of

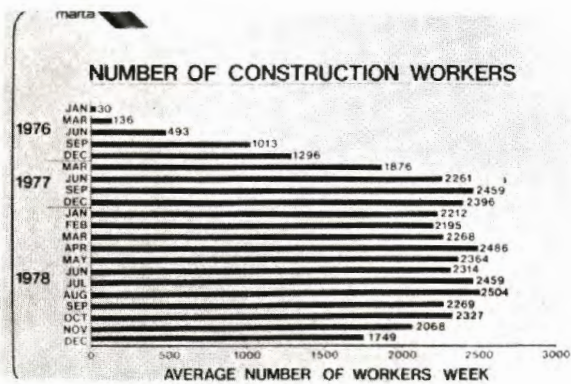


Figure 5

rapid transit construction is the fact that it does put a lot of money into the economy of the community in which it is being built. We've closed out ten contracts.

We've substantially completed twenty-one. We have fifty-five active contracts with a value of about four hundred and sixty-five million. We have two contracts on which we've opened bids but we've not yet opened them and we only have eight contracts left at a value of about twenty-five million for the phase A system. Our total equipment and construction contracting will total about six hundred and forty-two million dollars. Figure 6 shows our Avondale yard facility which has been sized



Figure 6

for three hundred cars. We will have one hundred and twenty initially. I'll be pointing out in a few minutes some of the problems that I see in trying to keep initial costs of rail transit systems down. I think it's terribly important when you are building basic facilities like maintenance facilities that you size them for the future because it is extremely difficult to come in later and do it. You'll notice the aerial segments constructed here. These have been put in over the busiest part of the yard, the throat of the yard, to carry the track that will later go out to the east to serve two additional stations. If we were to try to come in over the throat of the yard and put in these structures at a later time, it would be extremely costly and very disruptive to our operation. While this is a good example of the kind of cost trade off that you have to make in the early stages and sometimes those kinds of investments are very good even though they do increase the initial cost. Another shot of the throat area, Figure 7, where those aerial structures were, in fact, built and our eastern most and terminal station, the Avondale Station, from which service will emanate next July. Our line parallels a railroad and, therefore, we have had to build pedestrian crossings over the railroad and adjacent to get to parking facilities. This is a shot in downtown Decatur, Figure 8, and our station runs under this area and on the top of the

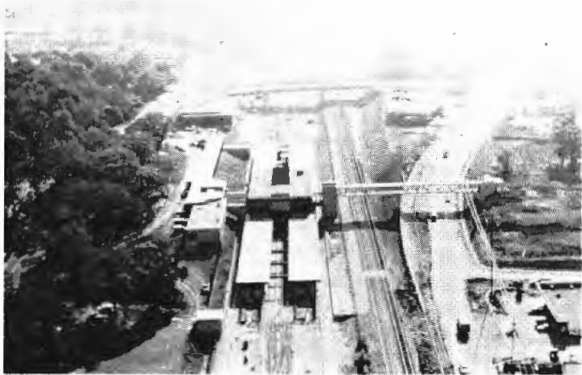


Figure 7

station. The city of Decatur has built a beautiful civic mall which is now being landscaped and which will serve as a focal point for that community. Again, this cost us very little but by coordinating our activity with the city we've ended up with something that is aesthetically and economically very desirable for that community. Our line comes through and goes on down in



Figure 8

this direction. This is another cooperative project where our station is located at the lower level of two twenty story office towers being built by the state of Georgia and we will have an upper concourse that will serve these buildings. The public concourse will be at the lower level. We've tried to do as much of this as

possible to incorporate our construction into public and private construction. Figure 9 is a view of that under construction. This is the MARTA station which is nearing completion near Georgia State Capitol, Atlanta Stadium, and Georgia State University. It's a very centrally located station.



Figure 9

The center of our system is Five Points Station, located in downtown Atlanta. (Figure 10) It involves two square blocks of construction: the subway level north-south, east-west level, which is at the railroad grade, the concourse level and then the plaza level. This contract was about forty-two and one half million dollars and is about fifty percent complete. Peachtree Center



Figure 10

Station will be tunneled and it is being tunneled in rock under Peachtree Street in downtown Atlanta. This is Peachtree Street. Figure 11 shows the portal from which the rock is being taken and it is in this block that the Georgia Pacific Company will be building its new world headquarters. They have recently made a decision to move their headquarters from Portland, Oregon



Figure 11

to Atlanta and transportation access, both local and air transportation to the world, was the principal criteria on which they based their decision and their specific location was dictated largely by the fact that at this location there will be an entrance to the MARTA Station which will be directly connectable to their building. This is the kind of value capture and type of investment that, of course, we all look forward to in the construction of rapid transit systems.

At one point the subway comes out of the ground, goes over an interstate highway and then back into a subway configuration and this structure is now being built over our two major interstate highways in downtown Atlanta. Here are interstates which have been detoured. Figure 12 shows the structure being built. It's a rather interesting structure. They are using Verendeal trusses which don't mean much to me as a social scientist but I understand that means something to engineers. This is the Southern Bell Building, a forty-eight story headquarters for Southern Bell which operates the telephone service in the Southeast United States. Figure 13 is the MARTA station which is being built as part of the complex and here is the building under construction. Here is the MARTA station under construction. The two will be connected. There will be a direct connection into the building. Another example of how we tried to integrate the system. These are our transit vehicles now under test. (Figure 14) They are being



Figure 12

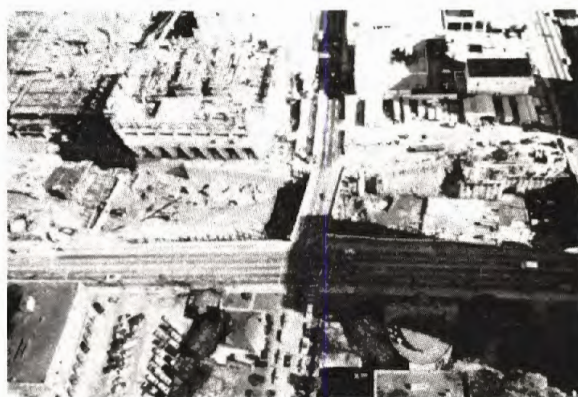


Figure 13

built in France and we now have ten of them in Atlanta with the rest in production and they'll be shipped to us on about an eight a month basis from this point on. Our next increment of construction picks up at the North Avenue Station and goes up to the Arts Center Station, a distance of about one and one-half miles and then goes from the south about one and one-half miles down to the West End Station which is shown here on the insert. (Figure 15) Our next increment goes up to the Lenox Station and down to the Lakewood Station. We now have an incremental plan for completing the entire system and the cost of our next increment, major increment, out to Lenox will be about half a billion



Figure 14

**SUMMARY OF UMTA
NO-PREJUDICE APPROVALS**

- CONSTRUCTION-READINESS FROM GARNETT THROUGH WEST END AND NORTH AVENUE THROUGH ARTS CENTER—\$29,384,000
- DESIGN-READINESS FROM ARTS CENTER THROUGH LEMOX AND ENVIRONMENTAL IMPACT STATEMENT FOR LINDBERGH CENTER—\$2,876,000
- ENVIRONMENTAL IMPACT ANALYSIS, DESIGN AND ENGINEERING FOR STAGES I AND II OF THE AIRPORT STATION AND AGREEMENTS WITH ATLANTA DEPARTMENT OF AVIATION—\$1,280,000
- OPTION TO PURCHASE 20 TRANSIT VEHICLES—\$14,440,140

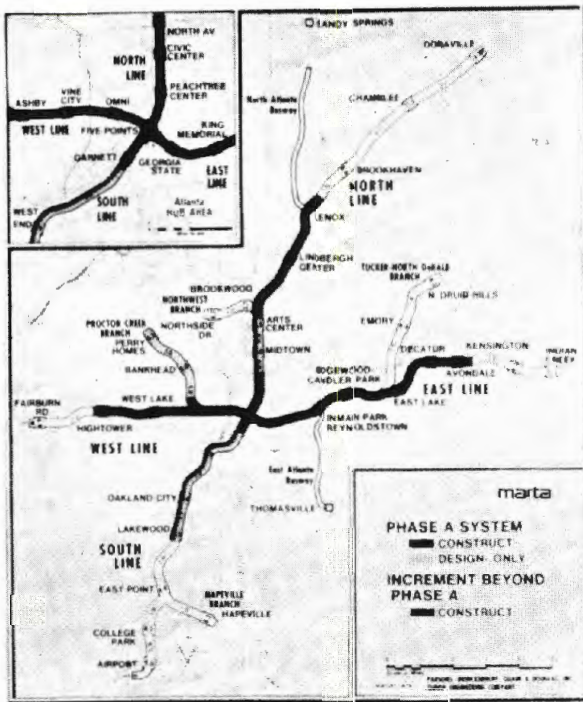


Figure 15

dollars. We're working on a number of no prejudice actions, which is one way we have of accelerating the work, putting our local money out front to build the shell of the Airport Station, because our new airport terminal is being constructed, (Figure 16) and to do construction readiness work. That's a term we have coined for everything prior to construction, land acquisition clearance, utility relocation. We're doing all of that in advance of the construction.

A few comments now on the new UMTA policy statement which is the principal reason for our meeting today. We certainly agree that rail transit costs need to be reduced. I'd put that statement in the same category

Figure 16

with "inflation needs to be controlled" and "the cat needs a bell." The question in those cases is "Just how do you go about doing it?" There has been an implication in a number of publications that somehow rail transit costs are special and they are escalating at a more rapid rate than other major construction costs. The information I've seen just doesn't support that. Highway costs are escalating at least at the same degree if not more than transit costs and, certainly, other major public works, dams, public buildings, et cetera are also escalating. There are some special things about rapid transit construction though, that cause the costs to get more than the normal attention. Rapid transit construction is new and somewhat exotic in the United States and, therefore, draws a lot of attention. The effectiveness in public acceptance of the new transit systems has really not yet been established. There is still controversy about every system that is either being built or in operation as I think you all know, although that situation, I think, is improving. They have been unprecedentedly large undertakings. MARTA is consistently characterized as the largest public works project in the Southeast since T.V.A. That's a favorite phrase of the news media. So, that tends to focus an inordinate amount of attention on costs. But, probably more importantly, the financial accountability for transit projects is substantially higher than it is for other public projects and this came about, I think, as a result of the fact that many of these projects have come about because of referenda in which cost figures have been put out in front. They've been conceived at almost the conceptual stage of design and almost invariably have been exceeded. You get locked into figures that you must put forward in order to get public support and then when inflation causes you to go over those you tend to get

your ears boxed. So, for these reasons, I think the cost of rail transit in particular, gets an inordinate amount of attention, although it has not escalated any more rapidly than other major public works projects. In spite of all this I certainly believe that rapid rail costs can be reduced. The question is, will the UMTA policy statement really contribute to that and I'm not so sure that it will.

First of all, it proposes that an Office of Program Management be set up to review design, plans, standards, specifications, contracts and procurement processes, et cetera. Well, if this is going to work it is going to require a staff of very highly qualified experienced people and the facts are, that people who are very highly qualified and experienced in rapid transit planning and construction are simply not available. As one who, over the last seven years, has had the responsibility for assembling a staff, both directly and indirectly through our general engineering consultant, I can tell you first hand that they are in short supply and they demand a very high tribute. They are very mobile and what we're doing now is sort of trading experts with other cities that are coming on line. I don't believe that there are enough of them to go around to properly staff the Office of Project Management as conceived in the policy statement. The bottom line is that any process that is developed has to take into consideration that we have a very limited number of experienced people who can exercise the kind of judgments that are proposed in the new policy. We're not likely to increase that number markedly, in my opinion, in the immediate future and I think that needs to be taken into consideration in any policy, because the policy is no better than its implementation.

The policy statement also deals with incremental development and I think we all agree that transit systems should be developed incrementally. It should have a starter line and then add to it on some reasonable basis but how do you increase the capacity of a given segment? The only way I know how to do this is to lengthen the trains and to decrease the headways to get more capacity out of the same track but this presumes that you build the system initially with longer platforms than you need in the initial stages and that you have a train control system that is capable of developing headways that are less than you need initially. So, that very assumption starts out with a presumption that you are going to build in some capacity growth and I think that this is the only sensible way to do it. It's not practical or cost effective to develop systems incrementally in terms of capacity as far as physical facilities are concerned.

For example, we are building all of our station platforms 600 hundred feet long to handle eight car, seventy five passenger per car trains. We will be operating four-car trains initially and then gradually build up to eight-car trains. We probably won't operate eight-car

trains for at least ten to fifteen years. So, we're going to have a substantial investment in unused platform capacity but, what's the alternative? To go back into stations and add to the platform at a later time is very, very costly. It is almost impossible in subway stations and it is close to impractical in at grade and aerial stations without significant interference with operations. So, I do think that the very nature of rail transit and, one of its greatest benefits is the fact that it does have expandable capacity, but inherent in that is that the front end cost must be higher.

Now, having said that, I do think there are some things that can and ought to be done to lower the cost of rail transit. One is that I believe the time has come for UMTA to develop and issue a set of design criteria for rapid rail systems. Several years ago, the Institute for Rapid Transit took a shot at this and did issue some criteria. They were very helpful. They were used by our engineers for the MARTA system and are still being referred to from time to time. I believe we have enough current experience in San Francisco and Washington, Atlanta and Baltimore and in some of the extensions to older systems, to now begin to develop a set of guidelines for design and I believe that it would help control costs. While I don't think that specific designs can be mandated, the guidelines, if they were established and required to be followed, would be utilized by local agencies and I believe would help cut costs. Secondly, I think the time has come to move toward, take some definite steps, toward the standardization of rail car design; maybe not one car but perhaps a family of cars. We know that some of the older systems have restrictions on the exterior dimensions of cars because of old tunnels that have to be taken into consideration. We've had a very good experience in this country with standardized design of a rail transit vehicle. The old P.C.C., President's Conference Committee, trolley car which was very successful. I don't think there is any need for individual cities to insist on their own unique design in every respect. We were guilty to some degree of this but there really wasn't a standard to which we could go five years ago. I think with the evolution of the MARTA car and the Miami and Baltimore cars that we are now at a point where we could develop standardized criteria for rail cars and still allow reasonable flexibility to meet specific local conditions.

The third suggestion I have, and this is consistent with the new move toward the Surface Transportation Agency, is that the Federal Highway Administration or the new Surface Transit Administration ought to absorb some of the reconstruction of highway costs associated with transit construction, out of highway funds. We are spending many tens of millions of dollars of so-called MARTA rapid transit funds to improve highways, to relocate them, to expand their capacity to current standards, all chargeable against the rail transit system but, in terms of the functional use of those

dollars, they are really to improve highway transportation, and I believe that our costs, directly attributable to rail transit, could be lowered somewhat if some of those costs could be put properly under the highway category.

A fourth suggestion is that I think consideration should be given to UMTA or the Surface Transportation Administration possibly getting on an excess coverage basis, into construction insurance. We expect to spend almost forty million dollars for insurance for the MARTA project under a wrap-up program. I think those costs are far too high. The losses, particularly in the liability area, have been extremely low, and while even under a retrospective rating policy we are getting some refunds, I think the costs are still too high and if there were some means of federal reinsurance on an excess coverage basis, I believe that could result in lower costs.

A fifth suggestion is that we ought to do more critiquing of construction at the time it is completed, when the lessons of a particular segment of construction are fresh in the minds of the engineers and the contractors and the local government officials, to see what experience we can draw from that particular construction. We're giving serious consideration to this in Atlanta. We are about to complete a seven mile section which has involved some twenty-five to thirty construction and equipment contracts. We made a lot of mistakes in that construction. We need some systematic way to record those problems so that we can crank them into future design and construction, not only in Atlanta but, hopefully, in other places as well. In the public area we do a very poor job of recording and critiquing our experience. In most cases, I guess, it's been so painful that we are very glad to close the book on it and not think about it but I think we lose an opportunity to learn from our experience when we don't do that.

Overall, I think the UMTA policy is moving in the right direction. We do need to simplify, standardize, and expedite rapid rail design and construction but in our zeal to do this I hope we don't set up a system with so fine a screen that nothing gets through, and we may be doing that. Let's remember that this country desperately needs new and better rail transit systems. Consider the news for the last week. The crisis in Iran. The slowdown in oil production and the difficulties that that is already causing. The rationing of gasoline by two of the major suppliers, Amoco and Shell, and the rise in gasoline prices about three cents expected over most of the country. Secretary Adams, on the Today Show this morning, predicted one dollar gasoline within the next two to three years. All of these actions sent tremors through the country and I think they serve to remind us that the mobility of our nation hangs on a very slender pipeline and any system, process, procedure, or policy has to take this into consideration. We need to be promoting improved mobility. Yes, on a cost

effective basis but let's not set up such strict standards that nothing gets built. So, while we are striving to cut costs let's not lose sight of the goal which is, in my opinion, to provide mobility for the citizens of major urban centers in a soon to be energy starved world. Let's be sure that the cure for past ills doesn't also frustrate those goals.

One last point. We've been talking today, and probably will for the rest of today, about urban rail transit systems as if they were primarily engineering and construction projects that can be conceived and executed by highly trained professionals using totally objective criteria. Well, you and I know that that just isn't true. That most rail transit projects are, essentially, political projects. They came into being as a result of political actions and political tradeoffs. MARTA exists because there was a referendum on public transportation and the success of that referendum depended on some very practical political tradeoffs in the community in order to get the system and the sales tax approved. Political projects rise or fall because of local political support and demands and in this context, at the local level, what we try to do is to desperately keep our projects alive and growing and continuing while doing the best job we can to institute and implement cost effective principles of design and construction but we're dealing, essentially, in a political world, and any new policy or system that is developed must take the essential nature of these projects under consideration.

DAVID G. HAMMOND

MR. SCHIAFFNER: Thank you, Alan. I think that last comment was particularly appropriate. Our next speaker will talk from the designer's point of view. David Hammond got a BS Degree in Civil Engineering at Penn State and a Master's at Cornell and has also had advanced studies in the army. After twenty-five years of varied experience with the Corps of Engineers he became Assistant General Manager, Engineering and Operations and Chief Engineer for the Bay Area Rapid Transit District from '64 to '73, where he was responsible for the design, construction and initial operations of the billion and one half, seventy-five mile

system. In '73 he became DMJM's Vice President in charge of Rapid Transit and Transportation of the eastern region where he is Vice-President in charge of the DMJM sponsored joint venture general consultant of the Baltimore Rapid Transit System. He's responsible for the planning, preliminary engineering and final design of section A, a seven hundred and twenty million dollar project; now under construction and scheduled for revenue operation in '82. In addition to that job which seems big enough alone, he has three or four other responsibilities, including the interesting one in Morgantown West Virginia. Mr. Hammond was named one of the top ten public works men of the year in a national program co-sponsored by the American Public Works Association and Kiwanis International and he's Vice Chairman of the United States National Committee on Tunneling Technology. Dave.

MR. HAMMOND: Thank you, Charles. As Charles has said, my assignment, at least according to the agenda, is to present the designers viewpoint, but I find this very difficult to do for reasons that have been referred to already, because I certainly don't prefer to think only as a designer or to be limited to "design" functions. Designers, very obviously, in my view, have to think in part like owners because, in the main, they operate as extensions of the owners doing what the owner would do for himself if he had the time and the capabilities for doing it and, certainly, to a large extent, a designer has to think like a contractor when he is putting together the designs and the specifications and the other parts of the contract documents. While divisions by titles are somewhat natural, of course, I believe that a large part of the many problems that we're talking about here that face rail projects in, first of all, getting approved and then designed and then built, is the adversary attitudes of the different members of what should be one team.

I don't think I, or perhaps anyone else, can presume to speak for all designers but I think all designers would agree with this view that, in the screwing up process that George Pastor referred to this morning, there are always other participants. Quite frequently to the extent that we don't recognize our own child sometimes.

We might, in pursuing the team concept because I think it is an important one, use the analogy of a football team with UMTA very much like the team owner who puts up the money and who makes the game possible. The grantee, then, would be the general manager who hires the players, who provides broad management, and who brings the operating team together, which leaves the designers, the consultants and the contractors then as the players with individual disciplines but who have to be part of the overall team's role. A well run team is a well disciplined team with each player having a responsibility within the limits of his authority, but nevertheless, a responsibility to play

his role, not merely as he is directed, but with initiative, imagination and with vigor.

Well, let's get down to discussing the UMTA's policy options paper which is the primary thing that brought on this conference. The notice of the meeting says that policy options are primarily aimed at one, improved project definition, two, improved project management, and three, improved review processes. It is also stated somewhere, that it is intended to cut the red tape. I heard someone say the other day that UMTA was good at cutting red tape and, of course, he was an UMTA guy. When I mentioned it to somebody else, however, he agreed, but he said, "The only problem is that they cut it lengthwise."

I would, at the outset, however, join other people in commending UMTA for recognizing the need for significant improvement in management and procedures and for initiating action toward improvement. I may be less generous with some of my comments later on in how they appear to be going about it or how they visualize the many hurdles that are going to have to be overcome in order to achieve it but the first step, at least, is a very good one in recognizing the need and expressing a determination to do something about it. And, certainly UMTA's leadership in defining criteria and in practicing better management and, at the same time, requiring grantees and their designers to do the same, are welcome goals that we all ought to address. How to get there is what we are here to talk about. The policy paper discusses several procedures and I'll touch on them a little bit in detail later on, which certainly ought to be improvements, but I think one thing that has to be said is that it is important that great care and attention be constantly given that these procedures not become ends in themselves rather than means to an end and I don't think I have to elaborate for this audience on why I make that comment because the temptation is always there to have the media be the message.

As I see it, UMTA's role, having established the criteria and general procedures, and assuming that that can and will be done, should be to monitor the way, the direction and the speed with which the projects they are reviewing and supporting are carried out. This has been touched on and you'll note that I will touch on it several times in my discourse here, that UMTA's monitoring must be tailored to its capabilities in exercising its control. If they are able to achieve sufficient staff and means to meet the needs, then they can establish more specific criteria and can monitor in greater detail than if needs and means are vice versa. Since it's very likely that the vice will be versa their control and their monitoring then is going to have to be tailored accordingly. I believe, for instance, that UMTA should not and cannot issue a detailed design manual applicable to all or even several projects whose physical as well social and political problems are different. That

doesn't mean, however, that it can't establish broad criteria and levels of quality that it considers acceptable. Perhaps as a starter, the set of guidelines that Alan mentioned here that were prepared some years back by IRT, which is now a part of APTA, could be used as a guide for UMTA to start with.

Certainly, UMTA can be helpful in either accepting as high cost factors, or attempting to get modified, the many federal requirements such as, OSHA, Minority Business, Buy American which has recently come into the act, "hysterical" preservation and provisions for the elderly and the handicapped. To the designer and the owner many of these are embellishments and not needs. Now, lest I sound unsympathetic to the elderly and handicapped, let me assure that as a member of at least one of these categories and I understand the push to provide for them. It does have to be recognized that factors such as these have much to do with the high and with the increasing costs of rail transit projects and the option is either to accept them as a fact which nothing can be done about or as, somewhat encouraged, I heard this morning that attempts in certain areas at least will be made to alleviate these rather odious, and certainly, costly requirements.

The policy options paper speaks much of cost effectiveness but it doesn't define it. Certainly, a clear set of guides or ways in which cost effectiveness will be measured would be a big forward step, but obviously it's a difficult one to achieve. One man's cost is another man's effectiveness, and the reference that's been just made to the elderly and the handicapped provisions is a very good example. To us, it's a cost. To the people who are pushing it, it's an effect which apparently is desirable at any cost. It has to be recognized that at the local level, codes, ordinances and desires of other bodies than the transit agency which have long been unfunded, but which now appear as if they could be tacked on to the transit project and other requirements are imposed that the designer, left to his own devices, would not consider providing for. Here UMTA guidelines could be effective both ways in establishing the basic requirement, but also in later support in sticking to the concepts on which the funds were based and assisting the local agencies in resisting the attempts to have additional things hung on the Christmas tree.

In addition to design criteria, and this part has been touched on also, procedures for contracting, and for contract provisions need to be examined. The report of Sub-Committee Number Four of the National Committee on Tunneling Technology was mentioned this morning and I won't ask for a show of hands here of how many people have ever heard of it before to keep from embarrassing both you and those of us on the committee who put it together, but it is an example of what Art Fox mentioned of the difficulties in communication. This is a publication which is at least four years old now which the final conclusion of the sub-committee was that we've not done our job if we've merely

convinced each other. We must go out now and educate the people who make high policy and set grand strategy as to the merits of these recommendations on how to improve contracting procedures. I was at a session recently which was made up mostly of people who operate in the design and the contract construction area, in which someone mentioned this report, so I asked how many people knew what he was talking about and out of about seventy-five people there, six did, four of whom were on the committee who put the report together in the first place. So, it is a continuing effort, but it is an area that very much goes with the possibilities for reduction in costs.

An important part of design is what kind of a contract package you put together. What kind of specifications, what sort of requirements or limitations do you place on a contractor. It has an effect on cost, and this is undoubtedly beating an almost dead horse, but anyway, the low bid procedure. It's certainly difficult to establish low-cost designs and contract specification requirements for difficult things such as tunnels, complicated train control systems, and vehicle systems, if you have no idea who's going to be the contractor and who's going to be carrying it out. If the designer were pretty sure who the contractor was going to be, or at least that it was going to be limited to somebody who had demonstrated experience and competence, he certainly would call for things that would cost a lot less than if he's got to cover any eventuality that might occur to an inexperienced or an incompetent bidder. And, again, this gets back to some of the recommendations in the Better Contracting Practices report. A low bidder is presumed, under our general rules, as being competent if he can get a bond which may or may not have any direct relation to his ability to do what's called for under the terms of the contract.

Getting back to the options paper, I believe that the establishment of an office of project management can be a significant improvement if it sticks to establishing criteria, general procedures, policy guidelines, and if it does its monitoring and controlling for forward progress rather than braking. In the case of establishing approval or disapproval of contracts that might include coming early to a no decision, that no, we are not going to support a project as well as an early decision, yes, let's get on with it. Certainly in the conduct of that office it must avoid the OSHA experience, although I do understand that OSHA is now holding a "going out of other peoples business" sale. As stated in the paper, the functions visualized for the office appear appropriate. Again, I have to get back to what I said I would refer to several times, that UMTA has to tailor what it does to its capabilities to do it. One of the contemplated ways seems to be to call on other transit agencies, individuals, other federal agencies, professional organizations. I believe there is some reference to peer groups, peer review groups. All of these sound as though they would be nice and easy, and let's say that that solves the

problem. Let's take peer review groups for instance. Unless somebody gives the peer review group its clear charge that you're not here to start all over again and do it the way they would do it, you are likely to have the opposite result. More often than not, peer review groups consider that their charge is to show that it could have been done some different way, not necessarily better, but different or, worse than that, they become reviewers of how does the project appear. And, if I seem to be speaking from bitter experience, I am. We've had a peer review group on the Baltimore project and they certainly had lots of comments, none of which reduced the cost, and I won't go the next step but you can decide that yourself. So, I find it very difficult to visualize how this can work effectively, nor how it can be cost effective in itself with that kind of fragmented approach. It doesn't seem to me that this kind of service could be readily available when needed, nor that they are likely to come for free or if they do, that they will be worth the cost. It seems to me that it would be much better for UMTA to hire a consultant or a group of consultants to function as extensions of its staff in the same way that consultants hired by transit authorities or other owners work as extensions of the grantees staff. I think you'll have to agree that this is a designer's viewpoint. But it certainly has some genesis within your own department because the Federal Railroad Administration is doing something similar to this on its Northeast Corridor Project, presumably for somewhat the same reason.

I mentioned earlier, the transit industry itself has done some assembling of guidelines criteria and standards specifications. Granted, that was started for a slightly different purpose going back to the law suit bit, so that you could at least prove in the law suit that if we did it wrong so does everybody else in the industry. Nevertheless, it could be a very good starting point for adoption by UMTA or modified by the UMTA staff, or the suggestion I made, a qualified group of consultants. Certainly, a general body of accepted criteria and guidelines has to be available to all agencies who are trying to put together a project and a grant application for that project. The reasonableness of a project, of course, has to be tested on a project by project basis, but the yardstick by which that measurement will be applied must be known to prospective grantees as they are starting to put the project together. It doesn't do any good to let it run on for a long time and then say, "Oh no, you didn't use the right set of measurements here and so we're not looking at the project the same way that you do."

Certainly, with incremental funding, and Alan has touched on this so I won't go into it too much, but in defining the stage of a project it is imperative that the limits of the total project being considered be made clear. The UMTA policy states that the system be approved in stages one segment at a time with federal

financial support limited to that stage of the project. While this is probably appropriate in view of the limited funds that are available for all projects is to get as many going simultaneously as possible and perhaps, most important of all, to be sure the wealth is spread around as much as possible. As Alan has said, projects cannot be properly designed and costed stage by stage without some idea of what the nature and number of stages is going to be, and what the ultimate configuration of the system will be, and he gave you some examples of things that have to be costed for cost effectiveness in the first stage if you are contemplating extensions at any time.

Maintenance problems such as shops can be more economically provided if the future extent of the system is known. In Baltimore, for instance, while we are now building an eight-mile first stage, we have had to consider the capability to handle additional stages which we hope will be coming along almost on the heels of the first stage and therefore, the time period of investment in these facilities that may exceed minimum requirements for the first stage, will not be such a long period of time. I noted, and quite naturally, in its paper UMTA addressed only the opposite side of this problem which is to be sure that you don't put anything in the first stage that is excessive to the requirements merely on the basis of area-wide future project plans, and I would agree with that, but it's like so many things, there has to be some recognition that there is an in-between.

Much has been said and done, not all cost or otherwise effective, on such things as alternative analyses, cost effectiveness and ultimate descriptions of projects and so forth. In principle, alternative analyses are certainly an appropriate method of studying what should or should not be done. Like all good things, that can be carried to extremes. It would appear, both from past practices and from the words in the policy options statement, that alternative analyses are expected to be made in great depth and detail, whether that depth and detail is necessary or not, in cases where the solution based on physical and political situations appears to be very obvious. From some of the comments made this morning there appears to be some hope that UMTA will develop guidelines and criteria for alternative analyses in greater, somewhat more realistic detail and apply it in its review as well as to the reviews of others.

I believe the proposed incorporation of the new step system definition is a very good one, if implemented as described and to a reasonable schedule, and somebody asked that question earlier this morning. It will give both UMTA and the grantee a better basis for carrying out the subsequently approved project. But, again, I have to put in the caveat that it has to be a means and not an end in itself. At some point there has to be a conclusion to the navel contemplating and a decision as to what the next step is and how we're going to get on with

it. This is particularly important to the grantee in view of the UMTA full funding policy. While I agree that this is a proper policy, I find the term somewhat amusing as a euphemism for "it may not turn out to be very full but it's as full as we're going to make it." I was interested to read a little poem the other day which is entitled, "Play it Again, Uncle Sam." I think this may be appropriate to bring to focus for all of us whose costs we're talking about here. They're always saying federal funds. You hear it all the time. You know there are no federal funds. They are using yours and mine. So we have to, all of us, remember that we're not talking about how we can get federal funds for this. There is no such thing.

While the system definition step could conceivably, and very probably will, lengthen the grant approval stage, it should certainly shorten the implementation of the resulting project. I believe that it is an even more important step than the design concept stage or any of the details of design on which so much discussion has already been given.

I'm particularly glad to see that UMTA is attaching much more importance to how the grantee proposes to exercise his general management function, how he will organize his staff and how he will set up the organization of organizations that he will use to assist him, what contracting policies and procedures he will use and in general, how he will get on with the project. Not stated, but I presume that it can be taken for granted, that now UMTA is equally interested in reviewing its own internal processes as to how it will manage its functions, how it will organize its staff, how it will organize its organization of organizations in making the establishment of criteria and the review and monitoring of projects. I think it's interesting to note that UMTA's new approach fits very well with the major recommendations of the National Research Council report about to be published which is entitled, "Better Management for Major Underground Projects." One of the principal conclusions of that group, however, was that the title should be, "Major Underground Projects," because that's where the funding came from, and I'll give a nod to DOT and to UMTA as the principal sources of funding for making this study, and that the conclusions and recommendations that came from this study are equally applicable to any large scale project.

Very briefly, the major recommendations go somewhat along the line as the approach outlined in UMTA's policy options paper. First of all, to establish the policy's goals and objectives and to organize the project so as to facilitate their accomplishment. In other words, start with, what is it that you are trying to accomplish and what kind of an organization are you going to have to do it. Plan the project in enough detail to be able to achieve the objectives. The next is to achieve effective design organization, supervision and accountability, and that was touched on somewhat in

the discussion period this morning also; to achieve effective construction methods, procedures and supervision.

It's been said that UMTA's role is much like that of a mortgagor on a house or other construction project, and I'll admit that I stole this idea from Chuck Bingham so I think it is one with which he might agree. As the mortgagor, he wants to know not only the purpose and the function of the project, that is, what effect will it bring about, but how it is going to be accomplished, how is it going to be organized and managed. What contractual procedures, design procedures, what schedules, what are the estimates of cost, what financing by others, if any, is involved? So, as the mortgagor he wants to be reasonably sure that his money is going to be well invested and the project that he is backing is well managed, designed and constructed. However, when his decision is favorable and he's going to back it, then he should look to the mortgagee to execute the project he has funded. I think it's much like picking a horse and putting your money on him. After you have checked the racing form and you've given your approval by putting your money on a horse, project, and the jockey, the grantee, then you had better let the jockey ride the horse. When I mentioned this to a grantee, or at least somebody who is a hopeful grantee, he said, you'd better add, and don't get on with the jockey and ride with him. Now, that doesn't mean that you can't cheer him on or yell at the jockey if he's falling behind the pace, or certainly not bet on him next time around. This does emphasize to me at least, the role of UMTA is very properly wanting to know that the concepts are and how are the job's going to be managed, organized and so forth, but at some point and to some schedule it must come to the conclusion that it's either going to hack that horse and jockey or it's not and, if not, then put its money somewhere else. If it is, then get on with it. So, I see, as a big function, the project management office holding their own and everyone else's feet to the fire to get on with things and to reach timely, firm, decisions. This is not a one-time but a continuing effort. It's necessary for whoever is a manager, and there are many managers in this long process, so quite frequently it is necessary to build a fire under the mule. (Figure 1) However, having done so you can expect that he is going to move far enough to get himself off the fire and pull the wagon over it, (Figure 2) so it's a repeat process which is necessary but I consider this to be one of the more effective, although more general, ways in which cost reduction can be achieved and that is, for everybody involved to have a gung ho approach that we're going to get on with it and we're going to do something.

Once the general concept of the project has been established then the greatest single factor in costs, either holding them down or incurring more than you should, is whether needed decisions are made at the



Figure 1

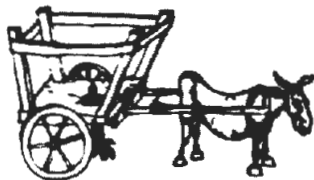


Figure 2

proper time. Some of you have probably seen this illustration (Figure 3) of decision making which is all too frequent in this and some of our other business. We have long meetings. We bring in all the experts and we all agree that immediate and decisive action is necessary and let's get together next month and talk about it some more and that very much is a factor in the cost of projects. In big, complex, projects such as we're talking about here, the point is often reached where no decision can be as bad as "no decision" and in case that doesn't seem to scan quite rightly, it merely means that you reach a point where whatever you decide, you are better off than if you haven't decided. Similarly, I think

the project delivery plan setting forth how the project will be done is a good new requirement. With careful attention to it by both UMTA and the grantee, it should form a good basic understanding for implementing actions subsequent to grant approval and funding and, hopefully, mean less involvement in the minutia of how the project is going to be implemented and fewer controls that are designed more to keep something from happening than to require that it happen.

Different levels of design, depending on how many unknowns there are; for example, underground, project conditions versus above ground projects should also provide for more realistic cost estimates at the initiation of the project. Note that I said, "realistic" and not completely accurate because, at this stage, there are still many uncertainties that involve either unknown but probable events or things that are uncertain enough to be unquantifiable with any degree of certainty. So, both grantee and UMTA, plus the designer must make some allowance for this in early estimates even where a higher than usual amount of design has been done. The hazard in this is obvious both ways. If you make it too high in order to be on the safe side, then you may well price yourself out of the game before the game even starts. If you make it too low, it may be attractive except that it comes back to haunt you later on because you are unable to do the job for the price that you said you could.

We come now to everybody's favorite, the EIS. I'm not going to belabor this one because it has been touched on by a number of people. I was interested in first reading it and mentioned it to several people, to have them recoil in horror that, my God, you mean we have to do that twice now. Actually, I see it as it is set



"The motion to take immediate and decisive action was tabled and next meeting..."

Figure 3

up here as being an improvement. It should facilitate the first one and assuming you get by the first one it should facilitate review and approval by UMTA and whoever else has to be involved in it much more rapidly. Certainly we have to get away from what has been the experience on a recent project. We had four months to prepare the EIS and twelve months were scheduled for review by others. We met our schedule! The key, as I've said several times, as I see it to UMTA's role, is how they will review and monitor the prescribed processes, the processes they prescribe and what their definition of monitoring is. As I see it, their role is laying out the ground rules, to see that they are being followed and to get in and admonish, interfere might be another term, only when the ground rules are not being followed. To repeat my commercial, UMTA can do this effectively only if they make their own involvement compatible with their immediately available capabilities. I believe that there are ways in which to achieve your capabilities, but I don't believe that they are going to be in the route of direct staffing.

To go back very quickly and wrap up, the UMTA overall objectives, that is, to prevent overdesign, the introduction of unnecessary embellishments, and the use of untested technology. Here I believe UMTA can be most helpful to grantees and designers by achieving the capability that we have discussed several times and by issuing criteria as to what constitutes, in their view, adequate but not overdesign. What sort of things it considers embellishment and by, if not endorsing, at least not condemning tested technologies. For the designers it should be both a relief from criticism for doing something that has been done before and less of a liability from his temptation to do something untested just to show how innovative he is. I believe at the same time, however, I think George Pastor discussed this very adequately this morning, that UMTA should continue controlled practical use demonstrations and, certainly, designers and owners should participate in practical use demonstrations of new but not radically new technologies at UMTA's expense and to the extent possible, at least, at UMTA's risk. I believe a good example of this perhaps will be touched on by the next speaker here, which is our concrete tunnel liner demonstration in Baltimore. It is one that holds good promise for cost reduction but it also, without this demonstration, I think, held the promise for a fair amount of catastrophe if it had been mandated for widespread use without really knowing what was involved in making it work properly. Well, in summary I think the policy statement is on the right track. Like all puddings the proof will be in the eating. I've tried to point out some possible pitfalls in its implementation. The biggest will be the temptation to make the procedures an end in themselves and keep on proceeding with the procedures rather than proceeding with the project. Proper execution, however, of the proposed policies

and procedures will certainly be of help to designers and owners in enabling them to prosecute worthwhile projects of the type which Alan Kiepper has described. There are many around, and we certainly cannot say that we should quit right now because all of this costs so very much.

I guess, in summary, I am saying that I commend UMTA for having its heart in the right place. I trust now that you will be able to get your head in the right place.

THOMAS TRAYLOR

MR. SCHAFFNER: Our next speaker, Tom Traylor, got his Bachelor of Science Degree in Civil Engineering from M.I.T. and an MBA from Stanford. He, of course, will speak from the contractor's point of view as Vice President for Traylor Brothers, Incorporated, who constructed over thirty miles of tunnel in the United States, over ten miles of which have been in compressed air. They worked at BART, worked in Chicago, Washington, where they have had particular success in limiting settlement under difficult situations and in Baltimore, as Dave just mentioned, where they are working on the concrete liner project. A good friend of mine and a classmate, as a matter of fact, and a man many of you know, George Fox, is a partner of Tom's in the Baltimore project and I talked with George last week and he said that I should pay strict attention to what Tom says because he knows what he's talking about so I would advise you to do the same thing.

MR. TRAYLOR: I am glad to see Dr. Page here today. He is young and has the zeal to get things done at DOT. It takes energy and plenty of it to accomplish any cost cutting changes where a public agency is involved. We are all here today to help in this effort.

Dr. Page's youth also makes me feel that I am not too young to be here and contribute a little bit of something.

I do not know that a contractor's point of view is a significant one at this conference. Russ did not invite me here today because we are good contractors. We Are! He brought me here because my position allows a sort of objective view of the problem. We work with

the results of owner and designer efforts. The key decisions are made before we become involved. We do not have an axe to grind, or a viewpoint to justify, so we can call a spade a spade. I am inclined to suggest extreme measures and I may view reality in an exaggerated fashion, but we need to over-react if we want to effect changes.

The problems that we run into as we try to improve cost effectiveness are often regarded as institutions. We accept them and give up the fight. I am probably one of the worst when it comes to fighting institutions. It is difficult for me to view problems and solutions through the eyes of a DOT Administrator, a Congressman, or a President. I have found in my preparations for today that I can't seem to envision myself in public service, and find it hard to relate to solutions that involve bureaucracies. In order to gain a productive perspective for this presentation, I have struggled with a theme, or an attitude, and I concluded that I really know what should be done, but have trouble with the reality of politics. My solutions would be effective, but would not always be politically popular.

So, ignoring political difficulty, I would organize my cost reduction efforts as follows:

1. Correcting wasteful or overconservative design
2. Eliminating union manning provisions (feather-bedding)
3. Forcing legislation to limit insurance costs
4. Explore ways to further utilize the initiative of engineers and contractors to cut costs on an incentive basis (value engineering)

Design Control seems to be the most tangible solution to our problems. We are dealing with a problem that no one wants to admit exists, and that is designer incompetence. Errors in judgment by designers carry such potential liabilities that suggestions for improvement are often taken as an insult and rejected. You know, we will always have incompetent designers, as we do doctors. The professionals won't rat on one another, and no client wants to admit his poor choice after the fact. We must admit the weaknesses in this profession, and set out to monitor design with a competent review board.

In order to indicate the scope of potential design savings, I want to relate a few personal experiences.

On the WMATA system, a bid item was invented early in the program called Cat II Underpinning. Designers were not competent to decide where underpinning was appropriate and so in questionable areas they failed to specify, but also failed to take the responsibility for their decisions. This Cat II underpinning was meant to be a catchall for all omissions and errors of judgment by the designer. Today in Baltimore enlightened engineers specify underpinning or ground control measures, and provide cost plus funds for restoration of buildings where underpinning was deemed undesirable or too costly. When the designer properly

recognizes possible structural damage as a viable cost alternative, and provides funds to cover these costs on a direct basis, he saves the administrative costs of insurance claims that would have resulted and a lot of headaches.

When I was a sophomore in college, the great Dr. Peck walked in and gave us a lecture one day. He was visiting from University of Illinois. He drew a little picture on the wall to demonstrate that in a fairly deep soft ground tunnel the forces finally come to near equilibrium and that there is little or no residual bending in the structure after some yielding of ground and structure takes place. All these years later we get a contract (G-1) with WMATA to dig a tunnel through a nice big hill of clay, an ideal application for the long accepted theories of Dr. Peck. But as the tunnel got deeper and deeper into the hill the density of reinforcing steel increases and vice-versa. Some designer had thrown those bars in for extra measure because he thinks they only cost thirty cents a pound. But that's not half of it! The construction of the entire tunnel liner is made less efficient by the existence of those reinforcing bars.

In Buffalo on new NFTA work, there are no unneeded re-bars, but a required construction joint between invert and arch is being arbitrarily insisted upon. This is more costly than one might think!

In Washington on D4 and F2a our contracts involved two miles of subway. To construct those two miles we were required to set up tunneling shields at ten different locations. These tunnels could have been driven right through the stations, leaving only an inexpensive temporary liner to be removed by the station contractors at a later date.

Station architecture is often an obvious area for quick cost cutting suggestions. Suggestions of flat ceilings with columns, e.g. BMT, IRT, and at grade book-ing areas may be examined for future systems. But for my part the WMATA Stations live up to the architectural heritage of the nation's capital. I'm also glad that cost cutters didn't get to the Jefferson Memorial and the Washington Monument. But there is room for architectural austerity in systems of the future. We Americans must overcome our penchant for conspicuous consumption and subway station design is a good place to start.

Overdesign from a structural standpoint is a symptom of our judicial system and the trend toward very high liability suit settlements. Designers must be ultra-conservative and must defend their competence at all costs. If the government wants to break this syndrome on federally funded work, I suggest that owner purchased insurance be provided to designers on major DOT projects. This will give the designers new liberty to seek out methods of effective cost reduction.

The concept of design review is one which must be developed. For review to be effective a competent design firm must be given great autonomy. Strong

competent and confident leadership is what our industry needs—a vehicle to take past lessons learned and apply them to our future.

Inflation and its effect on construction scheduling. We are constantly hearing about cost overruns due to inflation. Systems are costed in today's dollars and then a panic develops to hurry and complete a system to beat inflation. Contract requirements to finish early often result in additional costs of equipment and underground access. Real cost increases result and schedule improvements often do not materialize due to more complicated or less linear production sequences. All this accomplishes is to spend today's tax dollars instead of tomorrow's! Tomorrow's tax dollars are inflated and so are the structures they build. When a structure is completed has little significance where real costs in terms of percent of GNP are concerned. I believe that efforts to accelerate construction schedules beyond normal production sequences are harmful to our long term cost reduction efforts.

Featherbedding. Manning provisions developed by labor unions have gained national recognition in the printing and railroad industries in recent years. Gentlemen, the heavy construction industry in our country is the greatest single occurrence of featherbedding in the world today. In the New York City area, sewer tunnels in suburban areas similar to Chicago or Cincinnati, Ohio cost \$6000/ft. This same tunnel built in Chicago or Cincinnati costs \$1000/ft. Many factors contribute to this and they are all due to labor cost. But the greatest contribution to this cost discrepancy is a labor inefficiency due to excess manning. I would guess that excess manning in the mid-west approaches 25% in underground work. In New York it must approach 100%. That is, for every man that works another is required by union manning provisions.

I suggest that if the federal government can require 25% Minority Business Enterprise participation in EPA projects; if the federal government can place environmental restraints on construction that cripple large projects for silly reasons, e.g. snail darter; that the federal government can withhold funding to any owner who does not procure union agreements to eliminate all manning provisions on federal funded work.

Alarming trends in insurance costs are not new to the 1970's. Our workman's compensation laws were written long ago to eliminate the courts and claims of an extraordinary nature from the employer-employee relationship. This cost control intent has been eroded over the years by legislation and by the courts.

Although the Longshoreman's Act normally doesn't affect subway construction, it did in the District of Columbia, where all comp falls under longshoring. Other D.O.T. funds go into bridge construction across major waterways. Under the Longshoreman's Act, payments to workers can be two to ten times what they would be under state compensation laws.

Other states have liberalized payments to the point that insurance companies are reluctant to write coverage. Illinois is a severe example of this. The "Scaffold Act" in Illinois has come to be every lawyer's dream, as compensation claims are ruled to fall under this act and claims reach seven figures.

Legislators have not had motivation to correct this trend and will not, they are lawyers, unless the national agencies refuse to pay the bill in increased construction costs. I propose that federal funds for construction purposes be withheld from states whose compensation laws allow costs to rise above certain levels. You must also force the abolition of laws such as the Longshoreman's Act and Illinois' Scaffold Act. These costs are a result of legislation and must be controlled. Excessive insurance costs can be legislated away, as recent developments in medical malpractice insurance indicate. Indiana is an excellent example.

Wrapup insurance, or owner supplied insurance for contractors, has become commonplace on large projects. I might comment that present trends to reward contractors with favorable loss experience are long overdue. My observations have been that loss control programs seem to be more effective where the contractor has a strong financial motivation. I would like to see wrap up policies written with retrospective premium adjustments shared by owner and contractor on an individual job basis.

Motivation of Engineers through value engineering is an elusive goal in our contracting format. Design-construct would seem to provide all possible motivation through incentive fees. However, our competitive bid process demands that all design be complete before contractors become involved. My observations on design-construct power plant work indicate that economies do exist on straight-forward work, but where innovation and calculated risk-taking typical of the American businessman can be applied—such as deep caisson projects, tunnelling, or deep cofferdams, that the large design-contract firms over design—and then fail due to lack of a craftman's knowledge in doing a difficult task easily and inexpensively. I vote to keep our part of the industry on a competitive bid basis, with emphasis on contractor redesign with value engineering participation for all parties. Contractor 40% Engineer 10% Owner 50%.

Regarding the Japanese Scenario mentioned by our keynote speaker, I will stand behind an American's capability to build a better mousetrap anyday and cheaper too—in a given set of economic circumstances. Much ado about nothing, i.e. slurry moles, has delayed an important part of a San Francisco sewerage project for several years. If the structure had been let without prequalification and without specified method, it would have been satisfactorily finished some time ago. If serious questions existed about subsidences, stiff penalties could be levied along with appropriate repairs in

the case of contractor failure to control his procedures. This was not the City's approach and it all occurred because of a romantic sales job done by some Japanese in little white coats. In the end the procedures proposed by foreign interests will probably not be used, simply because we will not stand for the high expense. Yes, the American contractor will find a cheaper way, a simpler way. Where labor is so expensive, our methods must be labor conservative. The U.S. contracting industry is very cost effective on fixed dollar contracts. Our problem is the cost environment we work in, design, unions, insurance, etc. This construction environment is what we must change.

QUESTION AND ANSWER SESSION

MR. SCHAFFNER: George was right, wasn't he? I think now it's your turn.

AUDIENCE: I have one plea, one question, the plea is this, that you do not codify the criteria of subway design until somebody has done it right because you're not going to reduce costs with the kind of criteria which I see being applied now. I'd like to ask Dave Hammond, the designer, the competitive proposals as an alternative analysis.

MR. HAMMOND: I'm not sure I understand the distinction.

AUDIENCE: What I'm getting at is that if you have only the designers who are interested in proposing on a particular design segment present their ideas as they see it, they are going to put maximum effort into that. Whereas, if you collect a single designer he is going to examine alternative proposals, but they're only going to be the ones that one man or two men can think up. He may not ask to examine the full spectrum. By this proposal I mean a proposal which is complete down to some cost analysis of the proposal, construction costs.

MR. HAMMOND: I'm afraid the size and complexity of the projects we're talking about here that that wouldn't be very practical because you have several very expensive costs and to expect the proposer to absorb that I don't think is very likely. Consider that it might be funded by whoever, federal government, the grantee using federal funds, you'd have somewhat the

same problem. If you're talking about basic concept alternatives, talking about something smaller such as in a particular stretch, put a tunnel in this strata or that strata it might have some possibility but by that time you are pretty well locked in to a general design. I don't see the practicality.

MR. SCHAFFNER: I think this meeting is going in a great direction. As a designer, I think that. First, Tom suggests that the government pick up our liability insurance and now we have a suggestion that proposals get paid for and I like all these things.

MR. HACK: I'm surprised nobody mentioned OMB Circular A109. It's obvious it hasn't hit you yet, and I'm telling you it is going to hit you. We call it a subway system but all we need is that little catch phrase "system" and it's going to be brought in by the federal procurement group and they are treating grants the same way. A109 supports, in effect, what was just said. Sampson has agreed, GSA to go for funded, competitive proposals on all office buildings over twenty-five million so I think you are going to get some issues of government funding and I think the government better look at it and see what is cost effective and what is not in terms of how much they might save versus how much it might cost if you are really going to get system option. There are very serious problems, I think, all through the industry to recognize that A109 really was an outgrowth of the problems created by going to a new bomber system or a new rifle or a new tank, and it got built up by the aerospace industry. I want to tell you there are an awful lot of unemployed aerospace industry engineers around the government setting policy, and they don't want to talk our language, and they don't want to listen to it and we have some serious problems trying to interpret some of the valuable suggestions in that system into ours. Let's hope we can do it, but I really think it takes a concerted effort for the construction industry to try to get to the office of federal procurement policy and see if they can get AE alternative A109 that really deals with the problem of the industry. I think we will have an awful lot more design concept competition. I think in this administration, particularly, because it does have the tendency to delay committing to large amounts of money.

DR. LEVITT: I assume that there is some sort of feeling in the minds of people who prepared the new UMTA policy statement that the environmental impact statement in its present form commits the subway design construction team to detailed configuration and construction methods and so on, by requiring that decisions for all these things be made in the first step, prior to the design. I guess I'd like to ask the panel or anybody else if, in fact, they can support this conclusion, and how much more flexibility there will be now and what the value of that would be if you go to this two-tier departmental statement where, presumably, the first tier will specify more or less, the horizontal and

vertical, and if you don't tie yourself down at that stage to cut and cover versus tunnel over, how many access shots and which locations and so on. Is there really a significant potential savings from that?

MR. HAMMOND: I think this illustrates our whole dilemma of which project are we talking about and what kind of detailed problems are we addressing. I don't think there is any general answer I can give to that. I'm not sure I understood the two statements very well just from the policy options paper but as I gather, the first stage was to be a very general one, perhaps, in general type concept but not necessarily addressing all the questions. For instance, there is an alleged historical building somewhere along the line that is going to be contended has to be preserved. It seems to me that sort of thing could have been addressed as a problem to be decided in detail in the second environmental impact statement but not in the first, and if that is so, then I would see it as an advantage because you could, hopefully, get on with the first EIS. Otherwise, you're still leaving open some festering sores that you recognize afterwards in the second stage. Some, and I probably shouldn't say this, of those problems will get answered because the project will be found unfeasible and you won't get to the second stage. So, you don't really have to get down to solving that particular problem, but if that is the concept of the two stage EIS then that would be the advantage that I would see to going to the two stage, two tier.

MR. SCHIAFFNER: In reviewing that myself it seemed to me that it was very logical from the point of view of the designer and the owner and UMTA, but my question really was, whether the people who are going to oppose, and there are always people who are going to oppose, are not going to hit you with their best shots twice instead of once because I don't think they are going to be satisfied to wait for the second detail study because they will anticipate the things that are going to bother them in your second statement as inevitable and I think in public hearing and legal actions and everything else they may hit you with that stuff on that first statement as well as on the second one.

MR. RUDD: I hesitate to ask this question. Art Fox was mentioning the cost of construction in Washington, comparing them to London and Brussels costs. In Washington it was sixty million per mile and in London fifteen and I wonder if someone on the panel could summarize for me what the key reasons for this factor three are in the costs. I've lived a lot in Europe and it's very expensive there and I'm not clear why these costs are quite so high. Could somebody just give me three or four reasons for the difference?

MR. TRAYLOR: There are probably some people who have done those overseas studies that would know more about it, but my suspicion is that the density of stations has a lot to do with it. In other words, the density of stations in Washington, D.C. is just abhorrent. I just

can't believe it. There's one on every block in a lot of areas and nobody in Europe that's building subways for fifteen million dollars a mile at any depth is going to be able to do that if they put a station at every block. You know, the stations are almost end to end. That one job had three stations, four stations, that touched on it, three stations, almost the next one there was a little cut and cover. One place the line there was six hundred feet between stations.

MR. HAMMOND: I don't have very much knowledge on which to base it, but I have a suspicion there is no such figure comparison though we may not, necessarily, be comparing the same thing. There are some factors that are known as a difference and they don't all relate to detailed design per se, although there are some I think, like the greater ease to have simpler facilities with the European systems. They have a different contracting, not only practices, but climate in which the owner and a few of his engineers have a great deal more control in such things as the selection of contractors, and one way in which he can select them, as Dick said, maybe it was Tom, he may not select it the first time, but if he doesn't do the job right the second time, he doesn't have another time. So, you have a much closer fraternity as to how to do this sort of thing. As far as I know they don't have even a one stage, let alone a two stage EIS, so a good many of that sort of factors come into play. Bob O'Neil can probably answer this better than anybody else here because he made a study of why things cost what they do. Bob, do you want to help out here?

MR. O'NEIL: Thanks, Dave. I'm sitting here biting my tongue about the one hundred foot a day that Tom made a comment about. Actually, the Washington system has eighty-six stations, one hundred miles long. The stations aren't every block although it may seem like that. The section of line that Mr. Fox mentioned this morning in London happens to be an extension of the Heathrow Line and was built through open fields out towards Heathrow Airport. There were no utilities. There was no traffic maintenance. There was about two feet of cover over the top of the structure. There was no interference at all with any other work. There was one governmental agency to deal with. The approvals were made quickly. I don't know whether the cost was fifteen million dollars but it is considerably different than underground construction in downtown Atlanta, downtown Washington or downtown New York. I think it's very easy to talk about things that are twice as cheap as they are here but I think you have to know what you are comparing and that comparison of sixty million dollars a mile versus fifteen has no significance. Those numbers don't mean anything comparing one to the other. There's a lot more to say about it. We did a report at DOT on the cost of underground construction. We went to many different cities in Europe

and in North America, including Mexico City, and I think the report is worth reading. It's available from UMTA and one of the things it points out is that you can't look at these isolated circumstances without knowing what the urban geography is, what the urban constraints are, whether the contractor did the job as we do here in North America or whether it was an alternative design and of a design construct approach. There are all kinds of things that enter into this kind of a statement and to make these black and white statements, to say one is better than the other is rather immature. I think that what we've got to do is look at these cities and see what we really built and then how the dollars compare.

MR. GNAEDINGER: A question of Mr. Kiepper. We spoke this morning about the transfer of responsibilities of the local level and the spirit of trust and I'm curious to know how, with all of the multitudes of government agencies you have to deal with, in MARTA for example, how the accountability to the public is accounted for in this complex process.

MR. KIEPPER: Everybody transfers it to the independent authority.

MR. GNAEDINGER: In a sense you are no longer accountable to the public.

MR. KIEPPER: No, we have full accountability. That's the point. If anything goes wrong the local governments and everyone else puts the finger on us. I'm not quite sure I understand the substance of your question.

MR. SCHAFFNER: John's talking about voting and throwing the rascals out of office kind of thing, aren't you John?

MR. KIEPPER: I'm not sure I understand the substance of your question. Would you elaborate a little bit?

MR. GNAEDINGER: Well, I guess the accountability, I'm not saying you're doing anything wrong but if somebody doesn't like what you're doing or the public doesn't, what do they do about it?

MR. KIEPPER: We have a Board of Directors that is appointed by the local government, elected officials of local government and they are directly accountable to the local governments. If the local governments don't like what we are doing they are, of course, directly accountable to the public and they in turn come back to our directors, who they can remove or reappoint.

MR. GNAEDINGER: Is this a very active process?

MR. KIEPPER: Well, we've have pretty rapid turnover of directors. I've been with MARTA seven years and we have one director who is still on the Board who was there in 1972, so there's been a very rapid turnover and the directors appear to be quite responsive to the current political climate. I think the degree of accountability is reasonably high.

MR. GNAEDINGER: At least on the local level, but on the national level, since most of the money comes

from national funds, then there's no such relationship I gather. It's strictly on a local government basis.

MR. KIEPPER: I guess in that case UMTA is the steward to see that we're being responsive to the current national policies. I've spent a lot of my life in local government directly working for elected officials and I can tell you that an independent authority takes as many, if not more, licks and gets as much input. The idea that an independent authority like MARTA is somehow insulated from the public is a great misconception. We have a lot of direct input from many, many, sources that, if it isn't responded to, can directly result in negative happenings. For example, we operate under a state law. Our funding, the composition of our organization, is set up by state law. Well, every January when the General Assembly convenes, that state law is subject to being amended and they have yet to convene without making some amendment. Generally, to place more restrictions upon us. Our Board, which manages the project on a day-to-day basis is directly responsible for local officials. If what you are suggesting is that because we're authority and as authority we may somehow be insulated or isolated that does not prove to be the case. I find us to be much more responsive and much more on the firing line as was the case when I was in local government.

DR. BREKKE: I have two comments and the first is relative to your question, why things seem to be so much cheaper. I think Bob's commentary is very well taken, but it comes to mind that Terry and I were in Europe a couple of years ago in a workshop where we were actually observing drill and blast versus boring machines rock tunneling. It ended up also looking into how we run a job in the United States versus how they run them over there. There were two small panels, one working out the American way and one working out the European way and we both came up with some interesting results. Mainly, that for a given small job that was defined there were six to eight men needed per shift. Terry worked out the American way. He made it a little qualified he said. I had assumed that this job would be done in Toronto where you can run a very effective job. Now, I had written local 147 in New York and asked them to man that job. I received a letter and it was thirty-nine men per shift. Terry pointed out I'd forgotten a couple of them. A very, very, important point, manning provisions. Together with that I also think we should recognize that in many places there is great difficulty in getting people, not only with labor but good workers and good engineers and that the quality of these people sometimes leaves a lot to be desired. And the turnover rates in many places which are just fantastic taking people from the streets and two months later they are gone in a very short period of time. The other comment I wanted to make refers to something that Dave Hammond mentioned, mainly the decision making process during the time of construction. For example, in

Washington and Baltimore, we have a general engineering consultant with its specialty consultants. We have the general slurring consultant with is or her specialty consultants. We have the general construction consultant with his own staff. We have the section or final designer with his consultant. We have the construction contractor with his consultant and there are so many cooks in this, that while the job is going on and all his consultants get together to try to figure out what should be done, there are so many people in the tunnel you could get trampled to death. During the process of decision making, the final designer, as Dave pointed out, has concern that he will not have any influence on how the job is done, and there is enormous conservatism that follows from that period of time. I've seen it many times. I've seen section designers and I said, take and use shotcrete and they say, I agree with you, we could do that but we have to set steel because, who knows, maybe the construction contractor doesn't want to use shotcrete and so on down the line. I would like to ask, for example, David in your committee study on management, did you look into some way to get away from all these cooks and have somebody make a decision?

MR. HAMMOND: Somebody used the yes and no answer this morning and I guess I have to give the yes or no answer. Yes, we looked into it and no, we didn't come up with any magic solution. However, those of you who will get the report pretty soon, I hope will note the first and most decisive conclusion that you reached was that that is the biggest problem in getting on with projects as well as costs is the lack of decisive action. I'll say one thing here that is a little off the subject, in using the cartoon which I showed at the last board meeting tabling the motion to take immediate decisive action, there is a cartoon in our report and the National Research Council has never used and will never use a cartoon in any reports that they have. But we finally convinced them if they didn't take anything else for the report, if they just took the cartoon, we'd get our message across. So, it finally stayed in there and I don't really know of one other than the motivation all the way down the line. I guess I could go back to the analogy I used before in my talk about the football team. Any time that you hear the team lost a game last Sunday, it was always because you didn't execute well, there was nothing wrong with the game plan. We had great people. We just didn't execute very well, it really comes down to that that you've got to have everybody wanting to execute in the first place, otherwise he isn't going to execute at all and then, hopefully, he can enter into executing well. That's the no part of the answer but, yes, we did consider it.

MR. SAMUELS: To the designer and to the contractor, do you think the attitude of the designer in anticipating its design on bad workmanship or an incompetent contractor influences costs and the reverse

part of it, of the contractor approaching the bid and saying, the designer is going to beat up on us. The term, as required by the engineer is going to be badly, poorly, interpreted, therefore, we have to put money into it. This lack of faith, this lack of understanding, seems crystalized and ground into our public, especially, the contract mechanism. You have to presume the worst and the worst quite often happens.

MR. TRAYLOR: I'd like to comment that, by in large, we've succeeded. You know, the work we've done in D.C. has gone through with no claims of argument, period. In other words, we have had no claims for extra money except where directed to work outside the specifications. Our attitude is one of trust and faith in trying to do a good job and get it done and when I find a specification, which I do every day, that imposes on me an incompetence, tells me to do things that are unnecessary, I, by in large, ignore it. In other words, we're competent enough to know that if a specification calls for a certain feature in mining machines that's ridiculous, we just have pretty well gotten along with not doing it. We ignore it and just don't do it and nobody had been saying very much. In D.C. they knew that the equipment we were supplying didn't have feature "X" which was specified. It was good equipment and feature "X" was not necessary in the kind of circumstances that we had had, and the typical thing is soft ground shield where everybody for years has said, talked about the full breasted shield. You know, what is a full breasted shield? The old idea was that you had to have breast boards and jacks all over the face and that you could only remove one board at a time and scrape up a little bit of dirt with a teaspoon. What happens today when you put that kind of piece of machinery that Bob Mayo has made for years and people have used, once upon a time competently, to put one of those over there on Twelfth Street where Shea did, and turned your back in the middle of the night, the steel would come down because nobody is going to have the patience to use a teaspoon anymore. So, in Baltimore the specifications required full breasted shields and we interpreted it in our own way and asked some questions and nobody would admit that we could do it the way that we succeeded in working in D.C. The first job low bidder was Fruin-Colon and they nearly duplicated what we had been doing. We got the second job and we're doing the same, and I don't think there are going to be any problems, but if the designer would impose the old concept of full breasted shield on the two contractors it would have broken us both. You couldn't be low bidder and pay attention to what the specifications said, so when they are that unreasonable we have gone to ignoring them. I don't say you should remove them because once you get a contractor that puts a cheap tin can in there and wants to just push ahead and the stuff rolls in, you need the constraints in your specifications to control him. So, I'm not telling you to change what

you're putting in there. I'm just telling you that a man knows he can do the job, he can bid accordingly and get by with a finished product. Maybe what you need is a performance specification, as opposed to a mechanics specifications, but I've heard so many arguments about, well, God and circumstances and the earth and on that job on Twelfth Street I heard a lot of people say the vibration of the machinery under the ground is condensing the soil above, we're not really losing ground. There are all kinds of excuses and maybe that product could get through a court of law. Anyway, I think if we have more faith, have more cooperation, all of us and put more competent people in inspection, in the engineer positions on the field, we've had sometimes in the past the contractor make it a point to be sure his top man on the project is competent. That's more important than bidding right to specifications.

MR. SCHAFFNER: Tom, I take it that you would recommend having a construction man as a consultant as part of the design team.

MR. TRAYLOR: I think so, but I think you'll find that there aren't any contractors in the country that wouldn't, on the drop of a hat, take off and go somewhere for a major meeting at his own cost. I have gone to a lot and done a lot and would anytime, talk to any designer about any project in the country at no cost and I've had it offered to me and so forth and I really feel it's important. I think all contractors feel the same way. We'll do anything to put our input into the design procedures. You can't make a full time job of it, phone calls for a couple of hours or going places certain times of year is really worthwhile and I think most contractors would do the same thing at no expense.

MR. SCHAFFNER: Do you think any of the leading contractors in the field, however, would do it on a fee basis with an assignment of responsibility rather than just a drop in and give us your advice kind of thing?

MR. TRAYLOR: Well, in the particular instance of our firm, I don't feel that we have but maybe two or three people and their names are all Traylor, who I'd want to be involved and I don't think we could put anybody on a full time basis. I think there is probably a shortage of people and you'll find, you know, that Perini had one competent guy until a month or two ago. I don't know where you are going to get them. I think part time and retired people are your best shot.

MR. HAMMOND: Well, probably this is self-defense but I would like to jump in at this point. It's apparently being left that this is a very unusual procedure. There's nothing unusual about it at all. In the first place, on his own staff any competent designer has people who are construction oriented types. As I believe I mentioned in my discussion, a designer has to think like a contractor, how can this damn thing be built? You can't just go and put some lines on a piece of paper and write the words how it would be done with no idea of what the construction process is going to be. I think

most of us do, to the extent that we can, call on the contractor. This may be another institutional constraint, however, which you'll have to consider, that you would find great difficulty in going out and hiring for a fee, one, two or three contractors so that you would get the field construction input and then having those same three be bidders and then having to listen to all the other potential bidders who wondered how come they knew so much more about the job and got paid for it besides. It might be a worthwhile thing to do but it also has some institutional restraints. So, to the extent that it can be done on an individual basis I think it works very well. Private companies do frequently do that. They hire a contractor to come in and critique their design.

MR. SCHAFFNER: Yes, and many times he won't be allowed to bid on it.

MR. ARDING: My name is Ted Arding from Pittsburgh. I want to rise in terms of the comments just made and, in particular, trying to draw together what was said this morning. If UMTA is, indeed, beginning to want to look at cost estimates early and has as little staff as reported, and this afternoon we have heard of the scarcity of personnel in tunneling and what have you, I think we've got to be very cautious that UMTA doesn't force the local property to hire another consultant for a short period of time just to look at what the previous engineer or the current engineer has got because what you are forcing, what's going to happen is that the local property is going to have a consultant in for a small period of time to critique what the current consultant is doing and the local property and perhaps UMTA is now refereeing a match in which there is no winner. Indeed, it costs time and money and probably resulted in an overage anyway, another seat belt to the automobile. We've had some experience with this and I speak of it very cautiously. I don't think we're in the business of running a competition halfway down the track. If, indeed, you've picked competent consultants to carry out the preliminary engineering and most particularly the final engineering and specification, and I return to what I said this morning, let's have trust in that individual and I think there's enough people in the properties and also in UMTA, with no increase in staff, to judge whether or not that resource can continue on with the construction.

MR. MAYO: I'd like to comment on labor costs compared to Europe. In our country while we have a drill jumbo for a big tunnel, we have eight drills on there, you'd have sixteen men, a driller and a helper on every one of them. In Europe they do it, one man operates two drills and that's a savings right there of seventy-five percent labor. John Jacobs came back from a subway job over in Europe and told me that these four miners that run the drills, when they got through drilling they went back and dug out the trucks and started to haul them up. There's your savings. I also want to say, you mentioned compressed air, I was out in Chicago years

ago, and we worked an eight hour shift, and the lock tender or anybody would operate the lock. Nowadays if you work around certain parts of the country, you only work a four hour shift at four lbs. of air and you have a lock tender and a lock tender's helper and a lock tender inside and another man out manning the line.

MR. SHEPHERD: I'd like to mention something that we did in MARTA when I was consulting with Mr. Kiepper's outfit. At a certain point in time in the tunnel design at the Peachtree Station and running lines, when we reached a certain percentage of design, we invited the contractors, we contacted about twenty-six contractors. We invited them to come down and get their input, to come as close as you can to turnkey. We had a great response. They spent their own money, came down, spent the day with us. Mr. Kiepper was nice enough to take them to lunch. We felt we had to meet the contractors there and we felt that out of that meeting we got some major input and I think that's one of the ways you can solve some of the possible pitfalls you may have in the design when your contractor is bidding.

MR. BONFORTE: I'd like to carry on with Traylor's comment, "If I were king." To give you a contrast on overseas practice that may mean something, several months ago before this mess in Iran, I was involved in setting up the criteria for the Tehran Mass Transit System which is part of the development of the new international airport. It's about sixty-five kilometers long, involving a spine terminal, involving underground work for about the first fifteen kilometers. My task was to set the criteria for the tunnel. I've worked on transit systems in Washington, Baltimore, Atlanta and, of course, kept up with the IRT through the years and they used to put out a red book on transit car data. They haven't done it for several years by the way, and I wish they would go back to keeping up their books. Of course, they are swallowed into APTA now. As a result, I think they have less to say about what they can do with the project but Bob had a pretty good show going when it was IRT. One of the first steps was to analyze the practice in the United States for clearance envelope. Any designer who has tried to do that realizes that the track is so diverse as to be abominable. For instance, even part way through the Baltimore design we were told by our client to enlarge the tunnel, to make it bigger to meet an envelope that had been rehashed on the basis of experience in the United States. To get clearance envelopes like Washington which is considerably smaller than that say, for Boston, which I wouldn't want to have to build for the system that I had control over. Now, there are reasons for that I understand. I'll go back to Tehran, didn't want to use the London clearance envelope because I sincerely believe you need safety walls in these tunnels in case of fire or other emergency. So at the same time I wouldn't consider Boston and here I'm sitting, one man in a

firm, with no reviewing agency to tell me that this tunnel is too big or too small or whatever. I'm expected to use my judgment on what is a good envelope that will affect the cost of the project significantly in terms of the cut and cover and tunnel structures and the clearance through the spine terminal. I selected an envelope I thought was reasonable and practical and cost effective. Now, in doing so, I fully realized that car manufacturers, in some cases, would be knocked down because I knew the attitude of some car manufacturers would be, not to build a smaller car that would fit in the envelope. On the other hand, we don't know where the cars will come from. We don't know if they'll come from Japan, Sweden, the United States or what have you, but I kind of feel that they have the technology to build a car to fit a design parameter such as clearance envelope. If they can't do it, they shouldn't bid on it. Now, in Tehran we're talking about eighty cars. A substantial investment but not a tremendous one, but nevertheless eighty cars was a nice bid sum and I would think that any of the major car manufacturers would want to be responsive to that, build a car to fit the envelope by set. Now, mind you, the point I'm making, no layers of bureaucracy, judgment exercised by one person or maybe in conference with his peers, it didn't take three months to get clearance approval. It was done all in one day and sent out to our field office in Tehran, and that was it. I don't know that there is a lesson to be learned in that, but I'm just pointing it out as an example.

MR. SCHAFFNER: Tom, have you done any work in Iran?

MR. TRAYLOR: Not recently.

MR. KUESEL: I have a striking example that some of you have heard illustrated in Sam's concerns about trust and mistrust between designers and contractors. Twenty miles down the road here there is a tunnel under Hampton Road. The first tunnel which was conceived in 1954 as a revenue bond financed project by a Commission set up by the State of Virginia but it derived its funding from revenue bonds. The procedure was that a bond underwriting firm and the engineers and the contractors were all hired the same day and put to work. Everyone was a team. We worked hard together. The total number of drawings was less than one hundred but the book of specifications was about this thick. The work was completed, from the time of initiation of the project, open to traffic in three years, the cost in 1954 of dollars for the tunnel was, roughly thirty million. About fifteen years later, traffic had grown so that it was evident that a parallel double facility was needed and so, in 1971, a project was started to build a parallel tunnel identical to the first in function but by this time it was a federal aid project. The drawings were over six hundred. The specifications were at least this thick. The work took six years to complete. The construction cost was roughly one hundred million, allowing for escalation from 1954 to 1971, of thirty million to

seventy million. My guess is at least one third additional cost because of all the complications with this involved procedure. I'm not suggesting that you go to financing public works by revenue bonds as a general principal but there is something to be learned from the experience.

MR. SCHAFFNER: Sam, you've been trying to say something for a while.

MR. HACK: There is an awful lot of complaining about the other guys and a tremendous amount in this group about labor. There have been a lot of studies of power plants, both nuclear and fossil, and you get a heck of a lot of different data than you people seem to be getting. They find very serious productivity problems, thirty percent actual hands on time as compared to idle. However, they find that two-thirds of the idle time is attributable to management failures and not labor rules or things. Now, it is conceivable that the largest piece of the labor they are dealing with is the UA. Marty and his group have been on the productivity kick for a number of years, and maybe they have different rules, but we find management problems a lot more serious in terms of having the requirements there, the design problems, the interference problems, redo work, than the labor problems, and I don't think we are going to settle those labor parts until we clean up our own house. Maybe you people had an awful lot of luck here and had top management on your jobs, but I can't quite concede that the issue can drastically shift.

MR. TRAYLOR: I really have some first hand experience with that in the Mid-West and I can tell you that the thirty percent productivity construction work that is dominant, that is the rule not the exception in power plant construction in the Middle West. I know it's true. I know subcontractors that are doing work and I know that the work that is at that level of productivity is all cost plus B work. None of it is hard money contracts. I can also tell you that you wouldn't believe the effectiveness that we get out of the crews that are forced upon us in underground construction. People come in, people with DOT have come in, Russ has been at our jobs. They just shake their heads and can't believe that you can get that much work out of a man in an eight-hour shift. A lot of time we give them ten hours pay and let them go home when they get so much tunnel dug or other incentives and the people produce at one hundred to two hundred percent of what you would expect from a maximum, fit, male adult. What you've said is just not true. The construction, heavy construction, industry and particularly the tunneling industry has a ninety percent management productivity for their people and they have a sixty or seventy percent effectiveness as a result of manning provisions that are forced on us by the AFL-CIO.

MR. MAYER: Dave Hammond mentioned a publication, Better Contracting Practices, that is directed at construction contracts. What my question has to do

with is, do the consulting engineers or the grantees present here have suggestions for similar better contracting practices in the contracts that are negotiated between grantee and engineering consultants, practices that would encourage and give incentives to the consultants to promote cost savings. That's my question.

MR. HAMMOND: Well, I said that I couldn't speak for it, and they may be enhanced assuming that the new think, Joe, that there are some very good possibilities for it and they may be enhanced assuming that the new approaches in the option's paper are advanced. Again, it might be in stages. In the earlier stages when the scope is, of necessity, pretty uncertain then I think it is very difficult to establish a strong enough scope to base even an incentive on and, of course, the uncertainty of the scope is more reason for going for the normal type of consulting contract now, which is cost plus fixed fee, and there are various ramifications and limitations that are put in in different places but, basically, that's the kind of a contract. As you get closer, I think you still, even with the approaches that are being talked about, would have uncertain enough scope that you couldn't expect to do it on a fixed price or hard money, as Tom calls it, type of contract but you might be then enough closer that you could set some kind of a sliding scale of fee tied to an incentive basis. As has been made clear here, I think the difficulty of any of this sort of thing is that you are asking, in this case, the designer, to control things that are in some part at least outside his control and not within his control. I think you could, once you had passed the system definition stage, and had pretty definitely described the kind of project and the general approach that is going to be made to the project, to then come up with some kind of a sliding scale incentive fee.

MR. MAYER: Something similar to the value engineering incentive mechanism used on construction contracts?

MR. HAMMOND: That would be one possibility. I was thinking more of one that is used in the Boyd contract on the DPM in Morgantown and it's a little bit different because it isn't tied to design. It's tied more to manufacture in hardware, but their fee goes on a sliding scale. The lower the total cost is, the higher their fee is and, again, it's all within some limits, so that it isn't wide open either way to being a complete windfall or a complete disaster. Something like that I think might be possible but it could only be I think in the later stages when you're pretty well settled down as to what is it that you are applying the target to on which the incentive would be based.

MR. HAMPTON: We heard a lot about economies which are reached as a result of better contracting practices, more personnel. I'd like to ask Mr. Traylor does he feel that significant economies can arise through standardization of various components of the tunnel.

MR. TRAYLOR: Well, looking back on the D.C. system, I think probably there isn't any soft ground tunnel there that couldn't have been built the way, with the liner plates. We had a good job on that with the liner plates and some people would argue today that that's the reason for the success there. The smaller envelope might have helped some but I really think probably those tunnels could have been dug by the other method. If someone had imposed standard procedures of ribs and lagging and monolithic concrete on all of the tunnels there I believe they could have been satisfactorily constructed and if someone had imposed amounts of reinforcing steel which were intelligently engineered based on overburdens and type of soil I think it would have reduced the concreting costs. Yes, I believe so. In other words, there were some changes that took place from section to section in the underground work that was probably in retrospect and, again, I've made the same decision on the front end but having been through the ground as a contractor I don't think it was that difficult. It was difficult if you didn't have the right machinery but given the right machinery, the liner wasn't the critical thing, but I think in particular, you did do a good job of standardization of your station configuration, and there were some economies because they were all basically the same although they were also big, you know, and expensive to build. There may have been a better way but I think it was good that you did them all basically the same from a structural standpoint. I think that the station entrances could have been standardized a great deal more even to going to pre-cast stuff and cut and cover. I really believe there is a great amount of improvement to be made in the station entrance standardization. Of course, each of the section designers wanted to put his individuality in there to prove his need but I think you've got to measure. That's one of the things about our grand way of living. It's nice to have each station look a little bit different so that you don't get completely mixed up when you go in these places and I think that some of it has been done effectively, although I think some of it out on the Friendship Height Station, some of those out there, people went a little crazy on some of those things in the station entrances and I think you threw away money when you did it.

MR. MCFARLAND: Mr. Schaffner has to leave us and Mr. Page. They are both on a five o'clock flight, but if you like to continue the questioning, please feel free to do so or we can adjourn. Whatever you'd like. Are there further questions?

MR. LOUREIRO: With all the questions that came up on labor problems, why weren't union executives invited to this conference?

MR. MCFARLAND: I believe Mr. Georgine was invited. He was on our mailing list. He is one of the major spokesmen for the AFL-CIO in Washington, D.C.

MR. CASEY: He has nothing to do with tunnels and he's not aware of any in construction so his input into this conference would be virtually worthless. Number one, I'm very glad I came to this conference because I found out the truth that I've suspected for years. I've been an owner's representative for twenty-three years and I had a suspicion that the contractors always took the book of specifications and tore it up. Number two, is that seventy-five years ago the Public Service Commission built rail transportation systems in New York City and based on that, gentlemen, New York City became one of the largest most important cities in the world because it started out with a little village, a little town, the south end of Manhattan, and as the subway systems grew north the industry, the population moved forward. In 1904, 1905, Park Avenue and 33rd Street, Park Avenue and 42nd Street were nothing more than farmland. So, we have a very important commodity here, mass rapid transit. Now New York City is faced with a dilemma. They have a system seventy-five years old. We've been through all of this before. I'm amazed to see, in Philadelphia, where you can send a check to a building owner for taking of an easement under private property. This happens to be the case in Los Angeles. To take an easement fifty feet below private property in New York City, if you're lucky, it takes about four or five years. This adds on to the cost. As far as labor is concerned, I defend the labor in New York City and I'll put it up against any other labor organization or group of laborers anywhere else in the country and I think that what we have to do now is sit down and come together and decide what can be done. This is a very nice conference, Russ. We've been trying in New York City for two years now to get a conference such as this, to get people together to identify these high costs and do something about it and certainly, if this is only going to continue for one year or two years we're not going to answer the questions and I would like to propose that we make, as part of an agreement, that everybody go home and don't forget about high subway costs until you have the next conference. What I'd like to do is propose that maybe we can have some sort of a sub-committee, a committee established from this conference, as an on-going credit contracting practices. Let me just tell you a story, gentlemen, and I won't bore you very long with it. I was on the National Committee on Tunneling Technology. We tried to sponsor in New York City a meeting at which all the politicians and municipal people would attend so we could get the message across to the politicians on better contracting practices. Russ was good enough to send one hundred copies free of charge of the booklet. We passed it out to every important state legislator, county legislator and city legislator. We hired the union center. You know who came? The members of the committee, the members of the ASCE and as long as we talk about this among ourselves we're not going to get any place. We

have to identify ourselves with a spokesman. When Senator Ted Kennedy stands up and speaks, the press is there and I think this is what we need. We need an important person to take our message out to the people, the public and the governmental officials. When that man that represents our thinking stands up the press should be there, television cameras should be there and I think that's the time that we'll start to see some reduction in subway costs.

MR. MCFARLAND: Any comment?

AUDIENCE: I think Mr. Casey is agreeing that we should be getting together with representatives from labor as well. I agree they should be here. Is the next step going to be to invite them in with us?

MR. TRAYLOR: First, Russ didn't know that I was going to jump on the train that I've jumped on regarding over-manning provisions particularly in the big northern cities. In other words, your attitude that they should be here to defend themselves is one Russ couldn't have looked at in advance. The thing is the underground work is done primarily by the laborers and the operators. There are only two crafts and the laborers don't over-man. We're looking at the operating engineers and they wouldn't be existing today in any force whatsoever if we'd get rid of their manning provisions. So, you know their backbone, there are some cities where that has been broken by people, by people like Clive-Con, who are operating or threatening to operate a non-union shop, and the operators have backed off of twenty-five to fifty percent of their personnel and I'm talking about, not places like New York City. The electricians are bad also and there are other crafts that get in on the same thing. What I'm trying to say is bringing the head of the operating engineers into this conference to argue with me about the social value of a bunch of guys standing out there doing nothing is pointless. It's not going to help DOT or UMTA or anybody. This is a battle that must be fought against a cancer. Overmanning is a cancer and you don't talk about it, you battle it.

AUDIENCE: Sometimes it helps when an individual realizes that he may be out of work completely if certain processes are continued. I'm not saying that they are going to respond correctly but I've worked enough with individuals that most of them will respond.

MR. TRAYLOR: I don't think conferences like this are the place for that kind of an argument. I think I tried to bring the point up that somebody in the government needs to use their funding power to try to accomplish something but this conference is not the kind of place. In other words, conferences on labor effectiveness with all the AFL-CIO crafts and the construction industry, not just the tunneling people. This is a problem of the construction industry, not a problem in tunneling technology or UMTA. I mean, it's something that the federal government needs to do

something about but it's really not related to our problem here today.

MS. FINCH: As many of you probably know, we've conducted a rather extensive exploratory study on risks and liability in construction. We had about one hundred people of all of the interests in the construction process; government and labor were there. True, labor didn't participate to the extent that you gentlemen do because they aren't invited as often but I think there were certain things and the report is published, that they did say, we needed to do more of, and that was the contractors to look at their bargaining positions and how to strengthen them. This came out of the malice of the labor people, not the contractors. Now, George Fox was at one of those meetings, and he represented the contractor's view in the overall conference and he said the very same things you did, as did others, but there were other contractors that said the sort of thing that Sam Hack just said and I do think that there is an area here, if this is a tremendous problem, that there should be more dialogue and there should be equal parties to discuss them.

MR. TRAYLOR: I agree with you. One of the problems with the kind of situation that we have is that I'm a contractor from Indiana. There are contracts negotiated by non-tunneling people and, to give an example, Boston. Maybe Perini did participate, but by in large those contracts are written and negotiated before the bids come out and national contractors come in in their area of expertise and are saddled with what's already done if there are union contractors and the only people that are making any gains are the ones that threaten to go non-union if they don't get some concessions.

MS. FINCH: I think these were all things that were discussed and our contractor participation did come from across the United States. They operated nationally, internationally. We had the operating engineers. We had the UA. We had the laborers. We had a spectrum of the different trades involved. Most of the discussion did center around what happened before they got on the job and I think that's one of the things that was discussed by IBEW, they have national contract procedures, bargaining procedures, that they enforce nationally. Now most of the unions don't do that but that's something to be striven for and this can happen if you talk.

MR. TRAYLOR: I agree with you that, probably, in other words, if a job is in a northern city we don't fight the unions over their manning provisions. I learned to live with them as a kid. You know, I said, "what's that guy doing over there?" He says, "Oh, he's a whatever it is," and I said, "Well, he doesn't do anything," and my dad said, "That's the way it is." I grew up with it. I understand it. I put it in my estimates. We build jobs and they are successful. Union business agents don't have any trouble with me. That's probably one of the

problems. We've been bred to accept those levels of inefficiency and we don't fight hard enough against them ourselves.

MS. FINCH: I think that's the major case.

MR. HACK: To add something on that, I don't think we've had a national leadership in the union movement that is as sensitive to this issue. We've never had it before and, unfortunately, we're in a bunch of fights with them on other issues, picketing, which will create some difficulties on having a dialogue. These fellows are out to get productivity. They are very concerned. I mentioned Ward, they went over, they took over the union out in Denver, Colorado because of the productivity on one of our jobs. They just went in and sent in a custodian to see what was going on. So, the time is ripe. Joe mentioned IBEW has in its contract management has the responsibility to manage, not the union.

DR. NOVICK: I'm somewhat concerned about this morning's comments by UMTA representatives about an increase emphasis on construction estimating during various stages of design. Unfortunately, tunnels are not design problems, say, like a building where you can make rigorous estimates during design. Tunnels are construction methods problems. The construction methods often are not determined until construction starts. Now, it is important for the engineer, designer, who evaluates the various possible construction methods during the design stage. You should do this not only for one but for many methods but then he has a dilemma, how much should he tell the contractor on the plans. Take the case of a tunnel that is progressing through sand, under water. The designer determines that this should be pumped three drains in advance. He shows it on the plans, specifies the size of pumps, the project progresses and a long holiday weekend occurs. The foreman decides to shut off the pumps and save money. The excavation collapses. Who is responsible? The designer takes great risks in this case. On the other hand if he shows nothing on the plans the low bidder may not understand the magnitude of this problem and may decide to drive through the sand without drainage and I know of an actual case where the tunnel machine was bogged down. It took weeks to excavate it and the residential neighborhood looked like a bomb crater to get the tunnel machine out. How do you resolve these problems? Well, certainly one way is to indicate what the problem is, suggest approaches, suggest that the contractor provide the method for approval, but all of this, supervision during construction, you need the team, the contractor, engineers and owners. Perhaps a mediator or an arbitrator to meet in the tunnel during construction where the problem exists and you've got to resolve it at that point. Perhaps UMTA would participate in such a meeting in the tunnel. That's where the money is. Another factor is that many of these decisions are time dependent. Reference was made this morning to reducing factors of safety. Well, if you have a time

dependent situation, say, silt deposit. The engineer realizes that perhaps that excavation will stay open for a short period of time. The contractor may realize it. He drives through and he works over the weekend, night and day, to get through this silt pocket. Another contractor doesn't understand and he shuts down the job for the weekend, relaxes. How do you take time dependency into account in design? How do you take it into account in a cost estimate? These are the kinds of decisions that can only be made in the field by a very mature team who can do it on the spot. One further comment, the initial cost of the facility is, as we all know, only part of the problem. We should look at life cycle costs. What would it cost to maintain and rehabilitate this facility over its useful life. Reference was made to the New York City subway being seventy-five years old. They are undergoing maintenance and rehabilitation and I use as an example the interstate highway system wherein the design premise was low first costs. It was not possible to bring in the maintenance and rehabilitation during the 50's and 60's when the interstate system was designed. Now, it's starting to go into rehabilitation at enormous costs. I would only encourage you to think of life cycle rather than first costs.

MR. TAYLOR: I guess this is an opportunity maybe to clarify. We're talking about a lot of things. Construction and the costs of construction are one of our concerns and, obviously, in a two day conference you can only go so far on any of these subjects and we're just really scratching at the surface other than I think we all have a concern. I think we all agree together that there is a genuine reason for concern. We're also talking about design and, maybe to some degree, since that's my line or work, I'm more interested in the design but I also recognize that construction is an area where we can also, perhaps, find some economics. Frankly, we get into propositions where people are going to tunnel and they don't even know what they are tunneling through. They don't know whether they got sand and they don't know what kind of sand it is and they don't know what kind of rock it is and they don't know anything about it. The truth is the cost of those things go on on the order of magnitude of three and four times. We can't live with that. I agree with what you're saying. We don't want to meet down down in some tunnel with anybody. I love to go down and watch construction but I'd be utterly incompetent there and I'd be utterly incompetent in making any of the design decisions but I hope I'm competent enough, as a manager of a program, to insure that some rational process is used in coming to decisions. That's our interest.

AUDIENCE: One additional comment. It was touched on this morning. The idea of cost estimates, the basis of your budget projection, the initial guess of how much this particular project is going to cost. I think is a datum point from which an awful lot of our collective

troubles start. The guys in government having to justify the overruns. The people making these costs take one hell of a chance in trying to say I'm not going to be caught again that way. I'm going to go high or I'm afraid the job isn't going to go ahead so I'm going to low ball the thing and, we both, I think, have experienced these things and participated in them. I think here again is one of the strongest areas for the involvement of the contractor as well as the engineers and the owners at the pre-bid, at the design concept and the budgeting thing. It's too late when a contractor is forced to bid and make his guess or estimate as to how much the cost of the job is. That's the final crystalization but there can be some real good input and I guess George Schaffner has left. The Port Authority in contemplation of the World Trade Center foundation, which was a unique, crazy, weird thing, ten separate contractors or contracting groups to do a budget study and a critique of the job and then they beat the hell out of the low bidders based on all the input they got from these contractors ahead of time and it's not necessary to hire a contractor to get this input and then preclude him for bidding. All contractors aren't crooks and all contractors aren't idiots and they have a definite bit to input to this thing and I think it's about time that people, especially consultants who feel that they put it on paper and it's sacred and no contractor can challenge, question, even understand the complexities of design. There is competence on both sides and we have to work together.

MR. MCFARLAND: We're over. We were scheduled to end at 4:30. If there is a sentiment to continue I would like to but I see a lot of very weary faces. I think we are repeating ourselves a little bit and we'll have the opportunity to pick this up again tomorrow. In particular I want to thank Gene Casey with the explicit recommendation of what we do from here and also the recommendation that we get in the tunnel with Dr. Novick but I think, again, I would like to pick this up tomorrow. I would like to thank Mr. Kiepper, Mr. Hammond, Mr. Traylor for being here with us today, for accepting our invocation to take part in this panel. With that I would like to close and urge you to come ready for bear at nine o'clock tomorrow morning.

**ROBERT RUBIN
ATTORNEY
GREENBERG, TRAYMAN, CANTOR,
REISS, AND BLASKY**

MODERATOR

**QUENTIN LERCH
SECRETARY
THE SURETY ASSOCIATION OF
AMERICA**

INSURANCE AND BONDING

**JOHN T. RHETT
DEPUTY ASSISTANT
ADMINISTRATOR
ENVIRONMENTAL PROTECTION
AGENCY**

VALUE ENGINEERING

**JOHN R. ASMUS
VICE PRESIDENT
BECHTEL, INC.**

CONSTRUCTION MANAGEMENT

QUESTION AND ANSWER SESSION

MR. MCFARLAND: Our session this morning will be on insurance, bonding, value engineering and construction management. The moderator will be Bob Rubin a partner in Max E. Greenberg, Trayman, Cantor, Reiss and Blaskey, New York. Mr. Rubin specializes in construction contract documents, construction claims and state and local government contract law. He is a member of the construction industry arbitration panel, American Arbitration Association, Vice Chairman of the Committee on Contract Administration and past secretary of the executive committee of the American Society of Civil Engineers, Construction Division. A member of the New York County Lawyer's Association in New York State and the American Bar Association. Mr. Rubin received a degree in Civil Engineering from Cornell University and a Juris Doctorate Degree from Columbia University. Bob.

MR. RUBIN: Thank you very much, Russ. Yesterday, Art Fox read to you a prospective Engineering News Record story for December 7, 1982. You will recall that it involved a two hundred and fifty million dollar subway contract awarded by the Southern California Rapid Transit District to a joint venture of Kumagi Gumi Company, Limited of Tokyo and the Korean Overseas Construction Corporation. Last night over dinner and a couple of bottles of wine, Clinton, Jack, John and myself wrote the followup to that story which you may expect to read in the December 8, 1991 issue of Engineering News Record which I would like to read to you now.

"This week the California Supreme Court affirmed the one hundred million dollar breach of contract damage award rendered in favor of the joint venture of Kumagi Gumi Company, Limited of Tokyo and the Korean Overseas Construction Corporation against the Southern California Rapid Transit District and the dismissal of the District's counterclaim against the joint venture and its surety. This finally ended an eight year legal battle between the District, its contractor and surety arising out of the joint venture's default and financial insolvency. The issues in the law suit involved a massive alleged changed conditions' claim and the claim for delays, interferences and suspensions of work due to a local environmental injunction, a faulty environmental impact statement and a dispute between UMTA, the District, the general engineering consultant and the construction manager following the collapse of one of the completed subway tunnel sections. The Court also ruled that unexpectedly low local labor productivity contributed to the default. The widow of Moto Yakusaki, the joint venture's general manager, who, it will be recalled committed hari-kari at the entrance to the Magic Kingdom in Disneyland shortly after the default, issued a statement expressing her gratitude to the Court for finally vindicating her late husband. Court records disclosed that the legal expenses of both parties aggregated seventy-five million dollars.

Robert Rubin, senior trial counsel for the joint venture, could not be reached for comment aboard his yacht in the Caribbean." The point of this story is that the same conditions and contracting practices that lead to the inability of American contractors successfully to compete for the contract in the first place, lead to the downfall of the foreign competitor and that the American taxpayers ultimately had to pay the bill. We hope this story will adequately set the stage for this morning's session which is devoted to the issues of value engineering, insurance and bonding and construction management.

QUENTIN LERCH

Our first speaker this morning is Mr. Quentin Lerch who is the secretary of the Surety Association of America. This is a trade association of some four hundred and fifty-six member companies that write surety bonds. When in recent days clients have called me and expressed concern of their inability to find a surety company willing to write a bond, I wonder where all of these four hundred and fifty-six surety companies are hiding out at the moment. Quentin attended Princeton University and graduated from Baldwin Wallace College. He then obtained a law degree from Case Western Reserve University. He served in the United States Air Force during World War II and after his admission to the bar in Ohio in 1948, was an underwriting agent for two major surety companies. Since 1960, he has been with the Surety Association of America and since 1968 he has been its Secretary. Quentin.

MR. LERCH: Thank you, Chairman Bob, other members of the panel, ladies and gentlemen, I want to thank you for that nice introduction but it seems to me last night we had pretty much the same thing to drink and it didn't affect me like that but I enjoyed the story.

As Bob said, the organization that employs me is a trade association in the first context. It has certain legal standing as an authorized statistical agency for the fidelity and surety lines of business in all fifty states and it functions as a rating bureau in those jurisdictions where the laws require it. The members of our association are fundamentally free to use or depart from the rates established by the Surety Association of America

to the extent that they see fit. We don't mandate in this day and age any form of adherence and it's pretty much a free market place out there for the various kinds of bonds within our jurisdiction. Now, to keep this numerical question in perspective, while we have four hundred and fifty-six members in the Surety Association of America which share our expenses and for which we are grateful, it doesn't necessarily follow that all of them are engaged in the construction bonding business. Under the law we have to accept as members anyone who applies because that's a part of the service that people who are engaged in the fidelity and surety lines are entitled to under the laws of the various of the individual states. It is probably true that there are one hundred and fifty companies out there that are actively engaged, to some extent, in the contract lines of business. Of those, perhaps something less than forty write a volume of this business. Many of the members that belong to our association do so only because in some esoteric insurance package they write a little fidelity business. I don't want to mislead you that anybody can go to four hundred and fifty-six companies and try and get a contract bond. It doesn't work that way. Our association does represent about ninety-nine percent of the companies who are a factor in the marketplace. I could even say all but one company really and its parent company belong. We do not, in our association, perform a lobbying function. That function is performed for the entire insurance industry, by direction of the company, through what is known as the American Insurance Association. It's quite effective. So, I must be here today to perform what I would call an educational service to the extent that I can and having had some thirty plus years in the surety business, and most particularly, in the contract bonding business it is a fair assumption that I know that subject matter.

I know the general construction field to the extent that a surety man has to know it. I'm not an engineer and from some of the comments that I make later, I'm afraid that will become abundantly clear to you. You should not infer from what I have said so far that I am an expert, whatever that is, on all other insurance. Surety people need some basic understanding of contractors and financial institution insurance. I assume that the people who invited me here are aware of some of these subtleties and distinctions. After all, it's a free country and they could have invited an insurance broker, insurance agent or someone who would represent primarily the insurance aspects of the business. What you are going to get from me this morning is just one man's opinion of some of the things that I think can be done to control costs and improve the building of highways in this country.

If we don't get back to basics in construction inflation, contingencies and bids to protect it against us, we are going to drive prices even higher. Now, architects and engineers, we, in the bonding business have learned

over the years, if left to their own devices are going to build monuments. There is no way out of it. That's not going to control costs, unless there is some way they can warrant the cost when they do this design work. Increased labor costs, the costs of material, all these are nothing but natural consequences of little success in controlling the basic problem. The problem of inflation. Now, I go to other meetings whether they are hosted by educators, hospital administrators, or the family apartment builders, even home builders and it's the same story every place; everything costs too much and it's true. Some of the necessities of life are about to price themselves out of the market. Homes are on the very verge of doing that now. Automobiles, within the next several years, who is going to be willing to pay what they want for what you can get in this day and age. It hardly seems worth it. Now, here's a little rule of economics that's involved here, less doesn't necessarily cost less, sometimes it costs more. That rule has worked its way into our economy to a point we have to live with it. There is not, in my opinion, a great deal of money to be saved in the insurance and bonding areas until there are savings in every other cost area. Inflation impacts upon the insurance industry in exactly the same way that it does on owners, contractors, manufacturers, suppliers and working men. Everything costs more, including the cost of production, underwriting, claim handling. In addition, all too often, inability to see some possibility of adequate profits at some reasonably close point in time restricts the ability to employ adequate capital in the insurance business. Fluctuations of the stock market reduce the ability of insurance companies to finance premium growth and product development. Unfortunately, even in the surety segment of the overall insurance business very few of our own people realize that to restore the opportunity for profit that once existed, it would take three to five times the income that is presently available even to catch up with inflationary influences. Once caught up, we would be in a somewhat better position than most businesses and you know why. Premiums for contract bonds are based on the cost of construction and, to some extent, inflation is built into that figure.

The construction business, generally, is one of the most hazardous ways to make a living. Contractors get public work by agreeing to charge less than anyone else. Not just on the date that they bid but two, three, four, five years down the road until the job is completed and all of this in the face, now, of double digit inflation, material shortages, voluntarily controlled wages, prices, profits and all other natural and unnatural calamities. The surety in bonding a contractor casts their lot with him and, having written his bond, guarantees that he will complete the job on time for the agreed price in accordance with all the terms and, did you ever read them, of the contract and that he will pay all bills. All of this the contractors do for an average

profit of something like two percent on sales. The surety is lucky to make 1/20 of 6/10 of one percent or .0003 as I figure and for the last ten years we haven't made that on averages. If the contractor fails or is defaulted the surety stands in his place. Whatever affects the contractor concerns us with equal or unequal force. While the contractor is on the job the surety is around. The reverse is not necessarily true. Contractors die, others go to Brazil and some just fade away with far less dignity than old soldiers. To sureties these are the factors that we consider in looking at a contract account; we look first at the integrity of the operation. We look at the contractor's competence on work of similar size and scope. We look at his financial strengths, and believe me, we look at it. We look at the amount and profitability of other work underway and that is the key that one item today more than anything else to surety underwriting. We look at the contractor's organization, his people resources. We look at the quality of his subs and suppliers. We look at the adequacy of that bid price or at least we can get a comparison on public work and we look at the ability and the willingness of the owner to pay for the work promptly. In specific cases there are other factors to be considered. Who are the designers? The engineers? What financing is available? The method of construction to be employed, has it ever been used before on similar work? Did it work? Were there problems? Of most concern to us as sureties are the size of the job, the time allowed for completion, possibility, if any, of delayed payments. How the owner treats or proposes to treat change orders and most important of all, contract terms and conditions. It seems to me, the trend nowadays, particular in this underground and subway field, is toward ever larger single contracts, including diverse sections that were once let in increments. I guess the justification for that are supposed economies in time, supervision, money and interest on borrowed money, there are the goals but there are disadvantages, too, for contractors, sureties, owners alike. It's not unusual today to see fixed price jobs approaching or even exceeding, three hundred million dollars or more, running six or seven years. Such contracts are likely undertaken by joint ventures to spread the risk against labor and material increases, strikes, just plain mistakes in judgment, fluctuating interest costs and uninsurable disasters. Sometimes joint ventures are needed to provide required working capital, risk capital or just to obtain bonding. Sureties consider carefully big exposures on long-term jobs if contract terms are onerous or unfair, especially on long term heavy engineering contracts. Sureties read these contracts and contractors are starting to read them, too. It's amazing what you can learn by doing that. On occasion, there is less capacity today, in the marketplace than is needed and this is going to be a continuing problem for us until the bonding and insurance business are profitable enough to attract new

capital or until additional larger or new companies become more active in the surety line which many of them haven't handled before. We see some of that with the big life companies going into the direct bonding or, better yet, from the standpoint of many of our companies the reinsurance marketplace. Owners might conclude that they are mistaken in purchasing jumbo fixed price contracts five, six or seven years long to complete; if they were to intelligently consider the contingency dollars that must go into bids and calculate the tremendous problems of delay, costs which would be occasioned by possible default. All too often contracts appear to be rushed toward the award stage before the necessary engineering has even been completed. Volumes of change orders become necessary and their fair pricing and timely payment is neglected all too often. Much of this and the contractor is in debt, cash short and without ability to bid additional work. Nothing is more seriously regarded by sureties than unfair, unequal, and onerous contract terms and conditions. Contractors must have or insist upon, equal bargaining position in entering into contracts with owners. Historically, except for direct federal contracts, contracts are one sided in favor of the owner. Troubles for sureties multiply rapidly when the ultimate result, which it has to be, is to force contractors into an adversary position with the owner or other parties. Left free to do it, public and private owners will try to impose liability on contractors for the owner's negligence, the engineer's mistakes, for injury to third parties by reason of the contractor having taken on the contract. That's ridiculous. Contractors are entitled, clearly entitled, to time extensions for conditions beyond their control. Underground and subsurface foundation jobs must contain fair changed conditions clauses. Now, I've told you what ought to be. In the real world contractors do, still, or have to take chances when faced with bad contract conditions on a take it or leave basis on average size jobs. Eternally, they hope the contingency figure in the bid is large enough. That the owner will be fair despite the contract conditions or even that the owner will be generous when unexpected underground conditions are found or the owner causes delay or other unfavorable developments occur without the fault of the contractor.

On larger contracts, generally, the contractor's fondest hopes or fantasies, if you please, do not materialize because public officials can't take political risk or the fiscal consequences of doing anything beyond specific contract terms. What do we suggest? First, we suggest that we do everything we can to get owners to realize that multifaceted projects of several hundred million dollars, taking longer than three years, should not be packaged into single fixed price contracts. To do otherwise is not to the advantage of any of the parties concerned. Secondly, problems with long-term contracts could be minimized by more reasonable contract

conditions and inclusion of escalation provisions for increases in labor and material costs. Thirdly, it would be in order to reduce the impact of increasingly larger contracts by lowering performance bond penalties to not more than fifty percent of the contract price, so as not to restrict the surety market's ability to respond in better fashion in providing bonds. Some of you may know or may not know that the Miller Act, the guideline for bonding on federal contracts, does not require one hundred percent bonds. It provides for taking bond of less than one hundred percent if the contracting officer will make the determination that to do so is in the best interest of the government. He just won't make that determination on his own. He thinks he is giving something away. The Bureau of Reclamation has done so and the Air Force has done so recently. It's one way to make the capacity problem have less impact than it does in these giant contracts.

Fourth, much work remains to be done to treat the contractor as an equal throughout the construction process. Contractors themselves, ought to utilize the legislative process to achieve that kind of parity, in somewhat the same fashion that they have used it to outlaw hold harmless in some twenty states so far. Responsible sureties, as a group, stand ready to assist in any way that they can, any way that we can, to accomplish the goals that I outlined in this brief paper and to help in any other way that we can in the transportation or any other field. That concludes my prepared remarks. I am hopeful that in the questioning period you will raise such specific questions as you may have and I appreciate very much the opportunity to have been with you this morning. Thank you.

JOHN T. RHETT

MR. RUBIN: Our next speaker is John T. Rhett, Deputy Assistant Administrator of the United States Environmental Protection Agency. Jack is, in that capacity, responsible for the general direction and supervision of all operations and activities of the Office of Water Program Operations. Jack joined the EPA in 1973 after a distinguished twenty-seven year career in the United States Corps of Engineers. In the Corps

Colonel Rhett had numerous assignments both here and abroad. In recent years, he was the Chief of the Engineering Division of the U.S. Army Construction Agency in Vietnam, District Engineer of the Louisville Engineering District and resident member of the Board of Engineers of Rivers and Harbors. Jack graduated from the United States Military Academy at West Point, received a Master's Degree in Engineering from the University of California and a Master's Degree in International Relations from George Washington University. He is a licensed, professional engineer in the District of Columbia and Florida, a member of the Water Pollution Control Federation, The American Society of Civil Engineers, The Society of American Military Engineers and The American Academy of Environmental Engineers. Jack will speak to you on the subject of value engineering.

MR. RHETT: Thank you, Bob. You know every time they start reading one of these bios, by the time they get through the schools and societies, you wonder whether any of us ever do any work.

It's a real pleasure for me to be with you today. I think there are many parallels between EPA construction grants program and the UMTA program. We both deal directly with municipalities, have a heck of a lot of construction money, and our staffs are very small. Even though EPA's program deals with about twelve thousand grants and some twenty thousand communities we share many similar problems which we ought to discuss for our mutual benefit. Oddly enough, last night at dinner, Bob told one of the jokes that I use quite often at meetings. I use it with EPA because I think it's quite applicable. It's the one about the three little white lies. You know the first one: Well sure honey, I'm going to love you tomorrow morning. The second is: I can't figure out what happened, I put that check in the mail to you last week. The third is: I'm from EPA and I'm here to help you. I do hope that we can help you with the value engineering method of cost control. We've had a program in this area for five or six years that has produced a number of successes and failures.

Obviously, value engineering is only one portion of the cost control problem and that's the part I plan to concentrate on today. We've got a lot of money rolling around out there with a lot of people and we've got to make sure, in times of limited resources and a big goal to accomplish, that the money is used efficiently.

This reminds me of the session I had about five or six years ago when I came to the agency. The 1972 Water Act had just passed. We were moving from the bush leagues to the major leagues without even going through the minors. The original program was a straight grant program which had built up from thirty percent to fifty percent federal funding. It had a quite modest budget of a few hundred million dollars a year. The new Act had established an eighteen billion dollar

grant program that was going to run in the neighborhood of four to five billion dollars a year. The 1972 Act raised the grant level to seventy-five percent and the scrutiny of the program was increased drastically. In fact, when I had joined the agency, before I had a chance to take my first action and mess something up, I was being investigated by the GAO. Since then, I have never had a day in the agency that the GAO has not been investigating me. We normally have anywhere from fifteen to twenty investigations going on simultaneously. You know, I had never realized sewers were political but sewers are rough damn politics.

Having come from a direct construction program with the Corps into this large grant program with seventy-five percent monies, it quickly became obvious that we were not operating a pure grant program but a construction program through a grant mechanism. Our major problem was to get the program started down the proper path and build the mechanisms to assure that we would accomplish our goals in an efficient manner without any major scandals.

The program, in contrast to many of the others, provides grants directly to the municipalities. We deal with towns that range in size from a couple of hundred people up to cities like New York and, believe me, they are different animals. The states serve, hopefully, as our partners. I use the term "hopefully" because most of them are quite cooperative but sometimes we have conflicts which, personally, I think is healthy for the program.

As I said earlier, we have some ten to twelve thousand grants involving some twenty billion dollars. The actual amount of construction is more than that because a tremendous amount of the twenty billion is in the design phase. It's a big program all over the country. It affects everybody. It's into growth, environment, and many of the same things that are affected by mass transit.

Well, I think it is somewhat necessary to have this ground work to see how and why we moved into value engineering. I would hope that you all might look at VE and see whether it can provide you with cost savings and cost controls.

I personally think that much of the government's spending doesn't have good cost controls on it. We're going to have to do something about this situation since the American taxpayer is getting fed up with present government management practices. Yesterday our administrator had a meeting with a large city mayor concerning a small sewer project of forty million dollars. The Three Rivers project has grown from forty million to two hundred and nine million and it isn't even under construction. I tell you, we just can't have many of these situations and expect the American people to keep coughing up the money.

When I joined EPA, value engineering seemed a natural course of action since I had just left a Corps

district that was a leader in their successful value engineering program. At about this time, Senator Randolph and the GAO were starting to put the screws to EPA on cost controls. They said we ought to establish a VE program.

Well, it was really a fascinating period. The question was how could we institute a successful VE program, using the grant mechanism rather than direct construction, with a segment of the engineering profession that was not used to value engineering, much federal control, nor much federal money. It was a rough period of time. We initiated EPA value engineering program through the use of workshops in the project design phase. Our immediate need was to obtain some experience on value engineering under actual grant conditions. Breaking the ice and getting some of the initial studies underway proved to be the most difficult VE problem we faced. We made more than sixty visits, and hundreds of telephone calls to brief people on VE and trying to get the first analysis rolling. Finally, we started with the workshop in Ocean County, New Jersey. I'm sure you know the VE arguments back and forth and I'm sure that you can realize the resistance we were getting as the people were saying, look, we VE everything we do. I mean, obviously, the product we're giving you has already been value engineered. It's not even unnecessary but it's really decadent.

So, by the Fall of 1974, we had trained key people in EPA headquarters and regions, and we were ready to launch a voluntary program. In December of 1974 we advised our regional offices that value engineering studies were grant eligible on a voluntary basis. The program was voluntary because, (1) the application of the VE technique to waste water treatment projects, particularly under grant conditions, had not yet been fully demonstrated and, (2) VE was new to most of the consulting engineers and the regulatory agencies concerned with waste water treatment. The objectives of the voluntary program were to demonstrate how VE can be effectively applied to waste water treatment projects and to gain some experience in it.

In 1975 and 1976, we completed eight value engineering studies on a variety of projects. These were done on strictly a voluntary basis. The grantee, the applicant, the engineer, design consultant, and everybody voluntarily agreed to perform the VE studies.

The eight studies produced net capital savings estimated at eighteen million dollars. The VE fees to achieve these savings totaled about seven hundred thousand. These studies averaged about twenty-seven bucks return for each dollar invested in VE.

Weighted against the total project cost our net capital savings represented some four percent. The VE fees were less than 0.2 of one percent of the total project cost. There was an indication that we could increase the net savings by increasing the VE level of effort. In fact, our results from the higher VE levels are

somewhat mixed. The savings increase, but so does the time to do VE. We must be cautious at all times about delays. Overall, though, I've been very much pleased with our results, I feel the program is a success. In fact, it is something that we cannot afford not to do, but there's a lot of argument on that point.

Equally important, we also learned from the voluntary program that, for several good reasons, a VE analysis must be performed at the early stages of the design process. First, it minimizes the risk of project delays; Second, it minimizes the redesign costs. For example, results from the voluntary VE studies revealed that the implementation costs were substantial for projects which had completed their design beyond the ninety percent level. On the other hand, there were no implementation costs for two projects which were analyzed below the fifty percent completion point. A third reason for early analysis is that it places a minimum constraint on your VE teams. This is important because if a VE team were allowed to review the project with only the legal and environmental constraints similar to those imposed by the original designer, the team could recommend drastic changes with potentially higher savings.

On the other hand, when VE is performed on a project at a later design stage where a deadline for completion is imposed, the scope for VE is greatly reduced in order to make sure that any changes would not result in unacceptable project delays. Under these conditions, it is predictable that substantial VE effort would be required in order to generate savings. In addition, there is a risk that the VE effort here may focus only on cost reduction without careful consideration of function and reliability. For this reason, EPA discourages VE on projects at or near design completion. However, this policy does not apply to projects where construction is being delayed because of other factors.

Based on the results we obtained, it seemed clear to us that there was a need to extend value engineering to a broader range of projects than could be obtained under the voluntary program. For the most part, we found general acceptance of the value engineering concept but we needed an incentive for its use. There is still, as you all well know, quite a bit of controversy in this field. There were two reasons we felt that the mandatory program should be the next step. First, obviously, a large number of projects were not being subjected to value engineering and should be covered. Second, we found that value engineering was not being routinely included in the original grant proposals for design. It was being added as an afterthought, and thus, as I mentioned earlier, we were in the position of analyzing some designs that were substantially complete. In addition to the high cost of late implementation, we were paying a hidden cost of delay, because it inevitably took longer to revise a design that was nearly complete.

By January of 1976, we had updated our guidance on VE and told our regions that we were moving toward a mandatory program. After October 1976, we required all grant applications for project design, certified by the States to the regional office, to contain a VE proposal if the total project cost, excluding the cost of the sewers themselves, was greater than ten million dollars.

During the two years of our mandatory program we've conducted VE's on some fifty-six projects. The studies produced net capital savings of about ninety-five million. The VE costs to achieve this were about nine million. The studies averaged about eleven dollars return for each dollar invested in VE. I personally think we can do better than this. Weighed against the total project costs we achieved about a 5 percent savings on our investment at about a one half a percent for VE costs. A pretty good investment.

The substantial savings and high return for our invested dollar indicates that the mandatory VE program has been a success. More importantly, we have gained experience that will be extremely helpful in our future VE program.

Then the question is: What's our next step? Certainly, we are monitoring the mandatory program very closely and working intensively to be sure that it is successful and achieves the desired savings without delaying construction. Given that as our present effort, I think we have several options for the near future regarding VE. You should understand that we currently do not have the staff to implement all these options yet, and I point them out merely as examples of our considerations.

The first area we've been looking into is the planning area. This seems logical but I'm not sure of it. There is a lot of argument about this particular area because of the complexity of our planning process which involves some thirty-four pieces of major legislation, such as, archaeological, NEPA, the Historical Act. We've got to take a good hard look at the impact of these requirements. We're not sure that the VE process itself will operate smoothly in this area. However, we are attempting some other things in the planning area, such as, the possibility of developing two different sets of designs and competitively bidding them. We would pay for both designs and then at a certain point either select one or bid both of them. You know, the Corps and the Air Force have been doing some of this work. We are just playing with these thoughts.

Another option we are considering is an obvious one: extending mandatory VE to smaller projects. We could start to make VE mandatory down to the five million dollar area. If we get down to that level, we ought to be value engineering some sixty-five percent of the monies. So, that one, I think is coming down the pike with no problem.

The third one that we are planning for sometime this winter is a much more highly controversial topic. That's the use of VE in the construction phase. We'll use the approach which is similar to the one used by DOD, the Corps, and, I think, GSA. As far as I know, this approach hadn't been used within a grant program. The construction VE program will be conducted on a voluntary basis for projects over ten million. The idea is for the contractor to recommend changes and share in the savings. We plan to do a fifty percent cost sharing up to a particular level and then a sliding scale above that level. In other words, it's not going to be a straight fifty percent split. Any proposed changes will have to be agreed upon with the owner and the design engineer. Obviously, everyone is concerned with some of the problems which can be created by this approach.

Let me tell you why it has taken us so long to develop this program. We've wanted to do something of this nature for a long time, but I've got only nine hundred people trying to operate our total grant program across the entire country. I know you need a good, professional, staff to be able to get into this end of the business. Without adequate staffing and tight control, the chance for irregularities, or shall we say hanky panky, are just phenomenal. I can see a GAO investigation now. But the thing that is beginning to help us is the agreement we reached with the Corps of Engineers for some six hundred man years of effort to use in the Step Three construction phase of our projects. How long we'll be able to do this I don't know, but we plan on using some of the Corps VE engineering staff to monitor the VE in the construction phase.

In summary, our application of VE to the construction grants program has been a valuable learning process. We found that our efforts to establish the necessary VE expertise for the implementation of our program was greatly enhanced by the cooperation of the professional organizations such as the American Consulting Engineering Council, NSPE and ASCE. In some cases, they may have been dragged along reluctantly but I think that without them we would have had a heck of a time trying to do it. We were able to progressively expand our VE program by using a step-by-step approach which allowed us to consolidate our gains at each program level and pace the program development to the emerging VE capability of the engineering profession. During the past four or five years, the engineering societies have been conducting VE courses for us and GSA. Our experience with VE in the construction or wastewater treatment plants appears to support the old VE folklore which claims that significant cost savings can be obtained by a small expenditure of VE. Gentlemen, in our opinion, we cannot afford not to do it. Thank you.

JOHN R. ASMUS

MR. RUBIN: Our final speaker is John Asmus who is a Vice President of Bechtel, Incorporated and manager of Bechtel's Hydro and Community Facilities Division. In that capacity John is responsible for project management, engineering, and division services. Prior to this assignment Jack was the manager of transit projects for Bechtel worldwide. Before that Jack participated in Bechtel's efforts in the design and construction management of the BART system. Jack has a Bachelor of Science Degree in Electrical Engineering from the University of Texas and those of us who are civil engineers here will be indulgent of John. I will point out that one outstanding, redeeming feature of John is his selection of wine at dinner last night. John is going to speak to you about construction management.

MR. ASMUS: Thank you, Bob. Good morning ladies and gentlemen. I'm billed as the construction management point of view but I'm not going to restrict my remarks to that phase of a project. The concern is project cost and it was established in the discussions yesterday that cost increases occur early in the project, in the planning, criteria, preliminary engineering stages. The control of that cost is most easily achieved in those early stages rather than in the later stages when the job is under contract and the construction manager is concerned with it. Dave Hammond covered the cost control very well yesterday. I endorse all of his recommendations.

I would like to highlight a few points and express a few opinions to see if we can't develop some discussion this morning. The early UMTA speakers yesterday seemed under the impression that the cost increases in rapid transit construction were somewhat unique and I think that's been somewhat discounted but I would like to say that James Bay is not within its original budget, as someone said yesterday, and the Arabs are having problems with cost on their jobs, too. The high visibility of rapid transit cost that Mr. Kiepper mentioned is a very significant point. The early budgets used for voter approval of projects are based on the most optimistic estimate and can't possibly reflect the worst case conditions. I'm sure that in most cases, it is the most optimistic and not even the most probable and I would like to come back to the difficulties of the worst case condition a little later.

Turning to the proposed UMTA policies, I don't believe that the Office of Program Management will help if it's an overview operation. If it's a not involved review process it will only result in more second guessing, controversy, and delay. If it's to be of benefit it must be a part of the procedure or system that is to achieve the desired end result and that is a project on schedule and within budget. The system definition plan

as proposed by UMTA focuses heavily on cost because that is the concern and cost is the most important part of the three parts of a project, scope, schedule and cost. Transit projects like many others these days have a fourth dimension, also mentioned yesterday, and this is the intervenor in whatever form he comes, as a citizen's committee, a historical society or environmental concern and it's impossible to schedule with respect to when this will occur, how long it will persist and what it will cost. This is the greatest impediment to the establishment of an upset cost early in the project. The systems definition plan, however, is a good idea. It should be a complete system management plan with definition of scope, schedule, budget, what's to be done, how much is to be done, where, when, how long, how and who. It should include the tasks and activities of UMTA and other regulatory agencies and it should recognize the fourth dimension to the degree that this can be defined and these activities should be updated and added to the master plan as the project goes forward. This thorough plan is a prerequisite to control as it is working to plan, monitoring for deviations and taking appropriate, corrective action, that we keep a project on schedule and within budget. This is not to say that the plan is an end in itself. As Mr. Hammond mentioned yesterday, it can be corrected and it can be updated but it is a necessary part of the total budget activity.

Turning to the proposed two-step EIS, I am very fearful that this could cause additional project delay. It will give that fourth dimension, the intervenor, another chance to delay the project. I recognize there is a need for change to the EIS process. The present process freezes too much design, too early. There were comments yesterday that we can simplify and reduce the scope of EIS and I certainly endorse that. There was a comment that in respect to environment we are paying to buy our environment back, and with regard to water pollution and air pollution we can certainly endorse that, but I can't endorse protection of the white breasted rice mouse in the Sacramento Valley.

Another important point that was mentioned yesterday is dealing with each other with trust and cooperation. As someone mentioned, we are now operating like knights in armor, spending as much energy in self-protection as we are in project implementation. There are too many organizations involved with UMTA, the owner agency, general engineering contractor, section designers, one or more construction managers and the multiple contractors. Liability requirements inhibit their working together for the benefit of the project. We must find a way to improve cooperation and communications. A strong effort should be made to achieve the post construction critiques suggested yesterday, with all parties concerned in the critique and with the legal liabilities set aside in order to gain the experience of frank discussion of the successes and failures of the

project. We should reconsider the contracting methods with respect to the number of parties involved. Surely section designers with only one section of a system cannot bring the benefit of the learning curve to the job. Small projects should be designed by the general engineering contractor and there also can be a strong case made for the engineer and the construction manager to be the same firm on many projects. I would encourage the use of alternative construction methods in our contract documents, permit alternative bids for different methods and permit alternative bids on the basis of the best price to the contractor's schedule rather than to some fixed schedule that is put in the contract documents.

And, lastly, I want to comment on the presentation by a fellow panel member, Jack Rhett. Value engineering is a redundancy. When I went to school, engineering was the economic application of scientific knowledge to practical situations. If the engineer does his job, he's found the economic or the optimum solution to the problem and, therefore, you don't need value engineering. Thank you.

QUESTION AND ANSWER SESSION

MR. RUBIN: We can start some of the discussion which, I think, based on yesterday's experience, brought out many of the most interesting points. Over dinner and wine last night we were all chatting and Jack was relating some of the experiences he had in testifying on the Hill and this is a little bit different than the legal experiences that I've had where somebody is represented by counsel and when there is a question that is objectionable or difficult the lawyer can stand up and take the heat off of his client. Apparently, when you are representing the administration and you are at a hearing at Capitol Hill, you are there without counsel in front of the members of Congress and the press and you have to answer the question as it is put to you. I express great sympathy with that kind of a predicament that Jack is subjected to and I intend this morning to subject him to that kind of treatment. So, again, exercising my prerogative as the moderator I would like to ask the first question and I direct it at Jack

and I'd like to then get responses from our other panelists and then I'd like to get some responses from the floor and I think that might be a good vehicle for starting the discussion here. I'd like to make up a hypothetical question for you and I'm going to pick on a couple of people. I started picking on Tom Traylor this morning and I'm going to continue. Tom is invited to participate in a value engineering session for a tunnel, and by this time, Tom and I have become fast friends in light of his proclivities with respect to following plans and specifications and he calls me up to seek my legal advice on his participation in this process. I ask him what design experience he's had and he says that he has no practical design experience, but he really learned well from Doctor Peck and he has these principles down. He sees this design that has the tunnel lining reinforcing steel which varies with the depth of cover and he thinks that it is unnecessary and terribly wasteful and he wants to go to this value engineering session and he wants to express this and he wonders what legal precautions he should take. I ask Tom whether he has any professional liability insurance and he says he doesn't have any and I point out to Tom that, under his general liability policy, there is a professional liability exclusion and under his builder's risk property insurance there is a professional liability exclusion which means that, if he assumes any design responsibility and there is a failure or a claim he will have absolutely no insurance protection. So, he says "Well, can I get it?" We call up Quentin. Quentin, we call you up and we ask you can Tom get professional liability coverage for what he wants to participate in this value engineering for John and Quentin what are you going to tell him? Is the market out there? Can he get that insurance?

MR. LERCH: An honest answer is, I don't know.

MR. RUBIN: I've tried for clients and we've been universally turned down, at least with my experiences. Unless you are in the design profession there is no way that you can get professional liability coverage and if you can find a way, Quentin, for my clients to get it under these circumstances I would be greatly appreciative because we've tried in quite a number of instances. So, I advise Tom of this and he goes to the value engineering meeting and he makes his recommendation orally and I arm him with a letter that he should submit at the time to adequately protect his rights. So, he says something to the effect, we would like to recommend that the general design consultant consider reducing the reinforcing steel in the concrete lining in accordance with the criteria set forth in Doctor Peck's rock mechanics book. We wish to point out, however, that we are not engineers and we make this suggestion without assuming any responsibility, therefore.

Now, the designer on the project is Tom Kuesel. Tom is a friend and we speak with one another frequently and Tom calls me up and he says, you know, this fellow, this wild man, is in here and he is making

all of these wild suggestions and I really don't know what to do with him. I say, Tom, what do you think about this idea. He says, well, you know, I think he really has a point. To tell you the truth down deep I really don't think that the tunneling lining reinforcing steel needs to vary with the depth of cover. I say, "Well, Tom, how does Tam's do it and how does Dim Jim's do it?" and he says, "Well, the current practice is that everybody designs it the same way." I say, "Well, if I think you just accept this recommendation you are really going to stick your neck out." So, Tom asks me what to do and I write a letter for Tom. The letter says the following: It's from Tom to the owner and it says, "It has been recommended that the tunnel lining reinforcing steel be reduced. This is contrary to current sound design practices and we do not advise it. If directed to follow this we can assume no responsibility in connection therewith." Now, administrator Rhett, I hope that this has focused upon the issue. When you get involved in value engineering it seems to me that you face the real problem of divided responsibility and it leads to, perhaps, non-responsibility and do you deal with it and how do you think it ought to be dealt with?

MR. RHETT: You know how to get to a fellow. In the first place it sounds like you need a lawyer on your VE team but having gotten that off let me come into the VE process. In the first place it is made up of a multi-disciplined engineering team who have been trained in value engineering, too. When you get on to the basic gut issues of safety, steel and things of this nature, in fact, in any case, you expect the VE team to give recommendations to the designer and the owner. The designer accepts or rejects the recommendation. If he just automatically rejects everything the owner had better get himself a new designer. So, the responsibility does not lie with the little VE team. It still goes back to the same responsibility to the basic designer and the owner. Now, the question comes up, and I'm sure there are cases of this, where the owner and the designer disagree and that's between the owner and the designer. The VE team that did this or VE contractor is just offered, let's say, his recommendations along the line. It sounds like the man is irresponsible but it's not the case and doesn't prove itself that way. Normally, we do not reach the position where the designer will not accept something that's good. Now, there is a lot of garbage on the margin that, yes, you may or may not accept. So, I don't think the liability problem is as great as one might expect. Now, let me go into one other facet of this. We do value engineering two ways in EPA. We prefer, in a sense, a separate contractor but we don't require that. The value engineering can be done within the same firm under certain rules and regulations and procedures that are set up. In other words, if a firm is willing to set up a VE arm that is not under, you know, the other arm designing, so that this person does not report to the one who has the basic

design responsibility, we will accept it. You might ask, how successful is this? In some companies it has been very, very, successful and in some of them it has been very, very, poor, but I think the liability issue really goes back to the basic designer is still responsible and the owner, and if the owner and the designer have got problems it's normal whether it came up through a VE system or not.

MR. RUBIN: John, do you have any comments on that before we go to the floor?

MR. ASMUS: I'll let the floor get at it. They are waiting.

MR. MAYER: My name is Joe Mayer and I'm from UMTA.

MR. RUBIN: And, I'm here to help you.

MR. MAYER: I need some help. I have a certain amount of confusion here about the whole subject of value engineering. What I'm used to seeing and I think that many of the people in this room here are used to seeing is, value engineering incentive clauses that are put into construction contracts. Now, I think what Mr. Rhett is talking about is something that is quite different from that. Now, the value engineering incentive clauses that are customarily put in construction contracts provide for rewarding the initiative of the contractor on the job who, because of his knowledge of construction methods, may come up with alternate designs as the job progresses that he can suggest to the owner who, in turn, feeds that information back to his general engineering consultant and section designer with a proposed alternate design that must be okayed by the section designer and the general engineering consultant which, if adopted, rewards the contractor to the extent of, usually fifty percent of the savings realized. What I understand from the discussion that Mr. Rhett has been giving us is that that value engineering concept is extended back into the early design stage and that the reward, if any, goes to the general engineering consultant or the section designer.

MR. RUBIN: Or to the owner.

MR. RHETT: It goes to the owner.

MR. MAYER: Well, of course he shares?

MR. RHETT: No sharing.

MR. MAYER: Well, what I would like to understand better is a description of the mechanism for this, how this is worked out because it has been objected that, after all, an engineering firm is hired to come up with the best design that he can come up with in the first place so what are you rewarding him for? He got his reward from getting his contract. Now, how does this value engineering process work in the design stage?

MR. RHETT: Okay, let me come into value engineering. The principles, in fact, in many cases in the construction end of it is not called value engineering. It's called incentive contracting, something of this nature but it's the same principle. The only thing about it is a contractor gets a cost sharing but now let's come

back into design. In the design part what we are asking for is that a trained crew of value engineers; now, that's taking your electrical, your mechanical, your structural, your civil, who are trained in the principle of how to take a project apart from a value engineering viewpoint, independent of the original designers, take a look at it and take a look at it early and to come up with ideas and to come up with savings. Now, those savings, the AE himself, there is no incentive, monetary incentive, to him here except that he ends up with a better product for his owner which, hopefully, the owner then will hire him the next time. There are value engineering workbooks. There are extensive classes run, in fact, I think there are some going on right now jointly sponsored by ACC and AIA, courses in which they train engineers on how to use this type approach in design. Design is one of the better places because you pick it up early. But the proof of the pudding is in the eating and when we've gone back with the VE studies we have found out there were savings and the designer agrees with them.

MR. MAYER: Could I ask you, in practice in the EPA experience, is this value engineering team usually an independent consulting firm that is hired by the owner; who comes in for a review, let's say, at the thirty percent part of design completion stage or what?

MR. RHETT: We have both. There are teams. There are certain consultants or arms of certain consultants that are set up to do VE and the owner has a choice of hiring them. We have no objection to the same AE doing it as long as he has a VE arm that can look at the thing independently. Look, I spent years in the Corps and you know you have an engineering division and it's the same business. When they design a dam or a jetty or something like this the first design is the one that is the most outstanding, the cheapest, and all of that. Internally, in the Louisville District, I consistently force on our own design, on our in-house design, the VE concept. It's remarkable what came out of it. I did it over the dead body almost of my chief engineer. He just thought I had rocks in my head but we got a lot of savings, but I want to drift into the second part which is the construction part. You have to remember that this is an integral part, too. In fact, the area we are moving into now for the first time in the grant program is the construction part and the cost savings business in which the contractor shares and this has to go back to the designer and if the designer says, "Hey, are you putting this thing in." We were going to fill this cell with, you know, a poor grade of concrete and here the contractor is recommending sand and we can save two million dollars, that proposal has to go back to the base designer to say, yes or no, to say, "Well, you know as it turns out the reason why we put in, you know, cement in this thing and made it concrete is so if somebody knocked a hole in the darn thing all the stuff wouldn't run out." I mean, I've taken an oversimplified example so both of them are there.

MR. MAYER: But anybody who has worked in a design office is going to tell you that whenever you get into a design problem you consider maybe, six or eight choices and after you make preliminary analyses of those choices then you gradually eliminate them all and you narrow it down to one or two. So, in effect, in any design process aren't you going through what you would call a value engineering phase?

MR. RHETT: Sure, that's the definition of an engineer and all engineers are supposed to do it but what it does not provide is the outside look, forest for the trees, this type look at it by a trained crew that is in there to do it. If the engineer goes at this thing in a cooperative viewpoint, he ends up with the better design because there are just some things he forgot.

MR. HACK: There are some limitations on that, Jack, and one is you have to recognize, you say the design, but I really think the owner has to decide whether he wants to pay the price. Another point that has been overlooked which is, it needs some risk assessment in some of these where there really are high pay-offs in terms of costs. One should have a risk analysis. What do you pay off as a form of insurance analysis, and I think one of the weaknesses in our major system, trying to build it, is not having enough real risk analysis and ending up, maybe, being either super safe and paying insurances that are not worth it. The last part is to recognize that there are constraints on value engineering which are the non-monetary values which the system doesn't allow for. It was mentioned yesterday, a station is aesthetic not because it is subjected to value engineering principles but you want to see something pleasant and there is no way that VE can take care of that. It's also rather serious and, I must say, we have not used it where we should have used it because in our major projects we can't use it. Someone says, "Hey, we can change something," but the cost of re-engineering that is just going to blow the whole system and you just can't do it. You have to be careful. There are certain values in decisions, as I said, aesthetic, safety, which say, "Hey, don't try that because the initial cost, the firming up of this, puts you outside the ability to try to go through multiple choices."

MR. RHETT: Let me come back here on this one because, of course, what Sam said here is very, very, true. Let me make sure there is one point that is understood in value engineering. The principle in value engineering is you get the same thing. I have another program that's called my Gold Plating Program which is well known and that's completely separate from value engineering. If there is an aesthetic value, let's say, you've got a treatment plant out there. I don't know whether you all know I made the National Inquirer but I made it on gold plating, not running around and being a jet setter which is too bad. That's no way to make the National Inquirer but I made it on a treatment plant in California which I looked at before and

afterwards and I personally think we're right. The treatment plant is built like a hacienda. We looked at that from both the gold plating, value engineering and everything else and we built the plant, agreed that the plant should be built as a hacienda. The reason for it is because of aesthetics and if that's where we wanted to place the plant, rather than take it out and hide it in the woods somewhere. So, aesthetic values are very, very, important and you have not gotten a value engineering savings if you take a brick building and you make it a concrete block building unless the building is something that nobody is going to see.

DR. LEVITT: Sam mentioned the one point that I was going to make which is that most people don't see, much less ride in a sewer, and so a lot of these issues are purely technical issues in the design of waste water treatment and perhaps lend themselves more easily to value engineering but I guess there is another more important point that I'd like to mention and that is that the reason a lot of engineers object to this whole notion, I think, is that you're calling into question their ability to do what they've been told. As Mr. Asmus said, they are supposed to build the most economic product at the most economic price, which we all know. In fact, the real world involves multiple tradeoffs between conflicting objectives and there are always costs invented and how far one goes down the line to trim costs to achieve safety and other benefits I think depends as much as anything on there being adequate incentives to do so. If one looks at a building construction area, I think the reason that there are not some of the same concerns in United States building construction and design is there are many places that one can compare the design of one building to the design of another and building designers get very competitive with one another to be efficient. For example, pounds of square feet of structural steel per square foot, BTU's per degree day per square foot of building and so on and we don't have some of those same absolute measures for comparing waste water treatment projects much less subways and I think one of the big problems is, in effect, it's a cop out, every one is different than any other one because the underground conditions are different and so they are less comparable and so, in some sense, less incentive for the designer to design them efficiently because no one can easily evaluate how efficiently it was designed. Perhaps the way around that problem is to start to generate some of the same kinds of cost parameters, I don't know what they are. I think that they will have to be fairly aggregated kind of cost parameters, much more than what we have available now. I don't know what the solution is but I think that's the problem. The problem is the incentive that forces engineers to take, perhaps, what we might consider enough account of economic issues in making decisions is that there is no data base to easily compare one subway system to another one. We heard someone yesterday say, we cannot compare our sub-

ways to British subways since they are built in fields and we can't compare them to Canadian subways because they have nice clay et cetera. How do we get around this problem? I think that's the big problem.

MR. RHETT: You know I'm not sure. In the waste water field we've gotten two or three things that are very important from what you brought up. This business of comparison is extremely difficult and yet, at the same time, we're finding a lot of footprint work. You know you've got to find somebody that designs a 5MGD plant so you just footprint this thing all over and we do not have. I think, the good comparative data but let me come back to the VE team and concept. If you study the concept and really look at it and you take the standard engineer and put him through this process, I think much will fall out automatically because it is really a systematic way of going at these choice of alternatives and the idea is to get somebody separate who is not so closely and intimately involved. There is tremendous resistance, obviously, because you are questioning an engineer's design.

MR. HAMMOND: I think we're falling into the trap that yesterday's discussion kind of indicated, that designers go off in the corner and design something and they come back three years later and tell the owner what they did and that's not the way the process goes nor is it the way it should go. We do, in engineering, perform value engineering without calling it that. You always take your program and see if there aren't some ways in which you can have cost reduction or, frequently, if it isn't cost reduction it is a reduction in the increase in costs that you have, you're forced into doing it but that has two parts. One is the pure design which is strictly technical tradeoff but most of it comes down into being responsible to point out to the owner that the criteria is great but are you willing to spend as much as it costs you to have twenty-four karat gold, maybe fourteen karat is good enough and I think you'll find in total value engineering, cost reduction, whatever you want to call it, is why most of them fall into that area. There have been questions raised about incentives and in this particular regard, I think designers have, under the rules we operate, a disincentive. I'll give you an example of what we've done in Baltimore and we can call it value engineering. It was purely cost reduction to try to see if we couldn't get our costs down. We spend one million dollars of design money to come up with a forty million dollar reduction in costs. Now, we're busy explaining why the hell did the engineering costs go up five million dollars; you're apparently against the six percent of design, so you must be a lousy designer because you spent more money doing the design than you should. So, this is a reverse incentive. It's also a disincentive because every time you make the target go down and you spend money to arrive at that target, therefore, you're making the balance go in the wrong direction so I think we need to give some thought to

real incentives. I'll go back to my first part, I don't think we have completely an outside team to look at value engineering. Maybe you can on the technical part of it but they have to be part of the overall effort you're looking at. I certainly endorse all of the comments that Sam Hack and Ray Levitt made. I probably shouldn't make the next comment because, Jack, you mentioned that nobody in the grant program has value engineering in their construction contracts and we do in Baltimore but then we're the only ones that know we do, so I probably will deny it if anybody quotes me that we do.

MR. RHETT: Dave, maybe I'd better come up and look at yours.

MR. HAMMOND: Well, it's the kind of fifty percent sharing between the owner and the designer, just getting together the owner and the construction contractor and there is a very natural reluctance among designers, in general, to recognize that a mere contractor might be able to come up with an idea that is different from his basic design for the reason that several people have said here, the designer is supposed to design it right in the first place and if there is some better way, then automatically he didn't do all of the things he was supposed to do. I think it misses one important point and I guess I hurt contractor's feelings yesterday by using the terms, incompetent contractors, so I'll say that some of them are more competent than others and clearly, a designer will permit one contractor who he knows is experienced, has good men on the job and knows what he is doing, to do things he would not permit another contractor to do. Once you get to the stage of knowing who the contractor is, he's on the job, and you know that he knows what he's doing, you are much more willing to put something in the contract specifications or requirements than you would at the time that you don't know whether the guy with a wheelbarrow and a dump truck is going to be low bidder or whether it's going to be the Traylor or somebody like that. I think we, as designers, maybe have to recognize that there are circumstances under which we are a lot smarter years later than we were at the time we put the contract documents together. We've had several experiences where we have accepted value engineering proposals from contractors and he's got fifty percent and the owner has got fifty percent. We've even had one where we recommended to the owner the acceptance of the proposal even though the final designer was conservative and said, "No, that should not be accepted." Hopefully, that turned out all right.

MR. RHETT: Hey, Dave, one thing, maybe next time on the million dollars in engineering fees, maybe if you called it VE they'd say you're a hero.

MR. HAMMOND: I think that's a good point.

MR. RUBIN: To a certain extent I think there is a tendency to do something which in law we have an expression for which is putting old wine in new bottles. I

think what you are saying, David, is you've done value engineering long before there was such a term as value engineering and general contractors will tell you that they've done construction management before there was ever a term such as construction management. In part, I think it becomes a semantic problem and we tend to get hung up in that.

MR. KUESEL: Unfortunately, Tom Traylor is not here this morning because I think I would have enjoyed his rebuttal. I'd like to make a few comments. First, thank you, Bob, for a marvelous illustration of the workmen going around with a shield. The first improvement on that deplorable situation is to get a group shield so everyone doesn't have to carry his own. The best example of that that we have is the Better Contracting Report of the U.S. National Committee. This was organized, in very large part, to create a disinterested professional reference that everyone could refer to. So, here is the first relief of your sticking your neck out. You're going according to an industry-wide accepted standard, endorsed by the highest professional council we have. We are engaged now in a somewhat similar, but much more limited effort, on tunneling lining design. We are trying to get the ASCE committee to write a disinterested report that these things are ways to economize and improve tunnel linings without sacrificing quality to get some improvement in the state of the profession. The second comment has to do with the value engineering problems from the designer's standpoint. One aspect is that many of the best ideas a designer might like to incorporate are propriety. The concept of a patent is that it is to protect an idea that is good enough that it would be worth protecting against your competition. Now, we are prohibited in public works from specifying propriety materials or equipment or processes and so the designer can't put those ideas in, although professionally looking at it, gee, this is just the place to acquire that. A stage beyond that is the one Dave just mentioned that there is an idea that is not necessarily propriety but it's a tricky business and it has to be done by whoever submits the low bid. These are areas where the designer would like very much to implement, essentially, value engineering concepts but you're always hesitant where you are either prohibited or hesitate by not knowing who's out ahead of you.

MR. RUBIN: I'd like to pick up on that point, Tom. It's something that we discussed at the table last night. Let's assume for the moment that in my hypothetical example that Tom Traylor mentioned yesterday about the reinforcing steel need not vary with the depth of cover and let's assume for the moment that current practice is designed in that manner, there is more steel where there is higher cover, and that you, Tom Kuesel, honestly, sincerely, believe that it ought not to vary and what you want to do is you want to innovate or you want to innovate say, with a pre-cast tunnel lining that hasn't been done before and you sit down and talk

with your counsel and your insurance people and you recognize that you run into substantial problems and I think it's not unfair to say that the response around the table is going to be, why should we stick our necks out? How are we going to benefit? We can't benefit from it, all we can do is lose. We're going to get a law suit. Our insurance premiums are going to go up. We're going to get a bad reputation; things of that sort. There's been a lot of discussion about disincentives for innovation and the subject that we were discussing and perhaps the panelists might want to respond to this: for the value, for the social value, that is to be gained from innovation, would it be worthwhile for government to pick up the risk of innovation? When Tom comes back to the owner and says, you know, it's contrary to current practice and we want to be absolved of any responsibility, the owner is generally going to say, no. You're going to be responsible for it and he has to, I gather, because of the grant structure and what not. It seems to me that it's a viable alternative, a viable point to advocate, that government as a matter of policy, go into the business of assuming certain risks so that we can have greater innovation in construction which, there seems to be a great sentiment here that there is a reluctance towards innovation and there is a lack of innovation. Jack, what do you think?

MR. RHETT: We're doing something in this area. In innovation if you come in with what we call innovative or alternative technology that's pushing it. Number one, we will take our grant from seventy-five to eighty-five percent. The second thing we will do is guarantee that if it doesn't work we'll come back and the federal government will pay one hundred percent. In addition, if it's not working and, let's say, drives up the O and M costs, we will pick up that increment until such time as we can get it straight.

MR. RUBIN: Will you absolve the engineer? Will you go so far as to absolve the engineer in writing?

MR. RHETT: Well, you know I really hadn't thought of it in a legal sense, to tell you the truth. This is something that we're just starting and just trying. We got it passed by Congress in the last session, trying to stimulate innovative technology. It's a bandit of a problem though because you really have to have a bunch of pros looking at it or what you're going to get, and I know already we've got every snake oil salesman in the country coming down there beating on our door so we are trying it. Maybe a year from now, a year and one half from now, we'll have some experience because we have not awarded our first grant although it's expected pretty quickly.

MR. RUBIN: Would anyone want to respond to that?

MR. HACK: You have to recognize that it has been done with the Price-Anderson Act. The introduction of new technology where the federal government limited the liability and it also has said, we'll come in above

what the insurance industry can carry. Also it has been done as far as architect engineers. We're one of the few agencies after the AEC that has hold harmless clauses in its contracts that people don't object to because we hold the contractor harmless. We do use more often than other agencies cost contractors for our design, also we should on our construction and we do put in. We are now working with, and it's a good incentive, what we call award fees that you can set up if you have a CPFF, CPAF, award fee contract with an architect engineer you can put your award fee criteria as being how much value engineering you do, how well you appear to be doing it and the significance is we will pay. The base fee will generally be about fifty percent of what our current maximums will be and then the award fee will be one hundred percent of our current so a person can make one hundred and fifty percent having done an excellent job in any of the criteria and these are the criteria system. Bechtel was our first design contractor, design construction. In fact it was mostly the construction part under it. After there were failures in other systems we went to an award fee and the results were dramatic. I should point out the most dramatic not because the contractor was getting more fee but because every six months the contracting officer had to sit down with the contractor and tell him what he viewed as the goals for the next six months. He said, this is what I'm going to evaluate you against. This is what I think is important, that's the owner and the project manager's end and then monthly sat down and told him how he thought he was achieving the goals that the manager thought and it wasn't like a big, once every six months we're going to tell you how you're going. I think the improvement in the management and the actual savings after gigantic override were attributable to the fact that there was a team set up which actually communicated and recognized each other's goals for a period of time.

MR. LUCZAK: I think there is a combination of things that can be made a point here. We've heard talk about trust relationships so that we get along and I think there is tremendous ability to cut some costs in a trust relationship. I'd like to cite an example of how difficult this is. Trust and innovation don't necessarily go because suspicion gets in between and it's kind of changing the subject from construction of tunnels to rail equipment. Getting into cost escalation and progress payments and cost saving, we went through the process and came up with a different, I guess, cost escalation clause in our recent rapid transit corporate hearing and it was because when tailed with progress payments it, in effect, met the cash flow requirements of the builder all the way through the process if he could stick with his milestones. We presented this and had a difficult time of selling it because people felt we were trying to pull something and that we weren't using the standard cost escalation clauses, that we were trying to

favor one builder over another but at the bottom line a few people trusted us and let us go ahead. The result was that the low bid left forty million dollars on the table so to say, and I think maybe they were the only outfit that understood the cost escalation clause because when you escalate at their price it came in at the second low bid probably over the cost of the contract. The initial bid was one hundred and thirty-three million dollars, with the escalation clause it would be one hundred and seventy-five million dollars. The second low bidder was one hundred and seventy-three million dollars so I think we understood what was going on; the low bidder did too. The point I want to make though is that it is extremely difficult to evaluate bids when you have cost escalation clauses and thank God, there was a forty million dollar range in the bids because if it had been a ten million dollar range the thing that would have been critical would have been the work program schedule by the builders because cost escalation would have made the bids different because of their different manufacturing styles and I would have had or I would have hated and I think my company would have thrown their hands up if we would have had to gone back to the funding agency and explain that we weren't pulling anything, that, in fact, the second low bidder was actually low bidder because of our cost escalation curves. I think that this idea of trust means that our funding agency is going to have to talk to us on a professional level and understand that we are not really trying to pull things over in favor of one company versus another. We're trying to get the best system for our people that we can at the lowest possible price.

MR. RUBIN: How about a word from our funding agency?

MR. KRBEK: My question has two parts, probably the first part should go to Mr. Rhett. I'm a fan of BART's but the evidence and compelling experiences of being a BART rider for six and one half years and not only watching it from a professional viewpoint but a taxpayer's viewpoint is pretty grim. Today the system can field about three hundred cars out of four hundred and fifty total. The average commuter car from Concord to the city is crowded at a rate of two hundred and twenty passengers compared with a seating capacity of seventy. It is a common practice to ride into a station with the smell of burning odors, insulation. It's also common to see a passenger before the train moves out of the station to close the door physically. San Francisco passengers do this now as a common thing.

MR. RUBIN: They've just visited New York, that's all.

MR. KRBEK: It costs about one dollar and thirty-five cents to go from Concord into the city of San Francisco. It isn't thirty miles and the true cost is somewhere in the vicinity of six dollars and so I think I'm getting a bargain to pay the one dollar and thirty-five. The question is, here's a system that was using new technology.

In 1972 it opened. Six and one half years later it is floundering. It has been tested and yet, the conditions are overwhelming in the grim part of the engineering. What do you view value engineering could have done to a system like BART in 1972?

MR. RHETT: I'm somewhat at a disadvantage because, really, I don't know the BART system at all. I guess I really didn't pay enough attention. I was too busy closing the door and trying to rustle old ladies for seats but I am convinced that any major job, that an outside look will start to bring things up to the basic designer and to the owner that are not only going to be cost savings but also make a better product. I'm somewhat at a loss at the other part. It sounds like BART was pushing technology. I'm not sure that's all bad. You can't expect to win them all. I'm in a field, sanitary engineering, that is not very innovative. Maybe it isn't there, I don't know, but it's just not one, you go back and you look at a sewer plant and they're sort of the same thing. So, I'm not really sure what to say about the innovative portions of BART. I believe in all of this stuff and mass transit where we're going to put so much money, we're not pushing technology and we're going to be in real trouble. That's not a very satisfactory answer I realize.

MR. ASMUS: Let me have a crack at BART since I spent eleven years and made all those horrible errors. Isn't it grand that there are two hundred and twenty people riding in one of those seventy passenger cars with all those problems.

MR. KRBEK: You cannot legally carry cattle in those conditions.

MR. ASMUS: But it was a system that was pushing technology and I think the early board was, and it wasn't the initiative of us engineers that was pushing the technology. The early board was fully apprised of what we were proposing and what they were accepting as our recommendations. We did push technology and maybe we pushed it too hard. I told these guys last night that one of my early testimonies in Sacramento and Dave may remember this, that I spent about one hour describing the train control system and the traction control system and when I got all through Senator Mills grabbed his head and he said, "My God, you left the life boats off the Titanic," and maybe we did leave the life boats off the Titanic. I think if we had approached it from a value engineering point of view rather than a pushing technology point of view, we'd have built a New York City as Clinton proposed and there were car builders in those days that came in and told the BART engineers not to. A transit car is nothing but a people box and that's all it ever should be. It ought to have no seats in it and be made out of stainless steel so that you don't have to maintain it. We could well have built BART that way and we'd still be hauling the two hundred people probably but they'd all be standing up in their stainless steel box. I don't think you can push technology and be one hundred percent successful.

MR. KRBEK: One more part to the question. The second part of the question is to you, Mr. Rubin, because a lot of people have thought about what to do about BART. How do you make the BART trains more reliable? How do you give the passengers an idea that they're not going to ride fifteen minutes late, thirty minutes late, or even an hour or more late to their destination which is the present configuration in the system. Many people have thought let's redesign the controls, let's put in new circuit control boards, put in new signal systems and when the BART attorneys are presented with this idea, the attorneys say, oh, my God, you cannot do this. Westinghouse has proprietary rights. We cannot duplicate their design. We must just keep buying equipment from Westinghouse and yet, the evidence is persuasive that a little bit of ingenuity and a little bit of innovativeness, could use the Westinghouse equipment, copy it, and put in a new system. What are your views on that?

MR. ASMUS: Wait a minute, Bob. It's not necessary and I don't really believe that that's what the BART lawyers are saying because BART is redesigning the system. Westinghouse even has redesigned that system and is using a later generation in Sao Paulo, Brazil. They've offered to sell that whole system to BART and, of course, what the BART lawyer says to the Board is, "Well, you can't buy that because you can't get competitive bids." Now, there's your problem but there is a better system available on the market today and the BART lawyers are saying, you can't buy it because you can't get competitive bids.

MR. RUBIN: I'd like to say something in defense of the BART lawyers, none of whom do I know, nor do I know the facts relating to the situation so my remarks are probably totally impertinent and, perhaps valueless but I have an observation about the relationship between client and attorney and particularly in an institutional or governmental framework. Often times attorneys are looked to as somebody to shoulder the blame, somebody to bear the risk in the event that the thing doesn't quite work out, and particularly institutional attorneys, people come to them from the operating divisions and they ask for legal opinion and they want it in writing so if there is ever any problem they can run right back and say, well, the attorneys told me that I can do it. In engineering there is a great lack of certitude about things even though we like to think that engineering is a precise science. In law there is a much greater lack of certitude and what your counsel is often going to tell you is that there are substantial risks and problems in taking one course of action as against another. However, you evaluate these risks and you make a business judgment about it and then I will help you to set it up in the way most likely to protect you. In an institutional setting the administrator or the man on the operating level does not want to handle this because this now bounces the ball back to him, where he has to make that judgment and assume that responsibility

that he was hoping to stick on to the attorneys. I think there needs to be a frank recognition that this sort of thing exists and when you complain about the ultra-conservatism of your in-house attorneys I think you have to give due deference to this kind of an atmosphere that exists. So much in defense of attorneys but I deal with this quite frequently and it's something that is close to my heart.

MR. GALLAGHER: As I look out upon the hacienda across the street from my house I thank God for the EPA. I also appreciate the fact that as far as rapid transit is concerned I get the impression that it is generally recognized that Los Angeles is about due. However, I would suggest, Mr. Rubin, that the grape that you and your associates consumed last night was perhaps a little too rosé. The way I see it your scenario deviates from what actually happened in three respects. First, the court settlement you mentioned is preposterous because neither UMTA nor the District could have afforded it. Further, UMTA wasn't even a party to this law suit because after giving us the grant they pulled completely away and left us entirely to our own devices. Lastly, the law suit to which you allude never would have happened because our design consultants, PBQD, MJK, FGT, and our thirteen member special review board, their consulting astrologists and our Board of Construction Management, Conzalex, Mohammad and Levey, assured us that something collapsed even though to capture some value we left most of the steel out of the lining, this simply was not in the stars.

MR. RUBIN: There is no reasonable way that I can follow those remarks but attorneys are generally known not to stick their feet in their mouths so I am going to proceed to make a couple of comments about what you said. In this instance, there was no settlement. There was a trial and there was an award, there was a verdict and that verdict was appealed to the highest court and there was a judgment that was entered. Whether the entity against which there was a judgment had the assets to satisfy that judgment is another matter. There are many times that we obtain judgments and the judgment debtor simply can't pay. I don't know what the law in California is like but it is, perhaps, possible that the trustees in bankruptcy of this Japanese and Korean combine could take possession of your rapid transit system and, as a creditor in possession, operate it and perhaps, sell off portions of it. There are ways to collect judgments. The fact that UMTA is not a party, I never suggested that UMTA was a party. The contractor sued the only entity with which it had a contract and that was the Southern California District and this is, to us, a tremendous legal problem and one that we grapple with and one that the courts continue to grapple with and I can't give you any really good case precedent on it. For example, if a contractor has a contract with the owner, the local

transit district, and there are delays to the project and interferences and breaches of contract that are, in effect, caused by a federal agency, under the laws of most states the owner is not liable to the contractor for those delays and interferences and the contractor, in effect, gets stuck assuming that kind of a risk which is a monumental risk. It is conceivable that the contractor could sue the federal agency under the Federal Tort Claims Act which I don't think has been attempted yet and would be extraordinarily difficult to do because you would have to show that the federal agency was grossly negligent in the actions that it took and generally, that's not the kind of problem that you have. In law we have this concept of privity of contract. You can only generally sue the person that you have a contract with for breach of contract and anybody else in the world you can sue but you can only sue them on a negligent, on a tort theory. Yet, with the grant programs these traditional methods of legal analysis kind of fall apart and I suspect that you are going to find law emerging where the government entity that is really calling the shots and pulling the strings, does bear some legal responsibility. Now, there have been suggestions out here that this can be changed by legislation and it can. I think that the contracting and engineering community can propose and support legislation that would permit an injured citizen to make the kind of claim that I am describing here and not have that claim be barred by the traditional existing rules of privity of contract. In the housing field we have run into some cases recently which are going in this direction where the FHA, in effect, sets up a dummy corporation, a local company, to build a housing project and they have absolutely no assets whatever. They go out and they get a mortgage. It's a conventional mortgage and it is guaranteed by the FHA and then the FHA says there was some breach of contract by that local dummy entity and pulls the rug out from under them, terminates their contract and the construction contractor is left with an entity that it has contracted with that has absolutely no assets and there have been some court decisions. I won't go into the ramifications of it, where the contractor has been able to recover against the United States government. I suspect that this kind of precedent is developing and it's going to continue.

MR. HACK: I want to get back to your other statement and bring you back to reality. You have never worked with government as a government employee with government attorneys. I left counsellor's office because I couldn't look myself in the face as a professional attorney as to what the counsellor's office was doing. Counsel does not look to the contracting officer to see what he wants to do and try to get it for him. He tells him what he can do and what he cannot do. The problem in government, I don't know about the local agency, but the federal government attorneys have a client which is some amorphous public interest

and not the operating official and the last thing which I think is much more serious, is the fact that they have grown up now that the way to transmit information is by regulation. We find that simple engineering instructions now require regulations. Regulations have to be written by attorneys and we have like the Federal Energy Management Plan, thirty-nine pages of telling you what you are going to say and another twenty-nine pages which no manager of a facility is going to read and if he did read it he's going to have to get an attorney to tell him what it said. So, I think the problem is a lot more serious. We're not dealing with what the professional issue is. I serve my client, I represent him, I've got to explain to him I make him choose and then I advocate for him. It's quite the contrary and it's a very serious problem in project management. One of the things that may have come out is one of the most important things, deciding. I, as a contracting officer, attorneys will insist that you say, but this is really not a decision under the dispute clause which I want it to be a decision under the dispute clause because I want it resolved because you've got to move but they try to qualify it and get it out and drag it on hoping you'll get some compromise rather than deciding it.

MR. RUBIN: Sam, I disagree with you.

MR. HACK: You disagreeing with my experience?

MR. RUBIN: Not entirely but let's take this situation. The contracting officer comes to you and he tells you this whole tale of woe regarding the relationship with the contractor and he says, that so far as he is concerned he just wants to get rid of this contractor. He thinks that the contractor is in material breach and he wants to know whether he has the legal right to terminate the contract. Now, under those circumstances, you've got to tell him, like the two-armed attorney, no on the one hand and yet on the other hand, yes, you can do it. There is a clause under the contract but you run a risk and I can't tell you now, based on the facts that you've just told me, whether we're ultimately going to win. There were breaches of contract on both sides. You've not entirely clean, the contractor isn't entirely clean. You, Mr. Contracting Officer, have to tell me whether or not you want to terminate him and then I'll help you to do it in the most effective manner. Now, that's the context in which I was making my remarks to the gentlemen before. I don't think you are disputing me on that. You don't go to a regulation and say, yes you can, no you can't. These are very, very, tough questions and you can't decide it for your contracting officer. You can't give him a definite answer.

MR. HACK: Well, I'd say they had. We had one of those recently and I was furious. They did terminate for convenience and if I was the counsel I would have said, you issue a termination for default, the odds are you'll have a fifty-fifty chance you're going to lose. They are going to throw you into convenience but I would have said, you have very little to lose. Financially, it makes very little and yet, after what was a

royal goof-up this thing was terminated for convenience. In fact, when the contractor was called by the contracting officer and the president was not there and the vice president and it got to the secretary, who was the attorney, when the guy said "We're going to terminate the contract," the attorney's question was, "Will it be convenient?" That's all he was interested in, okay. Yet, the contracting officer and the attorney just didn't have enough guts to say, no, it's going to be a default.

MR. RUBIN: So, we don't disagree at all.

DR. GOLDBERG: I think there are two categories of situations. One is the one you alluded to, design decision relative to reinforcing steel concrete arch. The other is, those design steps that the engineer makes during the design process to mitigate potential damages and contingencies during construction. Now, in the first one, any of those measures which relate to design I think, clearly, that kind of thing would be appropriate to EPA process; when a value engineering team comes in and reviews. It certainly would be inappropriate, in my view, for the contractor to come in and have him dispute the weight of professional opinion and certainly those people would know what the state-of-the-art was relative to forces around a concrete arch on the ground far better than a contractor even though he was trained at M.I.T.

MR. RUBIN: With all due deference to our faculty here from M.I.T.

DR. GOLDBERG: I think that a very good example of value engineering is a case where you have buildings next to an excavation and you want to protect those buildings. You have a certain amount of uncertainty regarding the forces on the side of an excavation and you're conservative when you make those decisions. You're concerned about ground water and you want to protect the trees in Harvard Yard, for example. This is a real situation where the provision of the contractor which is on the street now, is to maintain the ground water level in Harvard Yard so that you don't affect the trees in Harvard Yard and that has tremendous cost limitations. All of these things could be managed in a different kind of a way where, either during design a value engineering team could come in and suggest alternatives. The project is big enough to allow a test, if you will, a particular section and see how the performance is and then take the results from that test section and apply it to something else later on down the stream. There is a tendency amongst design people to be conservative because their neck is out and nobody is protecting them against liability, let alone litigation. You can protect yourself against liability but I think you're going to have to pay to defend yourself and that costs money.

MR. RUBIN: Anybody can sue you at any time and at least as the law presently exists, unless you can prove that it was just a totally maliciously commenced law

suit, you have to pay your own attorney's fees and you cannot recover them from the other side.

DR. GOLDBERG: Well, that's true and decisions are made every day with that in mind.

MR. RUBIN: Any by the Bar. There are many criticisms that lawyers bring kind of shotgun law suits and it's true, because the lawyer doesn't know at the time that the law suit has to be brought who really is liable so he has to be conservative and he has to sue everybody who reasonably may have been responsible.

DR. GOLDBERG: Just to summarize, I think, those design steps alluded to which are intended primarily, to litigate contingencies technical in nature, for the most part. They relate to ground movement forces on support systems, movements outside the excavation and that's a big black box in many respects and there is a natural tendency to be conservative. I think there's really no reason why, in the first instance, you can't get a value engineering team in as experts. They are in the design process and those experts sure as hell ought to include experienced, highly qualified contractors, who should come in as part of that team. If they come in and make the recommendations then and they are accepted, in reality, I think the government is picking up one hundred percent of the savings rather than fifty percent of the savings.

MR. RUBIN: Did anybody on the panel want to comment on that?

MR. RHETT: I think a lot of what's said there is very, very, true. You know so often and of course, Bob, your case, anybody trying to prove a point and I do the same thing, picks the worst case. Usually in value engineering people are not talking about, you know, taking the steel out of it so it's going to drop on your head. There are other things in it. It's just a discipline procedure for looking at a problem. That's all it is.

MR. GARRETT: Least everyone think that value engineering is a new concept that hasn't been employed in transit work, we've had a value engineering proposal clause in our construction contracts the last nine years. Now, a decade ago we looked at value engineering as a separate entity, you might say, and felt at that time when it was in its embryo form as an engineering practice, we weren't ready to apply it for design, although I'm sure designers feel as a general engineering consultant, that they do employ some value engineering during the process of preparing contract drawings. I'd like to cite one example of how the contractors employ this value engineering clause. This was a section of our subway near the Kennedy Stadium. At the time it called for design there were three thousand feet of twin box and it passed under a twenty-two foot diameter sewer that services Southeast Washington. We designed that as a cut and cover section as suggested by our general engineering consultant. We employed a designer who was proficient in cut and cover design. He had no knowledge or experience in tunneling. We had to

support that twenty-two foot diameter sewer and the District was very concerned about that sewer as you can well imagine. The contractors bid on that job and the low bidder came in and said, we can give you back one half a million dollars if you permit us to earth tunnel this three thousand feet. Right away our design expertise was completely missing as far as the section designer was concerned. He had no knowledge of earth tunneling. We went back through our general engineering consultant and our peer group, the Board of Engineering Consultants. They both agreed to it and the authority agreed to it and right now we're operating trains through that three thousand feet of earth tunnel. One of the key points, of course, is that the District of Columbia Environmental Department, we're now addressing the contractor that was going to support their tunnel as opposed to any one in the industry and, therefore, when the designer prepared the specifications he had to anticipate unknown, unnamed contractors to perform that work. That was a good example. We've had a few bad examples of the application of this proposal but I feel that it has been of benefit to our program and Jack, I'd like to see you back in Washington and discuss further how we could possibly implement the value engineering during our design phase.

MR. RHETT: Well, I'd really be happy. The first time I came and gave a speech of this nature among professionals it was really very interesting because as I look at the back of the room on one side there were a bunch of guys over there plucking chickens. On the other side, there were a bunch on the other side heating up tar but I really feel we can't afford not to use this approach. I don't care whether you call it value engineering, whether it is in-house, out-house, but we'd be happy to show you where we are.

DR. BAKER: Mostly, I'm involved in contracting and I'd like to say, maybe ruffle some feathers and say what really happens in these value engineering programs that have existed for nine years and other years in Baltimore. One of the most demeaning experiences I've had are those outlaw contractors that have been in value engineering change we're involved in with Traylor. Tom Traylor spoke here yesterday and it was successful but no one was helping us for a long time to try to make that innovative change. The public not only got some money back but they were caused a lot less problems in their service disruption so it's on the books and it sometimes works but there are some real institutional problems with the individuals who know and want to get involved. We're talking today a lot about articles that are going to be published in a few years and I hope this conversation or this as an agenda item in a preconstruction meeting sometime. Now, Mr. Contractor, lists in our pre-construction meeting here, we want to talk about your traffic control situation, how are you going to do that? Let's talk about that and now we want to talk about the value engineering ideas

you have and let's get started on them right away. We talk and hear a lot about the advantage of the European construction program and I don't think we're ever going to really adopt their style because of the different laws and institutions that we have here. Perhaps we can start using some of the expertise that the contractors have and use it at the time when they're not going to get a windfall out of it, necessarily, so that they don't have to be looked at as somebody who is going to get something for nothing. Maybe on that value engineering team there should be some contractors involved at a time when they don't really have an opportunity to feather their own nest, contribution from that point and the people who actually put the nuts and bolts together.

MR. RUBIN: Of course, there is nothing wrong with a contractor who applies time and expertise and getting compensated for it. You have no objection to that I'm sure.

DR. BAKER: No, no, but we need to get it out of the role where he's looked at as somebody who is going to get a windfall because of some innovation or improvement that he is going to make. When he does that he does get a windfall in the sense that it cuts out the competition of the incompetent and maybe he'd be satisfied with just that. Finally, there is another experience that we had in Baltimore where they are now involved in some actually they are change orders now but they were discussed informally with engineers and officials as value engineering proposals with no open reception at that time and now due to difficulties encountered on a particular under-bidding situation well known by those people who are working in Baltimore, it's thrown that particular section of the project a year or two in delay with quite a few things adding costs and those same proposals, the things that are now being done, were discussed informally with people and these are individuals who, nobody wanted to share the risk of a change. I think we ought to talk about, address the problem. If you don't cut costs in tunnels you're not going to build any more subways. Now, we're talking about ways of reducing risks by putting it on the other guy and that's what the insurance company's approach is and that's what the attorney's approach is. If that's the way they view their missions, as an industry I think we have to say let's reduce the risk by recognizing beforehand and maybe setting up a risk fund so that when somebody overruns a little bit the public doesn't get out of hand.

MR. LEONARD: Do you think rapid transit costs could be reduced by stricter monitoring of contractor activity on the job site?

MR. ASMUS: Yes and no.

MR. RUBIN: I was with you too long last night.

MR. ASMUS: I think experience has indicated that some contractors perform better than others and the good performers you could monitor them to death and

they wouldn't be any better. The poor performers, that you discover that they are poor performers early on and not only monitor but help them perform their job in accordance with the contract documents will result in a satisfactory job at a lesser price than if you let them muddle along until you get to the point that was talked about there earlier, where you have to decide whether you're going to terminate them or otherwise shore him up.

MR. LEONARD: Would that indicate that the staffs of most of the resident engineers should be beefed up?

MR. ASMUS: I can't give you a general answer to that because again, you are dealing with different quality of contractors on each job and you don't want to beef up the staff of the resident engineer on a job that is going well. You want to keep a minimum staff on the part of the resident engineer and construction manager if everything is going well.

MR. LEONARD: What device do you use or have you used to compensate when you need additional supervision?

MR. ASMUS: Bleed and beg. You know that one as well as I do. It's the same sort of thing that Dave was talking about, cost is overrunning and the engineer has to redesign the reduced cost and, therefore, his engineering costs go up. You make a budget for construction management based on the average performance of the average contractor and you get ten sour contractors. Now, the construction manager comes back to the owner agency and says, we've got a problem. There is only one way to solve it. You either kick all these contractors off or you use more supervision to see that they get the job done.

MR. LEMLEY: Just as a general philosophy statement I'd like to suggest maybe we've lost sight of the fact that the owner really always pays the bills. The complete and entire bill for all public works in the United States is paid by the public. Now, what we're talking about here today and yesterday is how we're going to allocate risk to extract professional excellence in the implementation of our various public interest structure, public transportation, the subject of this conference. There is risk that is involved in all of that that can be apportioned to various segments of the industry and should be but, ultimately, the bill will always go back to the owner so, to think as a public official, that you are going to extract higher performance by getting "X" amount of the contractor's assets in a certain situation is foolhardy. If he's a professionally competent organization you may be putting him out of business but the next contract is going to have less qualified contractors because the people that he had employed and working as an organization, have scattered to the four winds and they are being pulled into other organizations which are being built at some price. It seems to me that the best thing we can do is set up management systems to handle these major projects that will extract

professional high caliber performance at all levels. In some instances it may mean relieving engineers completely of liability but only after you have gone through a selectivity process where you know you have professional expertise that is up to the job to be performed. If you're going to push technology you have to have the Tom Kuesels and Bechtels involved. You cannot, if you are performing a state-of-the-art type design function, get by with less. And the bill should be less. We should be willing to pay for the assignment of risk and if you want an execution contractor to accept risk you should be prepared to pay more money. He's not a professional insurer as is the insurance industry but he does have to make a profit to remain in business and he will in the long run and I'd like to leave that thought with this conference. If nothing else is realized here, the owner always pays.

MR. RUBIN: I think we've kind of reached the end of the session. I'd like to give the panelists a parting shot and then I'd like a parting shot. If you would bear with us for just a minute, do any members of the panel have anything they would like to add in the way of rejoinder or conclusion?

MR. ASMUS: I'd like to give Senor Ricardo the full aspect of how rosy it got in that glass last night and you may want to know the Japanese contractor went to the Department of State and got your subway declared a free trade zone in order that he could import materials and labor without customs restrictions and then negotiated a long term contract with you for the advertising and concession areas in your station and with that financed your system.

MR. RUBIN: I would like very much to express my thanks and appreciation to our panelists, Jack, John, and Quentin. I'd also like to thank Russ for giving me the opportunity to participate. Usually, scorn is cast upon attorneys. At this conference we have been spared that. I suspect perhaps, next year organized labor will be invited and attorneys won't be but I would like to thank all of you as well for being so attentive and responsive and I hope you enjoyed the program.

**GILBERT L. BUTLER
OFFICE OF RAIL AND
CONSTRUCTION TECHNOLOGY,
UMTA**

MODERATOR

**BOYD C. PAULSON, JR.
CIVIL ENGINEERING
DEPARTMENT
STANFORD UNIVERSITY**

MANAGEMENT R&D REVIEW

**EDWARD CORDING
CIVIL ENGINEERING
DEPARTMENT
UNIVERSITY OF ILLINOIS**

TECHNOLOGY R&D REVIEW

**WILLIAM C. SHEPHERD, SR.
UNDERGROUND CONSULTANT**

**TEST SECTIONS
DEMONSTRATIONS REVIEW**

QUESTION AND ANSWER SESSION

MR. BUTLER: Before we get into the presentations by our panel which will briefly review some of the R & D projects that are currently underway, I'd like to take a minute to briefly discuss how the construction technology program is set up within the Office of Rail and Construction Technology and which is also part of George Pastor's Office of Technology Development and Deployment.

We essentially organized our program into three major activities. The requirements analysis and evaluation work which is really the up-front studies on the direction we should be going in, the needs and requirements activities as well as getting into some of the cost analysis and estimating work. Then we have the technology areas and the particular program areas under technology development. Then we get into where the payoffs are and that is the systems integration and deployment, and we have the test sections and demonstration which have been alluded to before and which we will discuss further and, of course, the workshops and publications.

Earlier in the meeting both yesterday and today we discussed the cost differences between European systems and U.S. systems. Art Fox alluded to a study that Tom O'Rourke has just completed. This is an advance final copy. I am receiving the camera ready copy next week to get to the printers but I think that you'll find that this report, entitled, "Tunneling for Urban Transportation, A Review of European Construction Practice," is very informative. Tom spent a year on an exchange program with the Transportation Research & Road Laboratory in Great Britain and had a chance to travel throughout Europe and get a very good review of European practices. He looks at the practices, the inherent strengths and weaknesses. He gets into the economics and, in the view of economics, he looks at it from the point of ground conditions as well as construction methods and also examines the operation and organization of the European Metro authorities. He has done an excellent job of pulling European practice together and I'm sure that you will find this to be very meaningful and an informative report. I would say, within the next couple of months this will be distributed to you through our normal channels and will also be available through NTIS.

I'd also like to take a minute to, perhaps, clear up some misconception of where we're coming from with this conference. Some people were concerned that we're holding this conference after the fact. That we have a policy and nothing much is going to happen. There was a policy on rail developed in 1976. It was amended back in March of 1978. The material that was available on the table was an amendment to the original policy and what we're discussing here is further amendment to the original policy. Nothing is set. Dr. Page, in his address, was approaching what we are considering and we, indeed, are hopeful that you people will, as you have in your verbal comments, also

express those in written comments, either individually or through some other form so that we can take these into consideration in putting forth improved amendments to the rail policy.

Now, back to R & D. As George Pastor said, his shop was the one that put up the money to have this conference. I think that's one indication of how we, in the R & D, are trying to work hand in hand with the transit assistance people in getting improved cost effective transportation systems. In your packet that you received there were research summaries. Now these research summaries which number about eighteen are the major R & D projects currently underway. Not included in those summaries are things like the Tom O'Rourke study which is going to be out in published form, so we didn't include that. Also, there are a couple of studies that are just getting underway and not enough progress has taken place to where we felt that a decent abstract of the progress or accomplishments would be meaningful. One such study of that category is the National Design Practices Manual. Now, a lot of the discussion the last couple of days alluded to the need for some guidelines and some standards on design practices for urban rail transit systems. Now, we've recently awarded a contract to the American Public Transit Association to develop the outline for this study and I believe many of you or your colleagues are members of APTA task forces which are now in the process, or will be very shortly, of meeting to develop the parameters for this set of manuals. We are, indeed, looking here to the industry. We know each major design firm, each transit property, indeed, does have their own sets of standards and criteria. What we're trying to do is pull all those together into one set and, hopefully, be able to have some standard guidelines in which to base design, not only for your fixed facilities but for rail vehicles and other equipment. Once APTA completes the outline and it is reviewed, not only by UMTA but by the industry peers, we will then go out for a competitive contract to start filling in the blanks on those guidelines.

BOYD C. PAULSON, JR.

MR. BUTLER: The next speaker we have is Dr. Boyd Paulson. He is an Associate Professor of Civil

Engineering at Stanford University. He was formerly Assistant Professor at the University of Illinois. He is a third generation member of the construction industry, growing up traveling on heavy construction jobs in the U.S., Canada and Australia, so he is, indeed, no neophyte to the construction industry. He has also consulted off and on with several of the U.S. engineering construction companies. He is in the process of conducting a major study on research needs in the construction industry and that particular study is not funded by UMTA but by the Office of University Research. I am the technical monitor for that study. We have asked Boyd today to fill you in briefly on what is going on in Management R & D within the Department of Transportation. Boyd.

DR. PAULSON: I assume those of you who are still here at this time are the ones who are most interested in cutting costs on rapid transit construction and not the ones who have nothing better to do than to be listening to me. I hope I can at least contribute a little bit in that direction today. First of all, this I believe so far has been an excellent conference. There are many things I would like to follow up on, but time is very short and, as Gil said, I have been assigned this specific topic which is this Management R & D Review and within that I was told to narrow it down even further so I cannot cover the whole world in a few short minutes.

The first subject will be the risk allocation study which has recently been done at M.I.T. by my colleagues Levitt, Ashley and Locher at that institution. Second will be a report on the second year's results of the Stanford study which is in the general subject of development of research in transportation construction. And, thirdly, since it does tie in as a work task as part of the things we were doing in the second year at Stanford, I will be reporting briefly on my study of the Japanese approach to in-house construction research based on six months I spent there working as a guest, not as an employee, of Ohbayashi-Gumi, Ltd. and also as a visiting professor at the University of Tokyo in 1978. For the first topic it would be much better if I had Ray Levitt or Bob Locher up here. I'm definitely exceeding my level of competence there. For the second topic it would be better if John Fondahl were here since he actually wrote our second year's report. In spite of that, I hope I can do justice to these two reports in which I, myself, cannot really take much if any of the credit.

First of all, quickly, let me give you some background. Last year in Atlanta, when I presented the first year's results of our own study I was introduced by Al Mathews as kind of a prophet of doom as I recall, for presenting some rather dismal economic statistics. We just presented the statistics; we didn't make them up. None-the-less, I was the prophet of doom. This year I was very relieved to see that other speakers have assumed that mantle, especially Mr. Taylor, I believe, so

maybe I'm more free this time to be positive and, perhaps, to suggest a few ways out.

Before coming here I had one of the research assistants up-date the dismal statistics, and there is some good news or at least some rather temporary good news. First of all, the construction industry's volume turned up in the last two years. (Figure 1) As you can

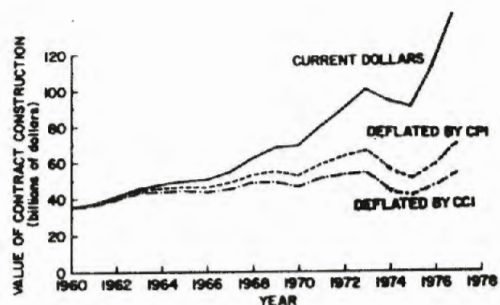


FIGURE 2-2: Value of Contract Construction

Note: The value of contract construction has been deflated by the Consumer Price Index and the Composite Cost Index (for Construction) to show trends in actual physical volume.

Figure 1

see, at least in inflated dollars, it turned up quite markedly. In actual dollars it's about up to the 1973 peak. In our more specific application, however, transportation construction shot way up, (Figure 2) even after allowing for inflation. Even in the famous descending industry curves, construction's physical share

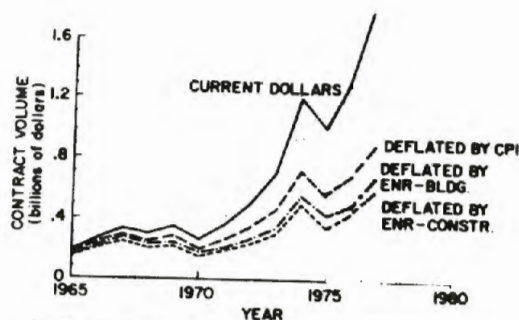


FIGURE 3-5: Contract Volume in Rapid Transit Construction

Note: The value of contract construction has been deflated by the Consumer Price Index, Engineering News-Record Building Cost Index, and Engineering News-Record Construction Cost Index to

Figure 2

of the GNP turned up slightly, at least in contract construction. (Figure 3). But I say this is temporary good news for a number of reasons. First, construction cost indices continue to trend much higher than the national average inflation indices (Figure 4), as you've been informed many times at this conference. Second, the statistics from the first three slides are cyclical, the long-term trend has been down, and government inflation fighters such as Mr. Kahn, tell us that we are likely

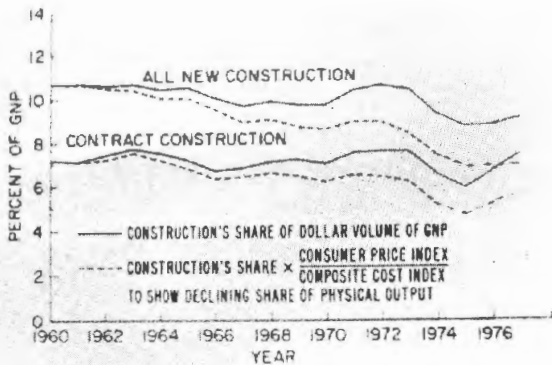


Figure 3

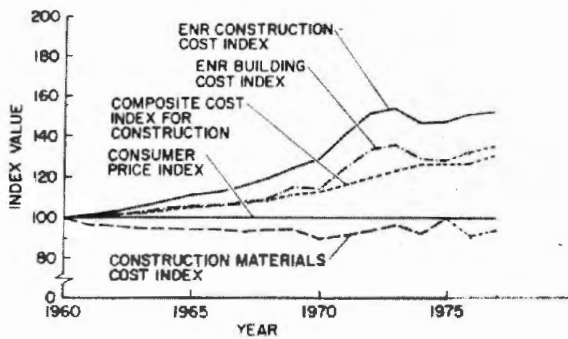


Figure 4

to be going into another slow-down. It's probably going to again follow, in fact, we are told that it is again going to follow, that construction is going to lead the charge in the fight against inflation, which means, of

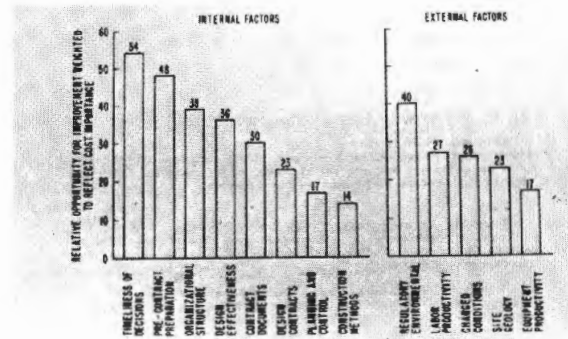


Figure 5

course, the housing industry is already turning down and other projects will as well. So, I say it is temporary good news but at least it's encouraging. The trends are not always down. Finally, however, from what I have heard at this conference, the trends identified, based on two year's work, continue. The major problems and priorities (Figure 5) that we identified in our first year's work, apparently pretty much remained as the people told us in a survey a while back. From this data, we concluded the greatest impact comes from decisions made at the planning and the design stage, which is what is shown in Figure 6 and has been repeated many times here.

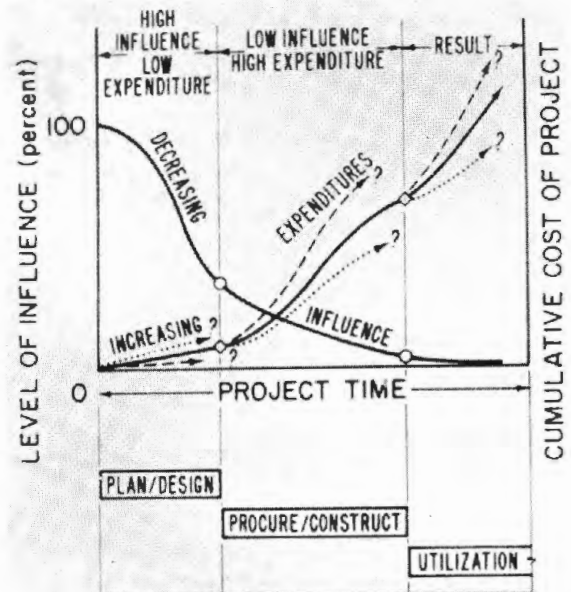


Figure 6

Second, the major problems have to do more with the institutional relationships and the constraints that bind the major parties involved in the overall projects (Figure 7). Of these constraints, one of the most important ones relates to the implications of risk and liability. I think Bob Rubin has demonstrated just how firmly we are entrenched in this legal system that we do have. Many times I think we're saying, "Well, that's the way it is, we're sorry but that's what we're up against."

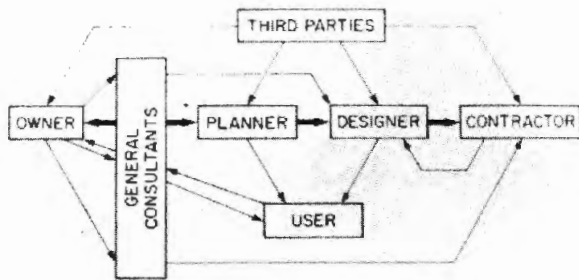


Figure 7

This in turn, after a rather long-winded introduction, brings me to the first task which I was assigned to report on. That is, the excellent study of risk allocation which has been done by the researchers at M.I.T. and the various designers, contractors, owners, insurers and so forth, who cooperated with them in developing a practical methodology to at least get at this risk situation that we have in construction. As I say, I'm going to try and accent the positive this year. This is, I think a positive result that can be accented.

First of all, what is this study? Well, what they are trying to do, I think, is to offer some hope for lowering costs by providing a structured methodology for rationally allocating the risks among the various parties as shown in Figure 7. They have prepared a report that anybody can read and grasp the key messages from it. First of all, in the early chapters of the report, they develop and lay the groundwork of proven theory and methodology upon which their research is based. This includes decision analysis (Figure 8), where you use both objective and subjective data, and I emphasize subjective data because that's really what we're looking at here, to quantify the relationships of decisions and the consequences of those decisions. They go on in their methodology to try to set bounds on the decisions and confine them to an area where equitable agreements

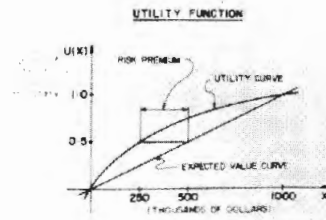
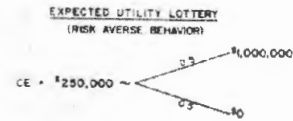
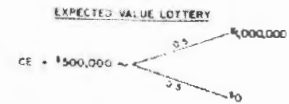


Figure 8

can be achieved (Figure 9). They continue to draw upon structured procedures which have proven successful in other environments (Figure 10). In turn, I think they have clarified these procedures and done a very nice job of adapting them for application in the sharing of risk, at least in the subset problem. That is, the sharing of risk between the owner and the contractor in establishing a construction-contractual relationship for a project (Figure 11).

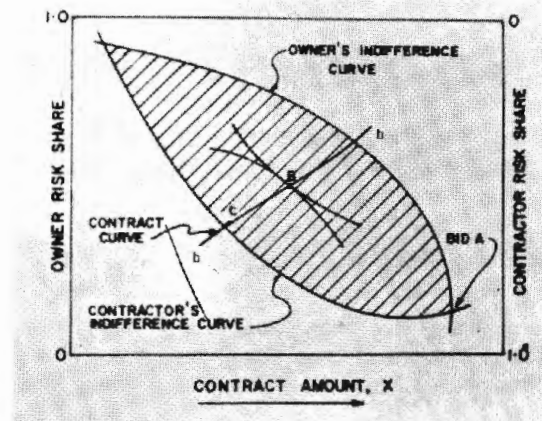


Figure 9

This is from chapters two and three of the M.I.T. report. These are the chapters which develop the theory. In effect, they provide a tutorial on the subject. Even though the theory may seem a little difficult, I

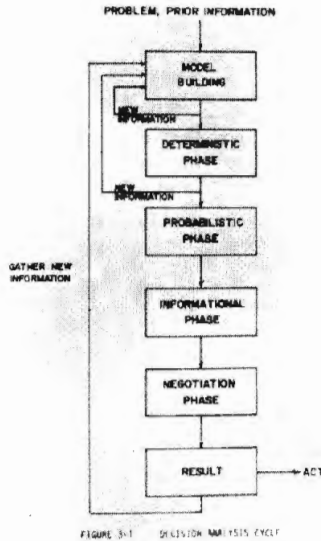


Figure 10

think, you, like me, though not trained in this decision theory field, can still at least grasp from those two chapters the underlying concepts of what they were trying to say. However, the real benefit of this research comes in reading the fourth chapter, where, with the

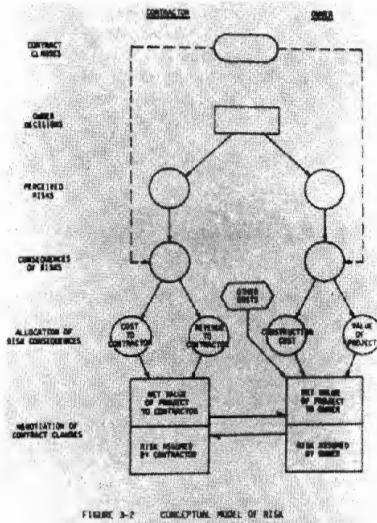


Figure 11

cooperation of the industry and with considerable practical field work, they have developed some example applications which, I think we heard yesterday, are already being picked up in Buffalo and in Boston on the transit systems there. The specific application they developed in chapter four is whether or not to use wrap-up insurance for workmen's comp, for liability, for the contractor's builders risk coverage and so forth.

To quickly summarize what they've developed, Figure 12 shows the contractor's model and Figure 13 an owner's model. Into this structure they also bring in parameters, (Figures 14, 15) which can be tied together in some reasonably easy to understand equations. Based on these parameters and cranking these into the model, one is able to get some feel for the relative sensitivities of these different parameters that they have and, in turn, with the different pieces coming together, come up with the integrated model that brings the owner and the contractor together in an effective system (Figure 16). I know I'm going through these awfully quickly but I'm trying to emphasize concepts

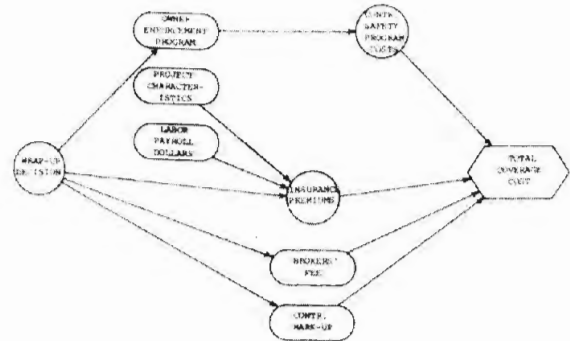


Figure 12

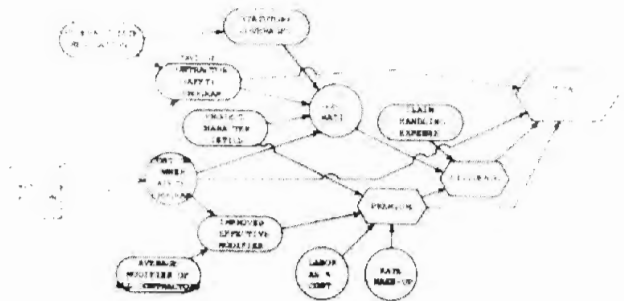


Figure 13

WORKERS' COMPENSATION SUBMODEL FOR OWNER

VARIABLES

T.C.C. = TOTAL COVERAGE COST
 COSP = COST OF OWNER SAFETY PROGRAM
 CCSP = COST OF CONTRACTOR SAFETY PROGRAM
 LAPC = LABOR AS A PERCENT OF TOTAL PROJECT COST
 PC = PROJECT COST
 RMU = RATE MAKE-UP
 PREM. = PREMIUM COST
 LR = LOSS RATIO
 CHE = CLAIM HANDLING EXPENSE

EQUATIONS

CONVENTIONAL T.C.C. = COSP
WRAP-UP T.C.C. = COSP + CCSP + LAPC(PC)(RMU) - PREM.(1-LR)(1+CHE)

Figure 14

WORKERS' COMPENSATION SUBMODEL FOR OWNER

VARIABLE	SENSITIVITY
W.U., LOSS RATIO	X
W.U., RATE MAKE-UP	X
CONV., OWNER SAFETY PROGRAM	X
W.U., LABOR PAYROLL	X
W.U., COST OF OWNER SAFETY PROGRAM	
W.U., AVERAGE MODIFIER	
W.U., IMPROVED EFFECTIVE MODIFIER	
W.U., COST OF CONTRACTOR SAFETY PROGRAM	
W.U., CLAIM HANDLING EXPENSE	

Figure 15

rather than the details of what is contained here. One thing I do want to emphasize, perhaps most strongly, is although these figures show boxes and flow charts and although many of you have already closed your minds to what I'm saying, don't, because this procedure does result in factual dollars and cents results. I should say, dollars and common sense results on alternatives, builder's risk, general liability and worker's comp and whether to use wrap-up or whether to use conventional approaches. They not only developed the data on the alternatives but the data, or at least their approach, appears to be producing significant savings over plans currently being used on major projects. Savings in the

order in some of those shown in Figures 17 and 18, minus ten percent, minus forty-seven percent, minus nineteen percent, I think the overall came out minus eleven percent, something like that. In comparing the possible versus the actual, I'm just coming up with a rational structured methodology for making these kind of contractual decisions in the first place.

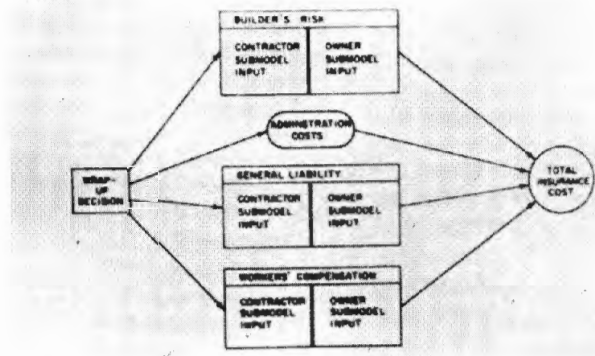


Figure 16

Another thing to emphasize is the insurance case is only an example of what can be done. The same structured methodology can also be applied to the changed conditions clauses, payment and retainage provisions and other areas that do reflect and that are subject to the allocation of risk among the parties. What you are

TABLE 4-13 TOTAL COST TO THE OWNER WITH TIME COVERAGE LIMITS
 (Dollar amounts in \$100's unless noted)

		BUILDER'S RISK			
CONVENTIONAL	\$1 DED.	\$19,150 + \$160	=	\$19,310	
	\$10 DED.	\$ 9,330 + \$160	=	\$ 9,490	
	\$25 DED.	\$ 7,569 + \$160	=	\$ 7,729	*A
	\$100 DED.	\$10,850 + \$160	=	\$11,010	
WRAP-UP	OWNER DED., CONTR. DED.				
	\$1, \$1	net. \$600 + \$8,857	=	\$9,457	
	\$1, \$1	\$ 1,000 + \$8,857	=	\$10,857	
	\$25, \$0	net. \$600 + \$6,656	=	\$ 7,256	*
CONVENTIONAL	\$5 DED.	\$32,886 + \$600	=	\$33,486	
	\$10 DED.	\$23,446 + \$600	=	\$24,046	
	\$25 DED.	\$16,820 + \$600	=	\$17,420	
	WRAP-UP	OWNER DED., CONTR. DED.			
\$50, \$1		\$ 1,232 + \$16,659	=	\$17,891	
\$100, \$1		\$ 1,232 + \$16,659	=	\$17,891	*A
\$1800, \$1		\$ 1,232 + \$ 6,487	=	\$ 7,719	
		WORKERS' COMPENSATION			
CONVENTIONAL	\$43,370 + \$ 2,007	=	\$45,377	*	
WRAP-UP	\$ 4,304 + \$16,820	=	\$21,124	*A	

* Best decision within submodel for type of insurance program
 A Best decision within submodel
 † Combination of deductibles not feasible

Figure 17

seeing here was only a one-year effort. I think they did a remarkable job in one year but they couldn't cover all aspects of the problem. Obviously, needed extensions would incorporate designers and consultants and other parties. This, I think, does mark a very significant start and the report definitely is worth your concentrated attention to try to understand the message that it has. I think it can help reverse our deteriorating contractual relationships and the downward economic trends, which maybe I was too heavy on last year. As an aside, I think it is worthwhile for the government to keep these people going in their research toward incorporating the designer and broadening the study into other applications. At least Buffalo, it appears, thinks that the first year's effort was worthwhile. If you have questions on this, however, I would ask you not to ask me but please ask Levitt and Locher about this study.

TABLE 4-18 COMPARISON OF TOTAL COST OF INSURANCE TO THE OWNER (REAL VERSUS ANALYSTS' RESULTS)

ACTUAL COVERAGES FOR TUNNEL SYSTEM ALL WRAP-UP	COVERAGES RESULTING FROM MOST ECONOMICAL ANALYSES	\$ CHANGE
WORKERS' COMPENSATION (STATUTORY COVERAGE) \$19,892,000	WORKERS' COMPENSATION (STATUTORY COVERAGE) \$19,892,000	0
BUILDERS' RISK (\$30' TOTAL COVERAGE) \$25,000 OWNER DED. \$ 1,000 CONTR. DED. \$ 8,568,000	BUILDERS' RISK (\$30' TOTAL COVERAGE) \$25,000 OWNER DED. \$ 1,000 CONTR. DED. \$ 7,718,000	-108
GENERAL LIABILITY (\$25' TOTAL COVERAGE) \$100,000 OWNER DED. \$ 1,000 CONTR. DED. \$15,901,000	GENERAL LIABILITY (\$25' TOTAL COVERAGE) \$100,000 OWNER DED. \$ 1,000 CONTR. DED. \$ 6,390,000	-478
ADMINISTRATIVE COSTS \$ 263,000	ADMINISTRATIVE COSTS \$ 263,000	0
TOTAL \$45,718,000	TOTAL \$36,779,000	-196

RESULTS OF THE ANALYSES	
WORKERS' COMPENSATION	WRAP-UP \$19,892,000
GENERAL LIABILITY	WRAP-UP 9,394,000
BUILDERS' RISK	COMPETITONAL 7,718,000
ADMINISTRATIVE COSTS	WRAP-UP 263,000
TOTAL	\$36,715,000

Figure 18

Under the pressures of time, I shall move on to the second year's effort at Stanford University which was under the direction of my colleague, John Fondahl, who is not here. He is a Caterpillar Tractor Company director and they have a directors' meeting. The second year's effort at Stanford focused first on the obstacles and mechanisms for improving the implementation of research results, and second on analyzing the impact that planning and design decisions do have on construction. First of all, in the implementation area we went back to using surveys, interviews, going into the field and talking to people. Our surveys were successful. We get returns on these higher than sixty percent. It means you out there are cooperating for which we are very grateful. This year we are looking at three categories on the area of obstacles and mechanisms for improving implementation. We talked to designers, to contractors and to the researchers themselves. We were

looking at both technologies and at management methods in these two areas. First of all, ranking technologies and the second looking at different kinds of management approaches which have been foisted upon the industry, perhaps, in the past two decades. Most of our technologies came out of DOT funded technologies. We got a big pot of these and then tried to correlate them by the ones which have been successful and unsuccessful and, within these, tried to assess the obstacles where they had failed, the incentives that had worked where they were successful, and the dissemination methods which were used to get these technologies and these methods into practice. The technologies studied included things like shotcrete tunnel lining; that's the list along the bottom of Figure 19, listed somewhat in descending order of designer plus contractor preference. Obviously you can see here designers and contractors rank these things quite differently. The lower area, the shaded part of the bar, is the designer's feeling. We're looking at shotcrete tunneling, slurry shield tunneling, precast tunnel liners, laser controlled tunnel alignment, tunnel preinforcement, compaction grouting, chemical grouting, concrete tunnel supports, pneumatic/hydraulic muck removal, and ground freezing.

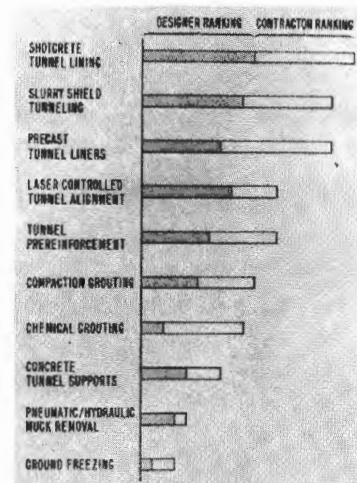


Figure 19

In the management area we looked at network scheduling which, believe it or not, all these people we surveyed ranked highest, in spite of all the failures of CPM (Figure 20). Small computers, value engineering, fast tracking, turn-key, and time-lapse photography are management possibilities which people have been trying to get across in the industry for at least twenty years. Within these, we came up with rankings that lead us into our findings. Here we have, for example, the ranking of perceived obstacles to innovations or implementation, ranked in descending order of combined technical and management innovations by contractors and designers (Figure 21). That's a busy slide. It says a

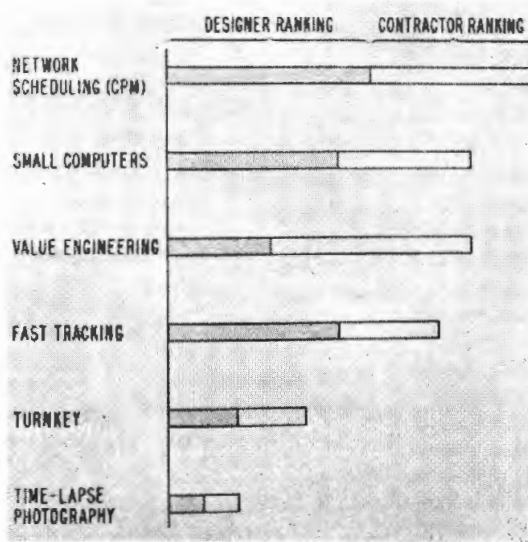


Figure 20

lot, but basically we are trying to set some priorities on where the problems are and what kind of incentives really work. I was interested to hear the EPA man this morning talk about the mixture of financial and risk incentives they had for getting innovations or at least value engineering changes into practice. We also looked, however, at the obstacles that blocked the least successful technologies and prevented them from getting into practice (Figure 22). Often it just turns out that the technology wasn't implemented because it wasn't worth implementing. This is one of the obvious conclusions that comes out of many of these. We looked at the incentives for those which were most successful,

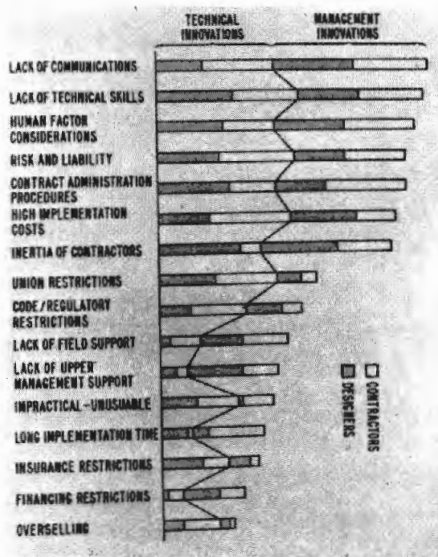


Figure 21

(Figure 23), and also least successful. We also ranked the dissemination methods such as articles in trade magazines (Figure 24). Art Fox's magazine apparently ranks high. Others are consultants, papers and technical journals which many people don't read, papers at conferences, equipment manufacturer's reports, and on

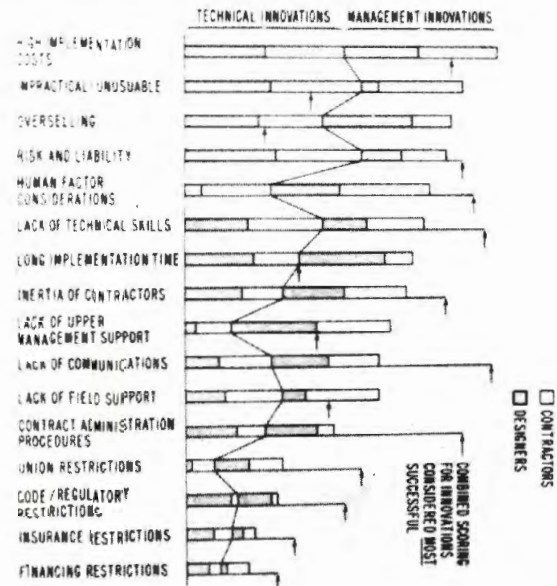


Figure 22

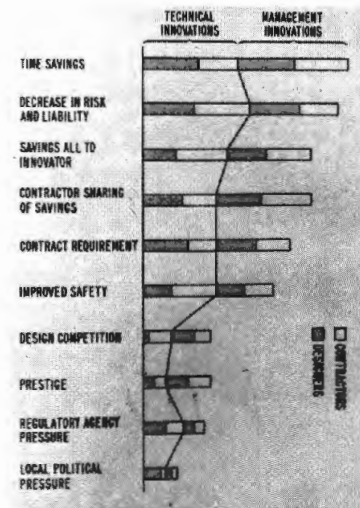


Figure 23

down to external advisory boards as ways of getting things implemented, or at least getting the message across. These are the dissemination methods. This is but one aspect of the general study where we had many technologies and management methods to look at. We also selected four of these for a much more in-depth study. These included rational approach to grouting,

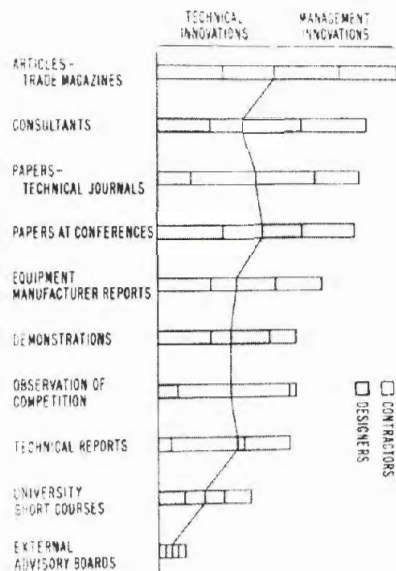


Figure 24

or at least a rational approach to designing of grouted structures, which brought us back to the Baltimore project and Dr. Baker's grouting work that he was talking about earlier. We also looked into the precast liner demonstration project in Baltimore. We were tracking the slurry shield. It's not transit, but the N-2 tunnel in San Francisco could have slurry shield technology or whatever happens to be the innovation on that job. The institutional obstacles that are happening there are rather interesting to study. They actually haven't even got to the proposal stage yet. On the management side we drew on Fondahl's expertise. He's received both the Golden Beaver's Award from the West Coast group and also the ASCE Construction Management Award for his pioneering work in CPM. Maybe one of the reasons they gave him those awards is he's a notorious devil's advocate and skeptic of much of what's been done in the name of CPM, and so he drew on that experience to say why and where that has been successful, and why and where it's failed, and that's the management method that we focused on in great detail.

Next, I come to the other slides I promised to you, Figures 25 and 26, where we did, indeed, look at the planning and design impact in this study. We were not as successful as we would have hoped, but at least I think you'll find the information contained in that report would help you gain at least an outsider's point of view of some things that might make the project still a bit better than they have been in many cases.

Finally, the third topic I will briefly link to our second year study was the Japanese approach to research and development. At this point I realize half of you are going to close the blinkers and go to sleep but I think others of you are beginning to awaken to the potential of what is happening over there. Yesterday, Art Fox

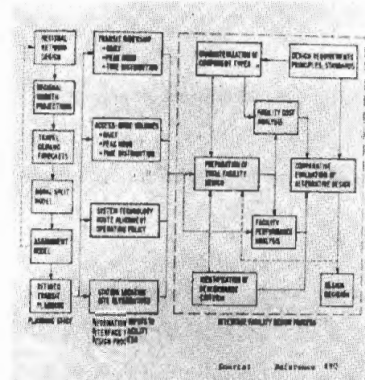


Figure 25

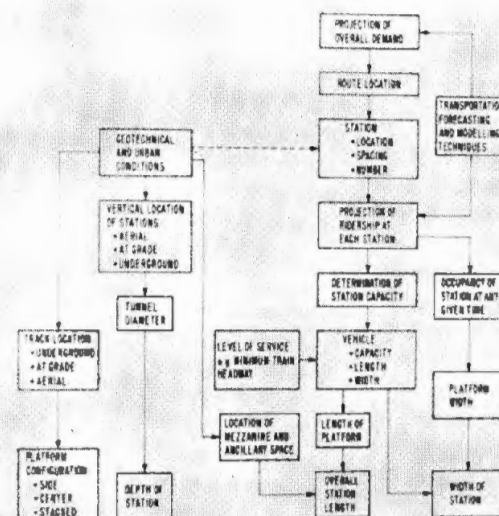


Figure 26

made considerable mention of Asian contractor's current and projected role in the international market, and I responded to his introduction very positively. I have a strong bias in this area, and he seemed to strike a few nerves when he included the United States in that foreign market for other contractors. His magazine has also published data such as that contained on this slide of the Middle East market (Figure 27). I understand from one of his more recent articles that the Japanese proportions and the Korean proportions have been reversed, but at least it shows the U.S. is ranking well behind European and Asian contractors in terms of the Middle East market share. In spite of the fact that we

have about forty percent of the free world's construction capacity, we have somewhere on the order of less than or equal to ten percent of that market. These numbers at least are beginning to get attention even though I realize they do strike some raw nerves.

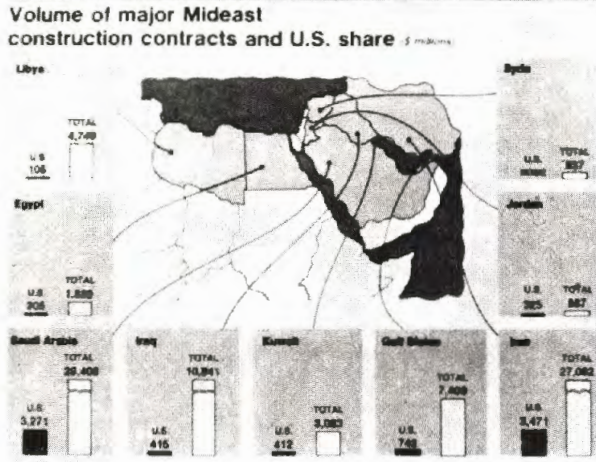


Figure 27

Art Fox also disagreed with me, however, about construction being a service industry, and to the extent that construction produces a product, he's right. But if you look at a contractor's or a designer's balance sheet it looks much more like a restaurant than it does like General Motors or I.B.M. or Ford or whomever, and so in the sense that construction has very low capital compared to very high sales volume, it does look very much like a service industry. However, one thing that has changed in my mind since I talked to this group last year is that this characteristic is not an excuse for opting out and saying that research cannot be part of a construction business on the basis that you can't capitalize it and you can't keep it forever and ever. It's been used as a scapegoat in the past but you find the same financial characteristics in Japan. One thing I have found there is research is and can be an integral part of the construction business. I also mean in the private sector construction business, not just government programs.

I spent six months in Japan this year and two weeks in Korea, on a grant from the National Science Foundation, to investigate both aspects of this question. First of all, why are other countries getting so much of the foreign market and second, how does in-house research fit into their businesses? I went there as a guest, an in-house guest, of a large construction company, Japan's second or third largest, and also as a visiting professor at their top university, which is Tokyo University. During this time I visited over twenty construction jobs ranging from cities to the far boonies, plus many

different companies, research laboratories, nine universities, several manufacturers and so forth. I was working for your taxpayer dollars while I was there, but I confess I also saw some of the sights that ought to be seen as well.

My findings. First of all, research. After World War II, Japan, some of you who were in the occupation forces may recall, was at least forty percent totally destroyed. However, under the brilliant leadership of a man who, perhaps fell into disrepute in this country but not in theirs, General Douglas MacArthur, who is very much respected there, they began to recover. Of major importance was the strength of their own earlier institutional structure. The construction companies along with many other industries, early established research institutes. These were established mostly in the late 40's, largely as sort of paper-study think tanks to study which foreign technologies could best help accelerate their reconstruction to overcome this massive destruction they had. Their openness to foreign ideas and their adaptation of foreign technologies and ideas is a tradition that goes back over one and a half thousand years in Japan. By the mid-sixties, however, they had kind of exhausted the paper study mode. They went into their own research and development, established major laboratories in the private construction industry which now play a vital role, first of all, in solving field problems. That's about forty percent of the work at the labs. In long-term, basic research of the type our universities do, that's about another forty percent of their effort. Market development for such things as say, deep oil storage tanks, is another ten percent and they spend about another ten percent of their time working for corporate clients such as oil companies and so forth, or even for the government. One example is my host company's laboratory, Ohbayashi-Gumi. It's located in Kiyose which is a few miles northwest of Tokyo. The laboratory has every conceivable facility like the National Bureau of Standards in Gaithersburg, Maryland. Excellent structural facilities, excellent mechanical and electrical facilities, any building discipline, they have it. They do structural testing such as large-scale testing of the hyperbolic cooling towers, perhaps, to avoid some problems that you had here while I was in Japan. They've got a two-direction seismic shake table which is driven by a fairly large scale mini-computer installation. This is a construction company mind you, not a university, and this facility is repeated in about twenty-five different companies, not just Ohbayashi-Gumi. This, I should emphasize, is definitely an integral part of their organization. From the president on down they are very conscious and very supportive of this effort, on down to the people working on the project sites who know they can draw on this facility as a resource to solve their problems. Market development, for example, includes some deep storage tank studies on what happens when you have LPG at

cryogenic temperatures and the system tries to freeze and expand and push one tank against another. They could study the Miami double "T" for example. DOT wouldn't have to fund that. They do that internally. Again, it's part of the way they do the construction business, they do this large-scale testing.

Japan is not an oligarchy of the type you think of General Motors and so forth. They have one half million construction contractors. Sounds kind of familiar I think if you know the number of U.S. construction contractors. I was amazed by the similarities rather than the differences between our industries and how the research function can fit in. What are some of the benefits? Well, I mentioned grouting. I mentioned precast liners. I mentioned slurry moles. Tom Traylor by mistake referred to the force balance technique as a way to combat the Japanese entry into San Francisco. That is also, I believe, a technology that is being worked out between the Japanese and Dick Robbins, and I think the technology flow is this way, not that way. So, by mistake he mentioned another technology that's Japanese. Regarding other methods, UMTA should note the Japanese are masters of construction in the urban environment with a minimum of disruption. For example, Tokyo Station handles over a million passengers per day on railways, subways, even the Shinkansen Line. If you were, however, to go down into the bowels of that station, right under the main platforms, literally under the main platforms, you'd find out there is a hundred million dollar construction project going on down there and you would scarcely know it from the one million passengers a day going through. Only when you are invited in and see the subterranean aspects of that do you realize there is a hell of a construction job going on there and it's not tearing up Tokyo Station to where it no longer functions while they are doing that work.

The Kudan Station is another one. Would you believe if you live in Washington, Baltimore, San Francisco or Atlanta that there can be station construction projects in progress without it really being noticeable? Their traffic flows normally on what looks like pavement. It's not pavement. It's metal decking and that's their standard procedure. It hardly disrupts the street at all. You'd scarcely know the contractor was there, but that's a major station construction project using what's called the reverse construction approach, or top down method. To answer your obvious question, isn't that more expensive? The answer is yes. As best I can tell this particular method, which is one of the most expensive they have, is about thirty percent more than our methods. Contrast that to our approach to tearing the juts out of Market Street as we did in BART, creating the bomb craters that we created all over Washington, D.C. being forced underground on Peachtree Street in Atlanta, and the current dilemma of the Charles Center Station in Baltimore. Maybe we could

consider at least some of these alternatives in situations like that.

In two other projects I visited they have deep foundations with computer monitored slurry walls and all kinds of bracing technology going in. This is the epitome of integration between engineering and construction in real-time computer monitoring, in effect, designing the supports as they go down, controlling the settlements as they go down and so forth. This is being done with cooperation between engineering and construction, not an adversary relationship between engineering and construction! The mini-computer system was on site on this job.

Let me just close with two editorial comments. First of all, as you've heard a few times at this meeting, there is a popular misconception in this country that somehow the Japanese or Asians in general are not really engineers or contractors but rather they are like a bunch of little elves who run around in white jackets, speaking gibberish and flogging their low-paid coolies, working under unsafe, slap-dash conditions and applying copied technology. Gentlemen, this is a myth in the strongest sense and I must respond to that. Americans living in Japan, first of all, appreciate the dilemma of the proud U.S. Lieutenant-Colonel in the Air Force who has to stay on his base in poverty making about the same money as a carpenter in Japan. Their labor is reasonably highly paid. Not as highly paid as our New York operating engineers, but they are well paid. Second, they are not only open-minded enough to study foreign technology, but they go on to greatly improve it and go beyond. They contribute many ideas of their own, like the force balance method which was mentioned.

There is another myth I'd like to correct. They are working under tougher, and I underline tougher, environmental and safety regulations than you are. Another thing I'd like to mention is they have, in contrast to London's blue clays which we always hear as a rationalization of why we can't do this or that, some of the toughest geological conditions in the world and other people who have been there can verify that from a geotechnical point of view.

Finally, from tunnel stiff to corporate executive they are not elves, rather they are some of the best engineers and some of the best constructors it's been my pleasure to meet. I mean, absolutely first class people if you will take the trouble to know them. Our perception of Japanese in this country is largely a myth, and the same is true of Koreans.

Last year at this conference in Atlanta I spoke about leadership and I spoke about courage. The courage to see a job through, to persist with a new idea, even in the face of failure. To persist until it is successful if it does have merit. I mentioned people like Roebling in Brooklyn. I mentioned Eads in St. Louis, 1853 as I recall. Strauss on the Golden Gate, Savage at Boulder

Dam. Notice these are all old names; old projects. However, I'd like to present to you an example of such courage which is still alive in the late twentieth century. It is the two billion dollar Seikan Tunnel across the Tsugaru Straits. It is a thirty-two mile tunnel which is being built to connect the main island of Honshu to the new frontier, in effect, the Alaska of Japan, the island of Hokkaido, important to their national development. Thirty-two miles of tunnel under rough water, under fault zones and every other imaginable geological condition which you've probably seen in your worst nightmares but probably not on your jobs. This is being constructed by about ten contractors and I think they are the cream of the Japanese industry. Certainly, they are the larger contractors. The subsea tunnels are driven from two shafts. The Kajima venture's shaft is on the south end. It goes down a couple of hundred meters to the bore, down another hundred meters to the drainage tunnel. The north shaft is for a tunnel being driven by Taisei, or a Taisei venture. These people started in 1964 sinking these shafts. That was a problem in its own right to get those shafts down. The tunnel itself consists of main bore, which is being driven by multiple drift methods. They also had two pilot bores, one way down deep for drainage and the second one parallel to the main bore, one hundred feet over, from which they could drill across and grout the main bore before they got there. They are doing long horizontal exploratory drilling, I believe a couple of hundred meters out ahead of the tunnel. That's I think a technology DOT has looked at. They also do have very stringent safety precautions. Another myth is the belief that Japanese have a callous disregard for human life. I'd say their safety standards are even higher than ours, and their regard for human life, if anything, is even higher than some of the callous attitudes I have seen in some American organizations. The safety precautions include flood gates and an initial pumping capacity of up to fifty tons of water per minute at each portal. That's water under two hundred PSI pressures that's likely to come in that tunnel. I think, as some of you are well aware on this tunnel, they have had some extremely tough problems, some extremely tough failures along the way to getting this thing done, and that's where their courage and where their persistence that I mentioned, does come in. I was particularly impressed when standing beside a bulkhead where they had a cave-in that brought in eighty tons of water a minute. I mentioned they had pumping capacity for fifty tons of water a minute. What would you do, and this is well out under the ocean by the way, and here you are facing eighty tons of water a minute? Shall we give up the job? I mean, the British gave up one of these before they ever got started as I recall, drilling through nice chalk. No, they didn't quit. They hacked up, drove out around it, grouted through it and they are off again. I'm happy to report at this stage that they are now, out

of the thirty-two miles of tunnel, within a few miles of completion. It's going to take them maybe a couple of more years to finish, and I only wish I could be there for that holing-through party.

The only thing I'd like to emphasize again is that people like those working on that Seikan Tunnel, working in Japan in general, are not elves, they are not using magic to get their jobs done. Rather, it is very simple. You go study them and you find out the answer. They are some of the world's best engineers and constructors and just as they have benefited from you and they acknowledge that they have benefited from you, you can learn from them. Part of their whole philosophy is to learn from others. I say you can learn from them if you will only try. That's all you have to do. There's a lot of things to learn and I at least will be trying to report some of that in the coming year. I guess I usually get people mad and I probably did it again, so you can have at me in the question session. Thank you.

MR. BUTLER: Thank you very much Boyd.

EDWARD CORDING

MR. BUTLER: Next is Dr. Ed Cording, who is Professor of Civil Engineering at the University of Illinois at Urbana-Champaign. Ed has been involved in conducting R&D in tunneling technology for a number of years. A great amount of that work has been sponsored by DOT. He also serves as a consultant on tunnel construction to all of the new rail transit construction projects.

We have asked Ed to summarize the technology, particularly in the area of ground prediction, ground movement, prediction and control since that's one of our major undertakings. I am sure Ed is going to be hard pressed to cover all these projects in the short time we've allotted him, but we'll see if we can't keep him going. Ed.

DR. CORDING: Thank you, Gil. I'm really happy to be here and participate.

Because of time constraints I can't summarize all of the research in the tunneling area that's being sponsored by UMTA, but I did want to highlight a few of the tunnel studies that have been carried out in two major areas, the area of ground movement prediction and control and the area of lining design and innovations in lining methods and materials. I apologize that I have emphasized some of our own research, because of my familiarity with it.

In the ground movement studies, efforts are being directed toward improving the methods of estimating or predicting ground movements and the potential for damage to structures. Secondly, the studies are addressing the question of how the ground movements can be controlled to keep damage to acceptable levels.

Damage due to soil movements around soft ground tunnels is one of the most critical problems in tunneling in urban areas. Many of the design and construction decisions on a soft ground tunnel project must be directed toward preventing excessive damage to structures or utilities near the tunnel. Decisions must be made regarding the choice of cut and cover construction or tunneling; the tunnel depth and the alignment required to minimize damage to structures; the need for underpinning or reinforcement of structures; the use of dewatering, compressed air, grouting, or ground reinforcement to improve ground conditions; and the use of restrictive measures in excavation and support of the tunnel to minimize loss of ground. The above measures will have substantial impact on project costs and the safety of the work.

In the lining design studies, efforts are being directed to designing tunnel linings in such a way that they are more economic. In many cases linings are overdesigned, with heavy reinforcement that is placed to satisfy an analysis procedure but is not required for the

stability of the structure. Research, consisting of field observations, large-scale destructive laboratory testing, and complementary analyses, is providing the hard facts needed to make informed design decisions. Research is also being carried out to develop and implement innovative tunnel lining concepts or prove out lining systems that have not been widely accepted by the tunneling community.

In the past eight years, several major studies on ground movement and resulting building damage due to tunneling have been carried out on U.S. subway projects. From 1970 to 1973, ground movements were measured around the first soft ground tunnel on the Washington D.C. Metro, in a program carried out by the University of Illinois and sponsored by the Washington Metropolitan Area Transit Authority. Both vertical and horizontal displacements were measured throughout the soil mass as the two tunnels were driven by the instrumented test sections. The results were correlated with the tunnel shield characteristics and the construction history so that the causes of the movement could be determined. Volume changes and strains throughout the soil mass and the characteristics of the settlement though were also determined. The studies helped pinpoint the characteristics of the first tunnel shield that were the cause of large movements. These problems were corrected in driving the second tunnel, which passed close to existing structures.

The U.S. Department of Transportation, principally through UMTA, has supported subsequent field studies on ground movements. Ground movements around three other tunnel sections on the Washington Metro have been observed and summarized, and structures adjacent to one of the tunnels were monitored to determine the relation between their damage, distortions, and the ground movements. A grouted tunnel section on Project G-1, Washington Metro, was instrumented, monitored and interpreted in a program carried out by Hayward Baker Co., the grouting sub-contractor, with the assistance of Stanford University and Goldberg, Zoino, Dunncliff and Associates.

The results of the tunnel studies have provided information on the causes of lost ground. Is the ground being lost ahead of the tunnel face, around the tunnel shield, behind the tail of the shield as the lining is expanded or grouted, or around the completed tunnel lining after it is in place? Deep settlement points anchored above the tunnel and monitored as the tunnel shield passes below the point have been useful for pin pointing the features of the shield and the ground conditions that cause the movements. The information should aid in the design of future shield tunnels.

The studies have also provided data on the levels of building damage associated with ground movements. Figure I illustrates the distortion of two brick bearing wall structures measured in Washington D.C. as the tunnel shield passed beneath the buildings. Measuring

(tape extensometers) were extended diagonally and horizontally in the interior rooms between bearing walls to measure lateral strains. Settlement and tilt of the structures was also monitored. Building II, located near the edge of the trough in the zone of lateral extension and convex curvature, was subjected to very little settlement (0.2 in. differential settlement) and underwent a lateral extension strain of $1/3000$ (0.33×10^{-3}) at ground level. The building was in a zone of convex curvature of the settlement trough, and because the structure was not laterally restrained in the upper floors, it was able to bend freely and develop progressively larger lateral strains in the upper floors ($1/1300$ at the top of the second floor). Building I, located nearer the center of the trough, showed very little final lateral extension at any floor level. The building underwent a differential settlement of 1.0 in., most of which resulted in shearing distortions.

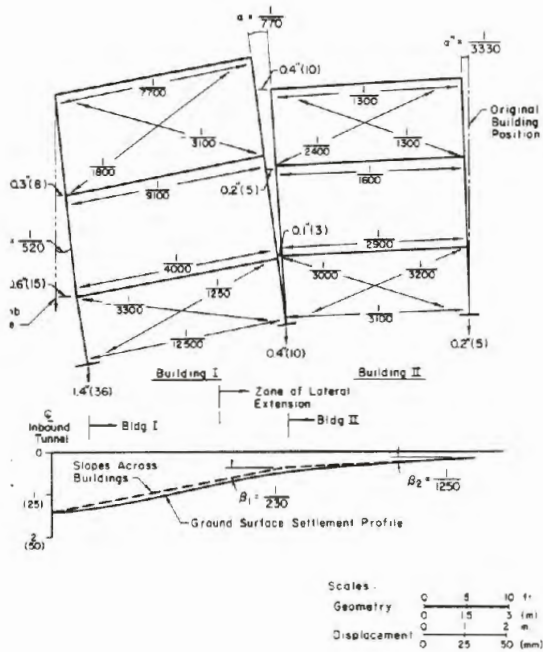


Figure 1. Final distortions of buildings I and II, Boscardin, Cording and O'Rourke, 1978 (case studies of building behavior in response to adjacent excavation)

The tape extensometer measurements have provided a means of evaluating the relative influence of lateral movements and settlement on the damage to structures. Near the edge of a settlement trough, lateral movements are a major cause of damage, and the use of

vertical underpinning beneath the structure does not prevent the lateral movement. From the results of the DOT studies, damage levels can be correlated with building distortion and ground movements, and then to the causes of ground movement around the advancing tunnel. Thus, a knowledge of shield characteristics and ground conditions makes it possible to estimate the ranges of typical ground movement and damage and the potential risk of large settlements.

I would like to describe a recent case where an instrumentation program sponsored by UMTA was used to evaluate ground movements. The work was carried out on the Bolton Hills Section in Baltimore; instrumentation was installed and monitored by Hayward Baker Co., the grouting subcontractor, with Goldberg, Zoino, Dunncliff and Associates. The Bolton Hills project provides an example of how ground movements can be controlled during construction. Compressed air was required in the tunnel. The specifications also called for certain characteristics for the shield before the shield went in the ground. In addition, for the first time on a tunnel contract, a compaction grouting program was specified. The concept that was originally proposed called for compaction grouting in the soil beneath the footings and walls of specified structures to restore them to their original level if the displacements of those structures exceeded or reached one quarter of an inch.

Prior to using the compaction grouting on the Bolton Hills project, previously collected data on the distribution of ground movements in similar soils in Washington, D.C. area were studied by the grouting contractor and his consultants to determine the most effective position and time for placement of the compaction grout bulb in the soil mass during tunneling. The previous studies showed that a zone of expansion developed in the dense sandy soils immediately above the tunnel and progressively moved upward toward the surface as additional movements took place (Fig. 2). The width of the zone of movement spread as it approaches the ground surface. Whereas the movements immediately above the tunnel are nearly vertical, those at the ground surface, near the edge of the settlement trough have a large horizontal component. To minimize both the vertical and horizontal movement of buildings located near the edge of the trough it was decided to place the compaction grout bulb through pipes drilled from the ground surface to a point approximately ten feet above the tunnel crown, rather than placing the grout bulb immediately below the building foundation. Thus, the volume of ground lost into the tunnel was replaced by the compaction grout bulb near the source, so that the lateral or vertical movements at the surface never developed.

The Bolton Hills project provides an excellent example of how instrumentation and observations can be used to monitor and evaluate construction procedures.

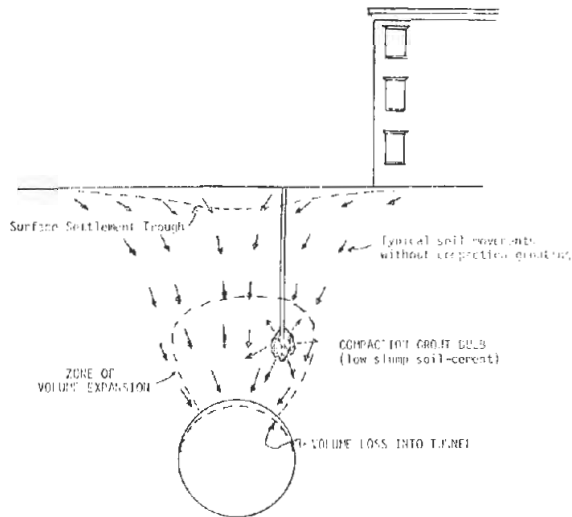


Figure 2

One of the instrumented test sections was established near the start of the tunnel in order to evaluate the effectiveness of the compaction grouting and optimize its use on the buildings further down the tunnel line. Enough information was obtained during construction to show that the compaction grouting was minimizing movements at the surface and that the settlement of the structures was held essentially to zero at the surface using compaction grouting process. The results are now providing the hard facts needed to understand the interaction between the compaction grouting and the tunneling, and to eliminate the "black box" approach common to many specialized construction processes.

Lining design is an area of research in which field observations are very useful, but much of the work must be conducted in the laboratory in order to perform destructive tests that will provide information on the ultimate capacity of a lining. The Department of Transportation has sponsored several studies on lining behavior. The behavior of rock bolts and rock bolt spiling in supporting tunnels has been studied at the University of California at Berkeley by means of field measurements and laboratory model tests. At the University of Illinois, large-scale model tests have been conducted on shotcrete linings to evaluate the parameters affecting its capacity under ground conditions typical of those encountered in U.S. rapid transit tunnels. The use of shotcrete and rock bolts, and tunneling practice in Europe has been studied by M.I.T.

Today, I will emphasize three other research studies on tunnel linings: They are: 1) the extruded tunnel lining system (Foster-Miller Associates), 2) segmented concrete tunnel linings and sealant systems (U.S. Bureau of Reclamation) and 3) structural capacity of monolithic concrete liners (University of Illinois).

Several years ago, the U.S. Department of Transportation supported initial studies, developing the concept of an extruded concrete tunnel lining system and testing and pumpability and setting requirements for the concrete to be used in the system. The program has now reached the point where components of the slip form system are being tested by Foster-Miller Associates. A subsequent objective of the program is to develop the system to the point that a full slip form can be tested under actual tunnel conditions.

The extruded tunnel liner is intended for use with a shielded tunnel boring machine. With this system, a non-reinforced concrete lining is placed behind a slip form as the boring machine advances, and serves as both initial and final support of the tunnel (Fig. 3). The pressure of the fluid concrete behind the slip form provides some immediate support of the rock as it emerges from behind the shield of the tunnel boring machine. The set time is adjusted so that the concrete lining is capable of standing and supporting the initial rock loads by the time it is extruded from the slip form. The slip form must be able to advance at approximately the same rate as the boring machine, although the connection between the boring machine and the slip form is designed to allow some relative movement.

Foster-Miller Associates has begun testing components of the system to evaluate the design of the bulkhead and slip form and the ability to inject the concrete and advance the slipform and bulkhead. After completion of the component tests, it is planned to fabricate a prototype slipform, of full circular section, for testing in a section of tunnel.

The U.S. Bureau of Reclamation has been conducting tests on the structural and sealant characteristics of concrete segments used for tunnel linings. Joint sealants from a variety of sources in the U.S. and throughout the world have been collected and tested to determine their strength, adhesion, deformability, and leakage characteristics. Segments and segment joints have been tested for shear and compressive strength. A full ring of concrete segments will be tested by applying water pressure to the exterior of the lining, then loading the lining with simulated soil loads to evaluate the leakage of the ring as it is distorted.

UMTA is also supporting the field testing program for evaluating concrete segments being placed throughout one of the twin tubes on the Lexington-Market section in Baltimore, the first use of concrete segments on a U.S. Metro project. That, and other field testing programs, will be described in Bill Shepherd's presentation.

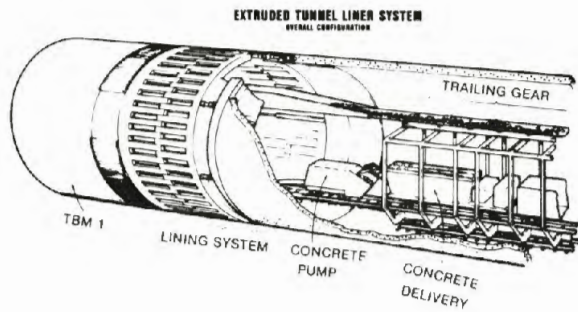


Figure 3. Extruded tunnel liner system (overall configuration)

Structural tests on ten foot diameter rings of reinforced and nonreinforced concrete have been carried out at the University of Illinois in a loading frame that applies active ground loads to the crown of the tunnel and provides a passive reaction at the side of the tunnel that builds up as the lining deflects outward. It is a well-known concept in tunneling practice that the ground helps support a tunnel lining; the test program has been carried out in order to quantify such effects, and to provide the basic data needed to permit designers to take advantage of this favorable interaction between ground and lining.

A lining that is flexible with respect to the ground suffers little damage (excessive cracking or spalling) as it deflects under load and is therefore capable of developing high thrusts. Non-reinforced concrete linings have substantial capacities in such cases, and are able to sustain tensile cracking without excessive damage or collapse (unlike a free-standing non-reinforced concrete column that would collapse if subjected to sufficient eccentric loading to develop tensile cracks).

Figure 4 shows the results of some of the tests. The ultimate (failure) thrust levels increase with increasing soil stiffness. The non-reinforced concrete has a significant strength, even though it is lower than the reinforced lining. Small amounts of reinforcement can help spread cracks and limit the damage that develops at or near working load levels. The results clearly show that adequate linings can be designed without heavy reinforcement, one of the greatest costs for a cast-concrete tunnel lining. The studies have already provided results that have permitted a substantial reduction of the

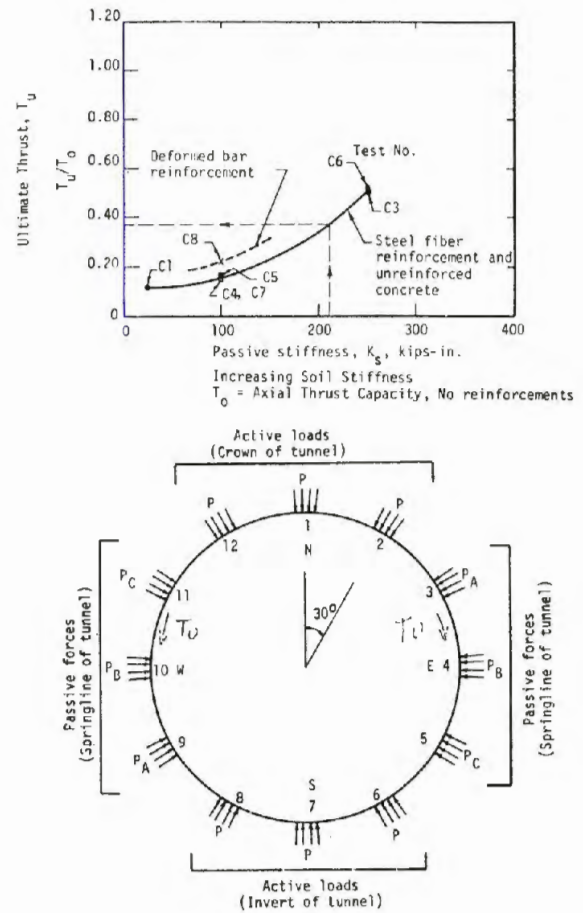


Figure 4. Ferrera-Boza and Paul, 1978 (structural behavior of monolithic concrete tunnel liner models, UILU-ENG-78-2028)

quantity of the steel used in the structural lining for a subway station.

It is encouraging to note the progress made in several of the tunnel research programs. We have seen examples of studies, such as the extruded tunnel lining program, that have progressed beyond initial concepts toward implementation in full scale test sections.

There are examples where field observations made on earlier projects have not just collected dust in a project file, but have been utilized in planning new projects, for example the use of compaction grouting to control ground movements and limit building damage. In turn, careful observation of these new procedures is providing the facts needed to eliminate the black box approach and permit the designer to make rational decisions about the future use of new methods in other soil and construction conditions.

The studies on concrete segments, both in the laboratory and in the field should provide more than just a demonstration to the U.S. tunneling community that segments can be used here as well as in Europe, but should provide useful new information on items such as casting tolerances, sealant requirements, and damage that will be of significant use to designers and contractors in the future.

There is a need to continue to collect good quality information on tunnel performance and to carefully evaluate new construction methods.

In the area of ground movements and building damage, more information is needed in order to make the proper judgments as to how to control movements, how to include the information in project specifications, and how to manage and coordinate the project in such a way that the objectives are accomplished at minimum cost.

Topics such as ground movement can hardly be discussed in technical terms alone, but must ultimately include the management and contractual relations on the project. John Asmus of Bechtel commented earlier today on the need for coordination between the designer and the construction manager.

In some of the comments made during the past two days, it has seemed to me that the problems that arise once the design reaches the field are largely attributed to the contractor. That's only part of the story. On too many transit projects, coordination between design and construction management is lacking. In order to carry out the design concept on a complex underground project, the designer should be in contact with the construction supervision staff regularly throughout construction. The resident engineer or manager should have the authority and the expertise, or have access to expertise, so that he can make informed and timely decisions.

Liability is not the only reason for design conservatism. If the designer does not know how his design concepts are going to be interpreted or what the quality of the work will be he will tend to choose a more conservative alternate. For example, if he feels that requirements for controlling ground movements will not be enforced, he may specify additional underpinning.

Monitoring on projects can be very useful for providing a means of controlling the project or confirming the design concept, as well as for research to advance the state-of-the-art. In establishing a monitoring program, it is important to determine whether the conditions can be observed in a timely manner so that changes can be made, or whether it is not possible to react to the conditions in time, or the cost of the potential change would be excessive. In the latter case it may be preferable to design around the problem or design conservatively enough so that design accommodates all potential conditions. Monitoring is very important when tunneling under major structures that are very

difficult to protect. Deep settlement points can be placed over the top of the tunnel to observe the movements close to the tunnel and tie them to specific events that are causing the movement. The information can be used to determine what corrective measures would be appropriate. If the movements are occurring around the shield because it's plowing through the ground, then the solution isn't more bracing in the face of the tunnel.

A monitoring program should not be made part of the design requirement unless there is a plan and willingness to integrate the program into the design concept and the construction control process. The inspectors and instrumentation and geotechnical people should be working together to observe and collect pertinent data in sufficient time so that the resident staff is informed, the designers input can be obtained, and alternatives pursued if indicated by the conditions. Similar comments have been made before—K. Terzaghi and R.B. Peck have described very adequately the use of the observational method in geotechnical practice. It is not new to U.S. tunneling practice. But it does require close coordination between designer and construction manager and a specification that can accommodate an alternative. Adjusting to changing ground conditions and ground behavior tends to test the seams of the organizations involved in rapid transit projects.

Education and training is another need in the U.S. tunneling community. More emphasis should be placed upon training supervisors, inspectors, and laborers in the use of new technologies on a project. Even with accepted technologies, there is a need for training of new personnel or of refresher courses for the experienced workers. UMTA support of training programs and inclusion of requirements for training in the contracts would be a means of accomplishing a higher level of craftsmanship on projects.

WILLIAM C. SHEPHERD

MR. BUTLER: Lastly, but not by all means the least, is the next discussion of the payoff of these R&D programs. Bill Shepherd has been asked to summarize some of these major test section projects. I first met Bill four years ago when he was a P.I. on a study group on safety and environmental guidelines; he was with A.A. Mathews at that time. Since then he has been a consultant with PBT on the MARTA project and is now a consultant for Law Engineering and Testing Company in Atlanta. Bill has been involved in a couple of our test sections and so we have asked him to briefly summarize our activity in that area. Bill.

MR. SHEPHERD: The first thing I want to do is scare you with all these research papers I have in my hand. I, of course, have no intention of taking the time to go into any great detail but I do want to present a quick overview of some of the current projects. First I would like to clarify that in your little blue agenda you will see that my name says William C. Shepherd. I am a senior but I noticed that it said, "junior underground consultant." I think that's true and I think a lot of us are junior consultants. I have known some excellent consultants in my life time. Some of them have passed away and some are retired now, and it's a shame that they have retired since we need their efforts. I call them senior consultants. I think some of us tend to think we're senior consultants but we're not. We still have much to learn. In listening to earlier presentations on what's occurring throughout the world, the Japanese, the Swedes and the Germans and so on, it sounds more like a horror movie as it relates to the U.S. I walked away from the conference in Atlanta last year extremely frustrated, having been to at least twelve conferences or more in the last four or five years all related to underground construction in some form or another. But I'm happy to say that I'm not frustrated today. I believe George Pastor said that he felt this was the first conference. Well, it is because now we have brought together the people that should have been at the first conference; the decision makers. I think we have made great strides in the past twelve months, some of which I have just become aware of. I didn't realize that some of these programs were going on. There are so many, it's hard to keep up with them. At the last conference a statement was made by Mr. Mathews that we needed more dedication. I am very fortunate to be working with a group of consultants which I put together about two years ago. I think great accomplishments are now coming forward, due to our group's dedication. One of the statements that was made by George Pastor was that this program was initiated in fiscal year 1973 with very little money and was a four-phase program. In the

past year we have jumped to what I call the three-and-one-half-step program, instead of taking another year or another two years to start implementation, we have started and are now ahead of schedule. I find in order to implement projects there are frustrations. If you intend to have any mind to do investigations that come under this program, please start early. The alluding fact that it doesn't take long once the grant has been accepted verbally and goes through the government bureaucracy of two or three months to fund the money is not the problem. It's the transit authorities themselves and the engineers. So, if you have any plans of implementing anything that is unique and you think it's valid, start early. It is not an easy process.

To justify R&D we know that industry has found that there is a certain amount of sensible investment, some proportionate investment should take place in order to yield a dividend beyond that investment. In order to reduce costs UMTA has selected to do just that. The recent philosophy of R&D is now not only recognized by UMTA but is supported by them. In fact, UMTA has taken the lead. They, themselves, have become innovative and if that isn't mind boggling in a government agency I don't know what is, but it really has happened and continues to happen and I now believe the efforts of the past few years, the studies and demonstrations, are about to reach fruition. In 1973, as I understand it, up to the present date including the current fiscal year, funding of UMTA R&D programs now comes to eleven million dollars. As I recall, the original request was four million dollars for the first fiscal year and unfortunately, that did not take place. As was stated, the basic philosophy was studies, reports, dissemination of findings and reporting, then full scale and monitoring demonstrations, and finally implementing them into the systems. The implementation is when the real dollars come back. However, indicators show that some of the dollars are coming back even prior to implementation.

Most of the projects are in your research summaries and I think they are important enough to point out some that I am very familiar with. I've been involved, in one completed study and am now involved in two more studies and two full scale demonstrations.

As mentioned yesterday, the dollar value of two hundred and ninety thousand was a grant to Miami for the double "T" R&D. The cost estimates show that the pre-cast boxes would be approximately twenty-five percent more expensive than the pre-cast double "T". The long range benefit, in only the first phase which now is becoming a reality is somewhere around six to eight million dollars. Bear in mind, that's half the money that has been totally funded for research and development programs since 1973.

Another ongoing program is the pre-cast concrete liners that have been discussed several times in the last two days. A monitoring program has been implemented

to document the behavior of this new type of liner system. I might add that these statements of work and their intent are available. If they are not covered fully in your hand-out I'm sure that Gil Butler's office will be glad to make the information available to you so that you can track a particular project to conclusion.

I found a very interesting one in the muck handling. I've been hearing about that for five or six years. A very interesting occurrence I had which shows that UMTA does have some foresight, was a tunnel in California wherein the bid proposal was the normal procedure of a cycle of ten miles to dispose of the tunnel muck. The owner did not have the foresight to investigate and try to envision where the tunnel muck might be placed. The tunnel was twenty-eight thousand feet long and nineteen foot diameter finish. So, we just plugged in the ten mile cycle like everybody else. When we got the job, guess what we did with the muck? We saved eight miles of the cycle and we delivered it on a two mile cycle and expanded a light craft airport. I see that this study is now basically for the Glenmore route in Washington, D.C. but I also see that Baltimore has taken some initiative and will initiate this concept. In Boston, it is incorporated in the contract document for the Red Line. The muck will go to one particular place and they have phased the haul routes through the various parts of their future structures to include running tunnels, open cuts, cut and cover, and the stations. Another interesting project is rail trackage. We've all heard the clicky-clack of the rails over the years and now UMTA has taken the initiative to try track fixation systems of various types in the Chicago Transit Authority's Congress Line, Clinton and Chicago Avenue Stations. They will take advantage of the track ballast that now exists and the wood ties and they will provide space prior to entry and leaving the stations. In several hundreds of feet will be installed different types of track equipment, fasteners and ties to monitor the negative environmental impact of the physical noise.

In Boston we have another exciting project which I have been advocating for a long time. We either do too much geological investigating in the wrong direction or we don't do any. I have constructed tunnels that were many miles long with a limited number of borings and short tunnels with many borings. Is that enough or is it too much? In Boston there will be a site exploration program which will be initiated on the first project of the Red Line which has been awarded to MK. The intent of the program is to involve the same group that did the original geo-technical report to do the monitoring. They will monitor the actual observational and instrumentation movements and the soils and rock as encountered versus the original geo-technical predictions. I think that's a big boost in our industry. As an underground consultant, I find that occasionally, when I am asked to solve a problem in the tunnel driving process, I have to involve at least two other disciplines.

Sometimes it takes more disciplines to answer all of the problems. That's how involved the tunneling industry is.

Another interesting project which is going to be done in Boston is called, fracture control in tunnel blasting. I would rather call it, preventing detrimental loosening during the blasting operation. Preliminary tests have been done in the lab and in open quarries. A small test was made in the MARTA test chamber and it was found that there was not that much difference. Driving horizontally in good rock with seams, it's pretty hard to use a system which was initiated for vertical drilling in large granite quarries. I think it has promise in large caverns where drilling vertically can occur. The horizontal drilling results to date I hope, doesn't destroy the program, if it is not understood that the fracturing in seams will take place in close proximity regardless of what method is used. You can drill two or three inches off that seam but when it loosens it's going to come down or the contractor will scale it down. If any of you become involved in such a program I would appreciate the results, especially from Boston. In Boston it will be performed in the pilot tunnel for the new transit station. They are driving a shaft, cross adit, and a six hundred foot pilot tunnel at the crown of the future station. The tests that were made in Atlanta were a very short distance. In Boston it will be done for a hundred feet or more so we should get a better idea of whether this system is beneficial or not. It could significantly reduce drilling costs, reduce vibrations, explosive cost, and detrimental loosening of rock.

The MARTA project was initiated about one year ago. I am no longer connected with it directly, however I did initiate it and I'm extremely proud of that because it allowed the assembly of the dedicated group I mentioned previously. This program is also in your yellow book and I would like you to take it home and read it and try to understand it. What we're trying to convey to you is that all of these things are possible under certain conditions. It's just a question of understanding how to implement them. In MARTA the rock is of excellent quality, so we have found another location that we will be using to prove the system by the three-and-one-half to four-step method of implementation. In the six transit systems that I have been involved in in the past years I found one to be very aggressive and we shall be proud to work with them. The basic intent of this demonstration is to implement an existing design, and an alternative design as an option to the contract bidders. The alternative design will allow the construction of the tunnels to be done in the state-of-the-art as they exist in the world today. And, not by conservative criteria that have been already established. The state-of-the-art does exist. It's just a matter of understanding and implementing it. This goes back to some of the things that Ed Cording said and Wally Baker's programs about compaction grouting. I pro-

posed to do that on a missile launch pad that tilted fifteen years ago. I proposed to the engineers to use that system which is now at least thirty years old. The engineers wouldn't let me do it because they didn't understand it. They made me remove the pad by blasting and rebuilding it.

We talk about support systems, there are many mining methods that exist. The Bureau of Mines and the mining people they don't even talk the same language as we tunnel stiffs do. If you walked in a coal mine and call the roof a crown, they'd probably throw you out. We don't have the same language and this becomes ridiculous, this bears out the problem of dissemination of information on common terminology. While I'm on the subject I hereby volunteer for the committee if there is to be one. I've talked to several people who have been here in the last two days and they have also agreed. They believe that should happen as soon as possible. We need to pass on case histories. If you've had an experience it is necessary that you pass it on to the next guy. No need to hide it. You'll probably never run into that situation again, but the next guy may. Why not tell him? Help him, he needs your help. To refer back to my previous statement, regarding the next implementation project that my research group will perform, I would like to make the following comments: heavy structural steel supports have been used where design procedures have not accurately predicted whether steel was really required or not. Such steel members cannot be made to follow irregularities of the rock. The result being only point contact. Only through the use of timber blocking or pneumatically applied mortar can the loosening of the rock and the creation of voids as falling be prevented. My research information shows that most current design practices now make allowance for the change in stress distribution that results from the opening being excavated, its changing equilibrium and the effect of the final lining. The final lining is often designed without any consideration of the existing initial support system. The objective that we propose to implement in this new transit system is to employ rigorous engineering and economic analyses to predict the performance of the tunneling process, not only when being constructed as a single entity but as they relate to each other. The salient features of information that we are developing in research programs in underground mining are to understand and convey to the engineering profession the conversion of the rock surrounding the cavity from a loading function into a supporting function. The rock carrying ring is activated by stabilizing medias such as systematic anchoring systems of dowels and by applications of shotcrete. This can be effectively achieved by controlled blasting and the choice of correct support methods at the correct optimum times. It is a matter of understanding the re-activated process during the excavation of the rock until such time that a new equilibrium is reached. Two

gentlemen to my right made reference to this. You need someone on the project who can make the decision with the contractor as the conditions change.

In closing, I would like to summarize with this statement. It appears to me in dealing with the unnecessary conservatism in the design of underground openings, our first step is to reduce that conservatism, hence reducing the cost. It would be necessary for us to understand the theories of behavior of structures media and to monitor such behavior very carefully during construction. Second, I feel that we should communicate more in order to take advantage of the case histories that are now available to us from all over the world. There's a great deal of experience being accumulated by different groups, different professions, different nationalities. Some of this experience, rightly called observational, is a very useful thing in advancing the understanding of people who, because of their positions, need to make administrative decisions on underground construction. An administrator, dealing with the methods to be used for his underground system, may not have had technical training of the proper kind or it may have been many years since he dealt with such problems in detail. It's much easier for that individual to appreciate case histories and methods that have been proven, it is more satisfying for him than relying on rather complicated explanations of elastic theories. He needs to have some way of evaluating the degree of conservatism that will go into his decisions. Case histories help provide that insight.

Many times designers of underground projects, technical staff and/or consultants are selected specifically for the reason that they are known to be conservative in analysis or judgment. Because of the excessive costs we are now facing it appears necessary for economic survival to reassess this conservatism. I would recommend for the next phase of professional development in underground construction that we consider it attractive to encourage more high level, ethical, professional caliber competition in the geo-technical professions to advance the state-of-the-art.

Contracts could be written to make it attractive for contractors and engineers to work more closely for such improvements. Probably the fastest advancements will come when far sighted owners offer such incentives. Thank you.

QUESTION AND ANSWER SESSION

MR. BUTLER: Thank you, Bill. We are past the designated closing time but there probably is a minute or two for questions if there are any at this time.

MR. LUCZAK: I'm not an expert on tunneling or anything like that but it seems to me if you are going to take the question of over-design, you're going to have to go from static loading investigations, dynamic loading investigation, on tunnels which carry vibrations. Is this a known science already or is this a new field to explore? Don't you need steel reinforcing if you are going to look at dynamic loading rather than static?

DR. CORDING: Well, there have been quite a few tunnels set up for seventy-five years in New York City that have had no reinforcement at all. That's been the normal design mode there.

MR. LUCZAK: Weren't they over-designed?

DR. CORDING: I don't know whether you would call that over-designed. I know there is conservatism in some of the designs, but the over-design has to do, not just whether the concrete thickness is a couple of inches more, but whether that should have been steel which would cost you a couple of hundred dollars more per foot. That's costs. It's the reinforcement, not just placing that form just another inch or two inside and another couple of inches of concrete. There are studies that have been carried out on vibrations and their influence and I think that that is not the major compliment of the loading and lining.

MR. BUTLER: Thank you. I know that many of you have five o'clock flights and we will call the meeting adjourned. We thank you that have stayed to the close of this particular session. We also thank those who had to leave earlier and for your input during the previous discussion sessions and it will all be taken into valued consideration by UMTA, particularly those in the Office of Transit Assistance in furthering the development of their programs. Thank you very much.

APPENDIX A

ATTENDEES

John R. Asmus
Vice President Bechtel, Inc.
P.O. Box 3965
San Francisco, Ca. 94119

Wallace Baker
President
Hayward Baker Co.
1875 Mayfield Rd.
Odenton, Md. 21113

Robert Bangert
U.S. National Committee on Tunneling Tech. (NAS)
Exec. Secretary
2101 Constitution Ave. NW
Wash., D.C. 20418

William L. Barnes
Project Manager
Chicago Urban Transportation Dist.
123 W. Madison St.
Chicago, Ill. 60602

Robert Belfi
Dir., Architecture and Engineering Div.
City of Philadelphia
Dept. of Public Property
Rm. 1080, Municipal Services Bldg.
Philadelphia, Pa. 19107

Kiran Bhatt
Sr. Research Assoc.
The Urban Institute
2100 M St. NW
Wash., D.C. 20037

Charles F. Bingman
Deputy Administrator
Urban Mass Transportation Admin.
400 Seventh St. SW
Wash., D.C. 20590

Charles Birnstiel
Consulting Engineer
230 Park Ave.
New York, N.Y. 10017

Gilbert A. Bonforte
Chief Tunnel Engineer
Tippetts-Abbott-McCarthy-Stratton
345 Park Ave.
New York, N.Y. 10022

Tor L. Brekke
Prof. of Geological Eng.
University of California
434B Davis Hall
Berkeley, Ca. 94720

Leonard Bronitsky
Economist
U.S. DOT Transportation System Ctr.
Cambridge, Ma. 02142

Larry Joe Burton
Chief, Program Management Div.
UMTA, Region 5
Chicago, Ill. 60194

Gilbert Butler
Office of Rail Technology
UTD-30
2100 Second St. SW
Wash., D.C. 20590

Douglas R. Campion
Regional Dir., Region IV
Chief Project Management Div.
DOT Urban Mass Transportation Administration
Suite 400, 1720 Peachtree Rd. NW
Atlanta, Ga. 30309

Gene Carroll
Urban Mass Transportation Admin.
Region IV
Atlanta, Ga. 30309

Eugene F. Casey
Area Manager
Mason & Hanter-Silas Mason Co.
437 Madison Ave.
New York, N.Y. 10022

Rama Pada Chatterjee
Indian Railways
UN c/o U.S. Dept. of Labor
Washington, D.C. 20210

Jasper Clemente
Program Officer
U.S. Dept. of Labor
Office of International Visitor Programs
3rd & Constitution Ave. NW
Wash., D.C. 20210

G.W. Clough
Professor
Civil Engineering Dept.
Stanford University
Stanford, Ca. 94305

Jose Comallonga
Chief Engr. Reg. II
U.S. DOT
Urban Mass Transportation Admin.
26 Federal Plaza Suite 14-130
New York, N.Y. 10007

Edward J. Cording
Professor Civil Engineering
University of Ill.
Urbana, Ill. 61801

Robert M. Coultas
Exec. Dir.
American Public Transit Assoc.
1100 17th St. NW
Wash., D.C. 20036

William J. Custer Jr.
Project Manager
Kaiser Engineers, Inc.
One Beacon St.
Boston, Ma. 02108

J. Gordon Davis,
Exec. Vice Pres.
DDR International, Inc.
Suite 800, 33 North Ave., NE
Atlanta, Ga. 30308

James E. Davis
Dir., Office of Grants Assistance
U.S. DOT
Urban Mass Transportation Admin.
400 Seventh St. SW
Wash., D.C. 20590

Bain Dayman, Jr.
Technical Staff
JPL-Catech
4800 Oak Grove Dr.
Pasadena, Ca. 91103

Roger W. Dewey
Senior Consultant
Pacific Consultants
47 Winter St.
Boston, Mass. 02108

Walter Dougherty
Civil Engineer
Urban Mass Transportation Admin.
5218 Pumphrey Dr.
Fairfax, Va. 22032

J.M. Duncan
Principal Engineer
Holmes & Narver, Inc.
999 Town & Country Rd.
Orange, Ca. 92668

John A. Dyer
Transportation Coordinator
911 Courthouse
Miami, Fla. 33133

George Earnhart
Project Engineer
Urban Mass Transportation Admin.
400 Seventh St.
Wash., D.C. 20590

John S. Egbert
Asst. Gen. Mgr. Design & Construction
WMATA
6316 Olde Town St.
Alexandria, Va. 22307

Joel Ettinger
Urban Mass Transportation Admin.
Chief Division of Analysis
400 Seventh St. SW Rm. 9314
Wash., D.C. 20590

Charles Fairhurst
Prof. and Head, Dept. of Civil & Mineral
Engineering
University of Minnesota
112 Mines & Met. Bldg.
221 Church St. SE
Minneapolis, Mn. 55455

John J. Fearnside
Deputy Under Secretary of Transportation S-2
400 Seventh St. SW
Wash., D.C. 20590

Douglas Feaver, Reporter
Washington Post
1150 15th St. NW
Wash., D.C. 20071

Jan J. Feberwee
Associate
Transit & Tunnel Consultants
S11 Rand Bld. 14 Lafayette Sq.
Buffalo, N.Y. 14203

Joan D. Finch
Staff Officer
National Academy of Sciences
Bldg. Research Advisory Brd.
2101 Constitution Ave. NW
Wash., D.C. 20590

Edward R. Fleischman
Chief, Planning and Analysis Div.
U.S. DOT
Urban Mass Transportation Admin.
UTA-32
Wash., D.C. 20590

Eugene L. Foster
President
Underground Technology Dev. Corp.
8425 Frye Rd.
Alexandria, Va. 22309

Arthur J. Fox, Jr.
Editor
Engineering News-Record
1221 Avenue of the Americas
New York, N.Y. 10020

Richard Gallagher
Manager & Chief Engr.
Rapid Transit Dept.
So. California Rapid Transit Dist.
425 South Main St.
Los Angeles, Ca. 90013

Vernon K. Garrett, Jr.
Dir. Office of Engineering
WMATA
600 Fifth St. NW
Wash., D.C. 20001

Robert D. Garrison
Manager
Construction Management-
Transit System Development
44 West Flagler St.
Miami, Fla. 33130

Irving Glasser
General Engineer
U.S. DOT
400 Seventh St. SW
Wash., D.C. 20024

John P. Gnaedinger
Chairman
Soil Testing Services, Inc.
111 Pfingsten Rd.
Northbrook, Ill. 60062

Donald T. Goldberg
President
Goldberg, Zoino, Dunicliff & Assoc., Inc.
30 Tower Rd.
Newton Upper Falls, Ma. 02164

C.W. Graff
Deputy Prog. Mgr. Const. & Procurement
Kaiser Transit Group
17282 SW 78 Place
Miami, Fla. 33157

Joe Guertin
Associate
Goldberg, Zoino, Dunicliff & Assoc., Inc.
30 Tower Rd.
Newton Upper Falls, Ma. 02164

John W. Guinnee
Engineer of Soil, Geology & Foundations
Transportation Research Brd.
2101 Constitution Ave. NW
Wash., D.C. 20006

Samuel Hack
Dir., Office of Construction & Facility Management
U.S. DOE
Wash., D.C. 20545

David G. Hammond
Vice President
Daniel, Mann, Johnson & Mendenhall
1900 Arlington Federal Bldg.
Baltimore, Md. 21201

Delon Hampton
President
Delon Hampton & Assoc.
8701 Georgia Ave. Suite 800
Silver Spring, Md. 20910

Theodore C. Hardy
Dir. Construction & Development
Port Authority of Allegheny Co.
Beaver & Island Aves.
Pittsburgh, Pa. 15233

Wilbur E. Hare
Dir. of Program Support
Urban Mass Transportation Admin.
Wash., D.C. 20590

Richard J. Hesse
Manager
Narza Assoc. of D.C.
1629 K St. NW 801
Wash., D.C. 20006

Warren J. Higgins
Dir. of Construction
MBTA
50 High St.
Boston, Ma. 02110

Howard Hoffman
Bernard Johnson Inc.
2021 K St. NW
Wash., D.C. 20006

Jerome S.B. Iffland
President
Iffland Kavanagh Waterbury, P.C.
104 East 40th St.
New York, N.Y. 10016

Dee V. Jacobs
Regional Dir. UMTA
San Francisco, Ca.

Francis M. Keville
Regional Project Manager-North
MBTA
58 Day St.
Somerville, Ma. 02144

Alan F. Kiepper
General Manager
MARTA
2200 Peachtree Summit
401 W. Peachtree St. NE
Atlanta, Ga. 30308

Frank J. Krbec
Regional Engineer
DOT
Urban Mass Transportation Admin. IX
Two Embarcadero Center 620
San Francisco, Ca. 94111

Thomas R. Kuesel
Sr. Vice Pres.
Parsons, Brinckerhoff, Quade & Douglas, Inc.
One Penn Plaza
250 W. 34th St.
New York, N.Y. 10001

Walt Kulyk
Project Engineer
Urban Mass Transportation Admin.
NASSIFF Bldg.
400 Seventh St. SW
Wash., D.C. 20590

James A. Langer
Geotechnical Engineer
Gannett Fleming Corrdry & Carpenter, Inc.
P.O. Box 1963
Harrisburg, Pa. 17105

J.K. Lemley
Vice Pres. Special Assign.
Morrison-Knudsen Co., Inc.
P.O. Box 7808
Boise, Idaho 83729

G. Leonard, Jr.
Manager, Engineering Services
Deleuw, Cather & Co.
c/o R.M. Parsons Consortium
20 S. Charles St. Suite 400
Baltimore, Md. 21201

Quentin W. Lerch
Secretary
The Surety Assn. of America
125 Maiden Sq.
New York, N.Y. 10038

Raymond E. Levitt
Assistant Prof. of Civil Eng.
Constructed Facilities Div.
M.I.T. Rm I-253
Cambridge, Ma. 02139

Thomas K. Liu
Sr. Vice Pres.
Haley & Aldrich, Inc.
238 Main St.
Cambridge, Ma. 02142

Robert D. Logcher
Prof. of Civil Engineering
M.I.T. Rm I-253
Cambridge, Ma. 02139

Ramon A. Lopez
Chief Engineer-Office of Transit Assistance
U.S. DOT
Urban Mass Transportation Admin.
400 Seventh St. SW
Wash., D.C. 20590

Raymond A. Loureiro
Asst. Engineer of Design-Railroads
Port Authority of New York & New Jersey
One World Trade Center Rm 59W
New York, N.Y. 10048

Norman Lovejoy
Dr. Manager
Kellogg Corp.
5601 S. Broadway Suite 400
Littleton, Co. 80121

William N. Lucke
Consultant
312 Seventh Ave.
Annapolis, Md. 21403

Ronald Luczak
Manager, Grant Programming & Admin.
Chicago Transit Authority
P.O. Box 3555
Chicago, Ill. 60654

J.W. Maddox
Project Manager
The Ralph M. Parsons Co.
20 S. Charles St.
Baltimore, Md. 21201

Kenneth R. Maser
Program Manager
Foster-Miller Assoc.
135 Second Ave.
Waltham, Ma. 02154

Joseph T. Mayer
U.S. DOT
Urban Mass Transportation Admin.
Chief, Engineering Div. Reg. III
Philadelphia, Pa. 19106

Robert S. Mayo
Robert S. Mayo & Assoc.
P.O. Box 1413
Lancaster, Pa. 17604

T.G. McCusker
7 Echo Ct.
Wayne, N.J. 07470

Russel K. McFarland
Office of Capital Grants
Urban Mass Transportation Admin.
2100 Second St. SW
Wash., D.C. 20590

James E. Monsees
Sr. Vice Pres.
Straam Engineers Inc.
11900 Parklawn Dr.
Rockville, Md. 20852

James M. Murphy
Vice President
Fred S. James & Co., Inc. of Md.
109 E. Redwood St.
Baltimore, Md. 21202

Chet Nelson
Supv. Research Structural Engin.
U.S. Bureau of Reclamation
P.O. Box 25007
Denver Federal Center MC1512
Denver, Colo. 80225

David Novick
Sr. Vice Pres.
Lester B. Knight & Assoc.
549 W. Randolph St.
Chicago, Ill. 60606

James F. O'Brien
Program Officer
U.S. Dept. of Labor
Office of International Visitor Programs
3rd & Constitution Ave. NW
Wash., D.C. 20210

Robert S. O'Neil
Sr. Vice Pres.
Deleuw Cather & Co.
600 Fifth St. NW
Wash., D.C. 20001

Richard S. Page
Administrator
Urban Mass Transportation Admin.
UOA-1
400 Seventh St. SW
Washington, D.C. 20001

Geogre J. Pastor
Assoc. Administrator for Tech. Development
and Deployment
Urban Mass Transportation Admin.
2100 Second St. SW
Wash., D.C. 20590

Bart Paulding
Chief Engineering Geologist
Geotechnical Engineers Inc.
1017 Main St.
Winchester, Ma. 01890

Boyd C. Paulson, Jr.
Assoc. Professor
Stanford University
Dept. of Civil Engineering
Stanford, Ca. 94305

E. Randolph Preston
Dir., Transit System Development
Metropolitan Dade County, Fla.
44 W. Flagler St.
Miami, Fla. 33130

Gene M. Randich
Deleuw, Cather & Co.
Senior Vice President
165 W. Wacher Dr.
Chicago, Ill. 60601

John T. Rhett
Deputy Assistant Administrator
U.S. Environmental Protection Agency
401 M St. SW
Wash., D.C. 20460

Neil P. Richards
Sr. Structural Engineer
Southern Cal. Rapid Transit Dist.
425 S. Main St.
Los Angeles, Ca. 90013

Carl B. Richardson
Dept. of Transportation
Urban Mass Transportation Admin.
Regional Dir. Reg. IV
Chief Project Mgr. Div., Reg. IV
1720 Peachtree Rd. NW Suite 400
Atlanta, Ga. 30309

Robert Rubin
Max E. Greenberg, Trayman, Cantor
Reiss & Blasky
100 Church St.
New York, N.Y. 10007

T. James Rudd
Div. Mgr. Transportation
Instrumentation Div.
Ensco, Inc.
540 Port Royal Rd.
Springfield, Va. 22151

Dick Sallberg
Highway Research Engineer
Federal Hwy. Admin. (FHWA)
400 Seventh St. SW
Wash., D.C. 20590

Winfield O. Salter
Sr. Vice Pres. Parsons, Brinckerhoff, Inc.
134 Peachtree St. NW
Atlanta, Ga. 30303

Rueben Samuels
Vice Pres. Chief Engineer
Thomas Crimmins Construction Co.
205 E. 42nd St.
New York, N.Y. 10017

Gerald R. Saulnier
Civil Engineer
Transportation Systems Center
Kendall Sq.
Cambridge, Ma. 02142

Gloria T. Saxton
Civil Engineer
DOT Urban Mass Transportation Admin.
400 Seventh St. SW
Wash., D.C. 20590

Charles Schaffner
Vice President
Syska & Hennesey Engineering
110 W. 50th St.
New York, N.Y. 10020

William Charles Shepherd, Sr.
William Charles Shepherd, Sr., Inc.
299 Albatross Lane
Decatur, Ga. 30034

Herman C. Shipman
Chief, Grants Assistance Div.
U.S. DOT
Urban Mass Transportation Admin.
434 Walnut St. Rm. 1010
Philadelphia, Pa. 19106

Robert Silver
Commissioner of Public Property
City of Philadelphia
Dept. of Public Property
Rm. 1020, Municipal Services Bldg.
Philadelphia, Pa. 19107

Jagat Narain Srivastava
East Indian Railways
UN
c/o U.S. Dept. of Labor
Wash., D.C. 20210

Eugene J. Stann
Project Mgr.
Kaiser Transit Group
44 Flagler St.
Miami, Fla. 33130

W.C. Steber
W.C. Steber Assoc.
President
717 North Overlook Dr.
Alexandria, Va. 22305

Sulki K. Suresh
Project Engineer-Construction
MARTA
401 W. Peachtree St.
Atlanta, Ga. 30308

Harry Sutcliffe
Project Manager
Bechtel Inc.
58 Day St.
West Somerville, Ma. 02144

George A. Swede
Dir. of New Systems Development
Southeastern Mich. Trans. Authority
211 W. Fort St., P.O. Box 333
Detroit, Mich. 48231

Fredric Tasker
Urban Affairs Writer
The Miami Herald
No. 1 Herald Plaza
Miami, Fla. 33101

John K. Taylor
Associate Admin. for Transit Assistance
UTA-1
400 Seventh St.
Wash., D.C. 20590

John S. Taylor
Project Dir. Manager
Pullman Power Products
666 Fifth Ave.
New York, New York

Dettmar R. Tietjen
Vice Pres. Washington Affairs
Kaiser Engineers, Inc.
Wash., D.C. 20590

Stephen Teel
Acting Dir., Office of Railroad
Construction Tech.
UTD-30
2100 Second St. SW
Wash., D.C. 20590

Erland A. Tillman
Project Manager, Assoc. V. Pres.
Daniel, Mann, Johnson & Mendenhall
201 N. Charles St.
Baltimore, Md. 21201

Thomas Traylor
Vice Pres.
Traylor Bros., Inc.
P.O. Box 5165
Evansville, Indiana

E. Duayne Trecker
Dir. of Public Affairs
Urban Mass Transportation Admin.
400 Seventh Ave.
Wash., D.C. 20590

Edwin R. Videki
Acting Chief Transit Engineer
City of Philadelphia
Dept. of Public Property
Rm. 1080 Municipal Services
Philadelphia, Pa. 19107

Ken E. Vought
Chief Project Management Reg. II
U.S. DOT
Urban Mass Transportation Admin.
26 Federal Plaza Suite 14-130
New York, N.Y. 10007

Josc Comallonga
Chief Engr. Reg. II
U.S. DOT
Urban Mass Transportation Admin.
26 Federal Plaza Suite 14-130
New York, N.Y. 10007

Hiram Walker
Dir. Reg. II
U.S. DOT
Urban Mass Transportation Admin.
26 Federal Plaza Suite 14-130
New York, N.Y. 10007

Ken Ware
Manager Geotech.
Bechtel Inc.
8820 Belmart Rd.
Potomac, Md. 20854

Theodore G. Wigle, Jr.
Regional Dir.
Urban Mass Transportation Admin.
300 S. Wacker Dr.
Chicago, Ill. 60606

Harold T. Whitney, Jr.
Asst. Vice Pres.
Law Engineering Testing Co.
57 Forsyth St., NW Suite 1205
Atlanta, Ga. 30303

George E. Wickham
Vice Pres.
Jacobs Associates
500 Sansome St.,
San Francisco, Ca. 94111

Toby Wightman
Vice Pres.
U.T.D. Corp.
8425 Frye Rd.
Alexandria, Va. 22309

Ellen S. Witt
Conference Manager
Pacific Consultants
47 Winter St.
Boston, Ma. 02108

Jay Wolanhan
Student
M.I.T.
Rm 1-242
Cambridge, Ma. 02139

W.W. Wolcott
Project Manager
Bechtel Inc.
15740 Shady Grove Rd. Bldg. 4C
Gaithersburg, Md. 20760

Faust Ystueta
Vice Pres.
Sverdrup & Parcel & Assoc.
800 North 12th Blvd.
St. Louis, Missouri 63101

George Ziegler
Exec. Deputy Chief Engineer
New York City Transit Authority
370 Jay St.
Brooklyn, N.Y. 10467