REPORT NO: DOT-TSC-319-1

FIFTEEN-OH-ONE TO SIXTEEN-THIRTY,
Technical and Managerial Lessons From One Experience in Introducing New Technology To Improve Urban Mass Transportation.

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NOVEMBER 1972

FINAL REPORT

Prepared for:
U.S. DEPARTMENT OF TRANSPORTATION.
URBAN MASS TRANSPORTATION ADMINISTRATION
Office of Research Development and Demonstrations
Washington D.C. 20590

TECHNICAL REPORT STANDARD TITLE PAGE

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
DOT-TSC-319-1		

4. Title and Subtitle	5. Report Date
FIFTEEN-OH-ONE TO SIXTEEN-THIRTY TECHNICAL AND MANAGERIAL LESSONS FROM ONE EXPERIENCE IN INTRODUC- NEW TECHNOLOGY TO IMPROVE URBAN MASS TRANSPORTATION	November, 1972
	6. Performing Organization Code
7. Author(s)	8. Performing Organization Report No.
Charlton R. Price, D Sam Scheele	DOT-TSC-319-1
9. Performing Organization Name and Address	10. Work Unit No.
Social Engineering Technology 1722 Westwood Blvd. Los Angeles, Calif. 90024	R3750
	11. Contract or Grant No. UM304
	13. Type of Report and Period Covered
12. Sponsoring Agency Name and Address	Final Report
Department Of Transportation Urban Mass Transportation Administration Office Of Research Development And Demonstrations Washington D.C. 20590	14. Sponsoring Agency Code

15. Supplementary Notes: The preparation of this report has been financed by a DOT-Transportation Systems Center contract #319 to Social Engineering Technology of Los Angeles, California for the Urban Mass Transportation Administration, under the Urban Mass Transportation Act of 1964 and as amended in 1968.

16. Abstract

Acquiring 130 new, double-desk, self-propelled, electrically operated commuter rail cars numbered 1501 to 1630 is part of a five-year effort to improve service on the suburban lines in the South Chicago area operated by the Illinoise Central Railroad. The introduction of the cars and other improvements represent one instance of attempts to upgrade service in an existing system. In the course of this effort, experience has been acquired that can be useful both to systems that are being altered, and to totally new systems yet to be designed and developed.

This report deals with lessons learned and the insights or new ideas that emerged which may be useful for: (1) the further development of this particular system; (2) the conception, design, and development of similar systems elsewhere; (3) stimulation of designers and related systems; and (4) the practices of managers and planners responsible for improving urban mass transit services.

17. Key Words	18. Distribution Statement
	DOCUMENT IS AVAILABLE TO THE PUBLIC THROUGH THE NATIONAL TECHNICAL INFORMATION SERVICE, SPRINGFIELD, VIRGINIA 22151.

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	128	

Form DOT F 1700.7 (8-69)

PREFACE

Acquiring 130 new, double-deck, self-propelled, electrically-operated commuter rail cars numbered 1501 to 1630 is part of a five-year effort to improve service on the suburban lines in the South Chicago area operated by the Illinois Central Railroad. The introduction of the cars and other improvements represent one instance of attempts to upgrade service in an existing system. In the course of this effort, experience has been acquired that can be useful both to systems that are being altered, and to totally new systems yet to be designed and developed.

This report deals with lessons learned and the insights or new ideas that emerged which may be useful for: (1) the further development of this particular system; (2) the conception, design, and development of similar systems elsewhere; (3) simulation of designers and builders of railroad equipment and related systems; and (4) the practices of managers and planners responsible for improving urban mass transit services.

The investment in these new commuter cars, including spare parts and extra charges, will be approximately forty million dollars. Related improvements to the commuter system, including a new ticketing system and station remodeling, represent an additional investment of approximately twenty million dollars. A capital grant from the Federal Urban Mass Transportation Administration (UMTA) will ultimately provide twenty-four of the forty million dollars for the new cars. This capital grant, however, is not to the Railroad, but to a special public body that was established to procure and own this equipment. The Chicago South Suburban Mass Transit District (CSSMTD) has title to the new cars and leases them to the Railroad. The cost of the cars not covered by the grant, now twelve but probably by the completion of the acquisition closer to sixteen million dollars, will be provided by the Railroad. The cars are being built by the St. Louis Car Division of General Steel Industries.

The cooperation and substantive contributions of many individuals have greatly aided in this project. Our collaborators include H. F. Davenport, Rollin Chinn, Bill Fritz, C. S. Condon, Paul Reistrup, Robert O'Brien, Paul Oppenheim, George Hennessey, Warren Broadfield, and Matthew Paul of the Illinois Central Railroad; Jack Pigott of the Chicago South Suburban Mass Transit District; John Tucker, Frank Doscher, Art Kincaid, Tom Taylor and John Matheis of St. Louis Car; and Yvonne Griffin, Stan Price of the Department of Transportation. In the report many comments, insights, and proposals are associated with particular individuals. But the words and ideas cited are not necessarily in the form we originally received them. Comments we received often stimulated our thoughts to go considerably beyond the remarks of our collaborators. Therefore, the authors are soley responsible for the organization and presentation of this material, and for specific interpretations and inferences.

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THE BIG PICTURE

Reporting the facts is the refuge of those who have no imagination.

VAUVENARGUES

Upgrading railroad commuter services seems a logical and compelling first step in fashioning a viable urban mass transit system. Commuter lines have current users; existing rights-of-way; stations, signals, bridges, power-plants, and controls (infrastructure); and a functioning organization for operations and management. But on many commuter systems the means of conveyance, the cars, are nearing the end of their useful service life. The presence of new cars (that could offer a level of service that has come to be expected in modern people-moving) seems to be the key ingredient lacking.

We will be writing comments in these margins throughout -- the first one is below.

For years building better highways for automobiles and buses has dominated improvements in transportation systems, particularly in urban centers. The federal interstate highway program that passed swiftly through Congress in the 1950's directed nearly one hundred billion dollars into super-roadways. A tiny fraction of this amount, perhaps five hundred million dollars, has been spent on urban mass transit. This investment really only began with the Urban Mass Transportation Act of 1964, which has been expanded by amendment in subsequent years. Yet rush hour traffic jams in every urban center, continuing pollution from automobile exhaust, higher auto insurance rates with congestion of business districts and recreational areas, still bear witness to an almost reverential devotion to the automobile. Urban mass transit -- the movement of people by public conveyance (usually bus or rail, although more exotic systems are being contemplated) -- is now being regarded as an important way to increase the chances for

What about staggering activities to reduce peak demand?

a better way of urban life. Some fear that without quick improvement in mass transit, the very survival of many cities is at stake.

For the present, the federal government has decided to support the improvement of urban mass transit systems, chiefly by demonstration and planning grants and by capital grants for new equipment. Some of this investment will form the core for totally new systems, such as the BART operation in San Francisco. More typically, and in the experience to be captured and passed on in this report, the capital grants are being used to provide new equipment for existing systems.

In the case of introducing any new technology -- but especially with complex technology containing multiple effects on the system to which it is being introduced -- the conception, development, production, and initial use of the hardware can serve as an occasion for installing related improvements from both social and physical engineering. Yet introducing new conveyances to an existing rail system is far more than a matter of buying and introducing the equipment itself. Involved also in undertaking the process of introduction should be an understanding of the setting in which the equipment is going to be used, the probable behavior of the users of the new environment it will provide, and a reorientation of the personnel who will operate the equipment. If these broader considerations are ignored or misconstrued, the effect of introducing the equipment may be to raise more new problems than are solved, or to miss opportunities that otherwise could have been realized. Furthermore, there is no guarantee that the separate perspectives of management, designers, manufacturers, public agencies, and customers will dovetail smoothly in getting the job done.

One change occasions another and creates expectations for additional improvements.

Things Don't Go Like They Should

Introducing new cars to a rail commuter service would seem to be a pretty direct job. The first question always seems to be: where will the money come from? The revenues and costs of operations are important to any financer. Attractive, high-performance equipment will attract fares and new equipment can reduce costs, chiefly labor expense for manning and maintenance. Concepts have to become clear and shared, organizations created, approvals given, designs and specifications prepared, to merely start a list. The feeling of this whole process is summarized in the quote below:

> "Maybe we need to rethink the whole process of getting these cars produced. Looking at it on the surface, it should all be very simple. First you write up the specifications, learn the problems the other fellow has had and you incorporate these improvements. You relate all that to the car builder, he designs the car so he can build it, he tells his production department how to put the car together, the customer approves the drawings, if he can read them, then you build the car to the drawing. Of course, there have to be some bugs in the first few cars; you expect that. Now, as we know, it isn't at all like that, and I've asked myself why."
>
> – William Fritz
> (Representative for Illinois Central Railroad at St. Louis Car.)

It is very likely that adding improvements to any commuter system will continue to be a complex task with many decisions to be made, judgments to be rendered, and possibilities to be considered. The process will never be smooth. In fact, as we collectively come to know more about what options are possible, the task of improving rail commuter systems may become less orderly and well defined in advance. Progress involves at least as much improvisation and capturing of opportunities as systematic investigation.

When you get things down pat, then they're usually not worth doing.

Why This Report

A lot of mass transportation technology is going to be designed, developed, and installed in the next few years. As those who have already been involved in such efforts well recognize, much develops in the course of a project that is not put to use in the project itself but might be crucial for a subsequent effort of the same kind. These "products" -- insights, hunches, good ideas -- may not be noted at the time they occur or, if noted, may not be shared with others who could benefit greatly from the experience gained. Getting more such relevant but often neglected or unreported experience to people who can use it is an important part -- perhaps the most important part -- of what has come to be called technology transfer.

TECHNOLOGY TRANSFER

The purpose of this report is to make available to all those concerned with new urban transportation technology some of the things that are being learned -- including insights and hunches based on experience -- from one such development: the new electric, multiple-unit rail cars on the suburban lines of the Illinois Central Railroad. The Transportation Systems Center of the U. S. Department of Transportation contracted with Social Engineering Technology, Los Angeles, to report the Chicago experience in ways that would prove most useful to individuals and organizations elsewhere who are already or will be concerned with similar developments. Thus this material is directed to engineers, designers, planners, administrators, financial specialists, manufacturers, managers, public officials, and others with a stake in providing better urban transportation. It is not the purpose of this report to present a cookbook for producing the perfect rail commuter system every time, but to develop a method for passing on information about where you, as a planner, developer, or manager of such a system, might look for opportunities to make improvements when it's your turn to try.

What you always wanted to know about how to start making a better commuter system, but were afraid to ask.

What It's About

To discover and organize this type of material, the authors visited the Illinois Central Railroad (IC), the Chicago South Suburban Mass Transit District (CSSMTD), the St. Louis Car Division of General Steel Industries (StLC), and the Urban Mass Transportation Administration (UMTA). Those in each organization who have been most involved were asked to discuss aspects of their experience that are summarized in the diagram on the next page. As the diagram indicates, many events in each part of the total effort occurred simultaneously.

See Figure 1.

> The universe is true for all of us and different for each of us.
>
> MARCEL PROUST

We were particularly interested in:

- How the rationale and the objectives for the project were developed.
- How an organizational framework was created to finance and manage the development.
- What assumptions were made and what problems were addressed in the design and engineering of the cars.
- What was experienced in the bidding-contracting process.
- What significant insights have come from putting the new equipment into service.
- With all or any part of the above, what might have been done differently, and what might be considered by others involved in developing a course of action concerned with similar programs of technology development and management.

After initial visits, interviews, sifting of much written material and reflection, a rough report draft was prepared and circulated to all who had provided information initially, plus others at Transportation Systems Center with an interest not only in this report but in its audiences and in the problems

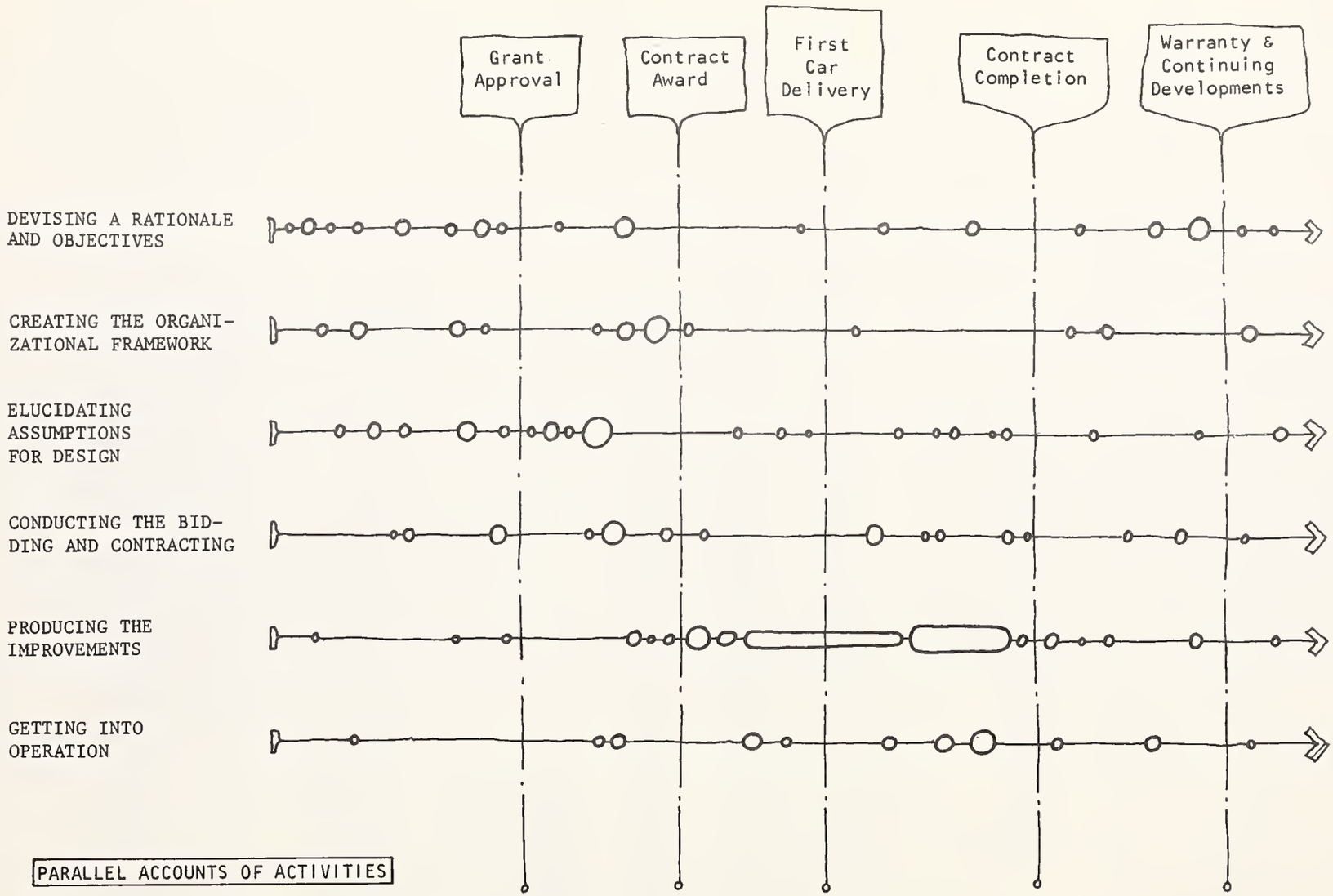

Grant Approval
Contract Award
First Car Delivery
Contract Completion
Warranty & Continuing Developments
DEVISING A RATIONALE AND OBJECTIVES
CREATING THE ORGANI-ZATIONAL FRAMEWORK
ELUCIDATING ASSUMPTIONS FOR DESIGN
CONDUCTING THE BID-DING AND CONTRACTING
PRODUCING THE IMPROVEMENTS
GETTING INTO OPERATION
PARALLEL ACCOUNTS OF ACTIVITIES

Figure 1.

and methods of transferring experience and technologies. Then visits and telephone conferences with the Illinois Central, the CSSMTD, St. Louis Car, and TSC were held to solicit additional information to clarify and correct specific points, to stimulate additional thought and, in short, to involve all of these groups as collaborators in the reporting process. The report as presented here is a result of that second iteration plus additional writing, editing, and revision by SET.

As the diagram below illustrates, the complex process of considering the problem, devising possible approaches, thinking about financing, justifying actions, preparing proposals and specifications, getting things done, and now getting into operation can be seen from different points of view. Along the lines indicating each point of view there are "bubbles" to represent schematically how particular events and processes occur at different stages in the total effort and may influence each other. A single step in implementing a program can be interpreted from several points of view. Also, no doubt other themes could be discovered and traced.

See Figure 2 on the next page.

Packaging Progress: A New Approach

This report is not a history of the Chicago experience. Nor is it an evaluation of performance on this project. Rather, it is a gleaning of learnings, ideas, hunches, insights, and proposals for policy and action that come out of what has been done in this particular urban transportation technology development.

The new approach in reporting used here thus consists of two elements:

- Active collaboration with, rather than passive participation by, those who were involved in the experience.
- Highlighting of different kinds of experience that we believe might be most significant for others with similar concerns. We call the three experience types smats, druns, and gleebs. They are described below.

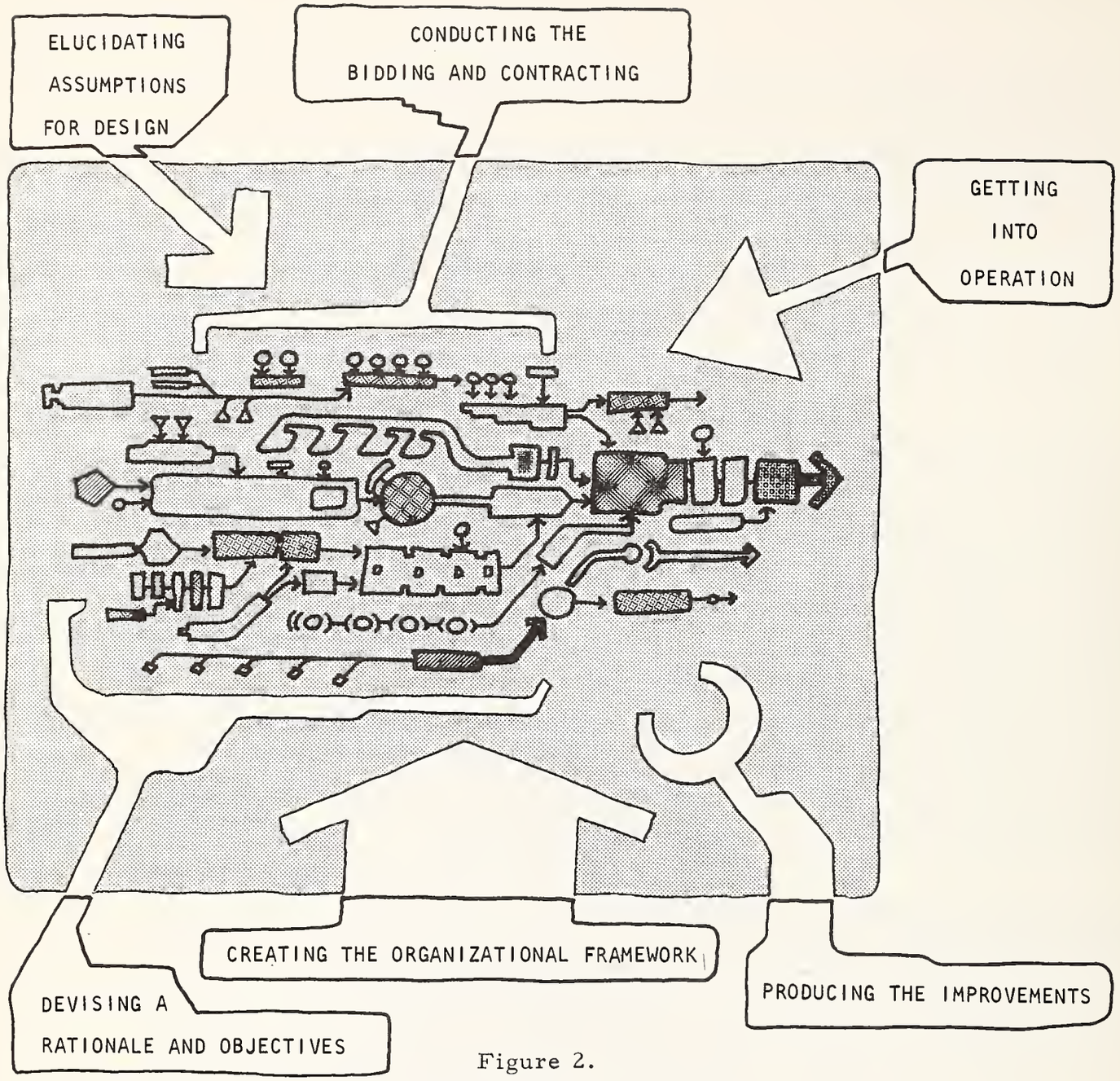


Figure 2.

The history of gear cutting, thus, demonstrates the need of revision of both of the more common concepts of the history of science and technology. The romantic concept of invention is clearly inadequate, because there are many more steps in the process that is presumed by those who think in terms of rare acts of inspiration. The concept of a simple linear development is also unsound. Inventions do not emerge directly and inevitably from specific generalizations in the pure sciences, nor from a practical achievement in producing or controlling specific modes of motion. The records show so much interdependence, that the development can be adequately described only as a form of multilinear process.

ROBERT S. WOODBURY
History of the Gear-Cutting Machine (1958)

As Robert S. Woodbury said at the beginning of his MIT Press series of monographs on the history of technologies:

The undeveloped state of the history of technology and the pioneer character of these monographs make inevitable gaps in the evidence, of which the author is only too painfully aware. But the detailed map must be left to later scholars, when so much virgin territory cries out merely to be explored.

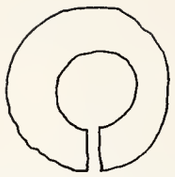
Readers should use the Chicago experience as a jumping off place, to begin to shape their own plans and programs with the benefits of not only what others have done, but what these same people might do now if they had another chance. In this way, experience and insight already gained can be put to work in urban mass transportation programs elsewhere and, indeed, in large-scale development programs of other kinds. Though every program will have unique features, there are more common problems and issues to be dealt with in many programs than is generally recognized or believed. Frequently time pressures and prior commitments make it impossible to actually act on "possibly better ways to do things" and incorporate them into the project at hand. But we believe the kind of reporting illustrated here can keep such hard-won progress and expensive learning from being wasted. It is important, both to individual programs and for the nation, that this kind of technology transfer occur. We hope this report contributes to this objective.

Progress consists of not only what we did, but what we now know to try.

Types of Experience

To package the insights that the Chicago effort has produced along the way, three different types of experience have been identified. Since the idea of distinguishing between types of experience is new, there were no convenient labels ready to paste on. So we've invented some. We think you'll find them handy. Each of the three types is described below and given an identifying symbol. These symbols reappear later in the text to "flag" items of lore that we believe may be significant to others.

SMATS are innovations or improvements that can be simply substituted -- task for task -- with what was done before, or item for item with what was used previously. SMATS do not require major changes in other parts of the system, nor do they redefine boundaries between the steps that make up the system. Improved reliability, better work methods, easier installation, more durable fastening, cost-savings, and higher performance are examples. (SMATS are not to be confused with the Bostonian definition of intelligence.)



UNIT SUBSTITUTIONS

DRUNS are new approaches for reaching performance objectives that rearrange the way in which the tasks were previously accomplished. DRUNS require changes in several parts of the system, and frequently define new boundaries between the steps that make up the system. Examples: new arrangements of organizational structures, designs that redistribute loadings or change the relationship of the elements in a particular task, or alternative contractual relationships.

PURPOSIVE REARRANGEMENTS

GLEEBS are redefinitions of the problem or reconceptualization of the objectives for the system that could result in more appropriate solutions. Incorporating new objectives, extending or modifying the definition of the system being designed, explicit consideration of induced or spillover benefits, and incorporation of new considerations are examples of how premises can be restated to stimulate major improvements.

REVISED OBJECTIVES

The reason for recording these different kinds of items is to distill not only the facts, but the learning, of those who were involved in doing this once, to act as a head start for those who will be doing it again elsewhere. In this sense "what I now think I should've done" is probably more important than "what I did." Yes, sometimes experience is applied to situations which are essentially different -- but which are compellingly similar. The quote at right illustrates this point. In the end you, the reader, have to be the judge of what to apply, and where and when.

The cat, having sat upon a hot stove lid, will not sit upon a hot stove lid again. Nor upon a cold stove lid.

MARK TWAIN

The differences between the three types of experience defined above are illustrated in the diagrams of hypothetical flow charts below. The particular form of the individual tasks or operations indicated by the circles, squares, and other symbols is unimportant. They might be steps in any activity. Figure 3 shows the initial state of such an hypothetical system. Figure 4 shows the substitutionary changes that result from the introducting of SMATS. Figure 5 shows the results on the system of incorporating DRUNS. Figure 6 shows how the introduction of a GLEEB affects the whole system. Together with the definitions on the previous page, these illustrations indicate the differences between the three kinds of improvements for systems that are suggested by experience.

Figure 3. A TYPICAL SYSTEM

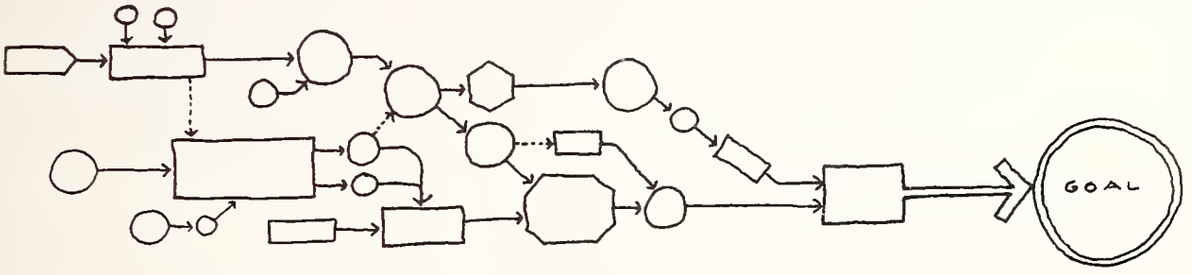


Figure 4. INTRODUCING SMATS

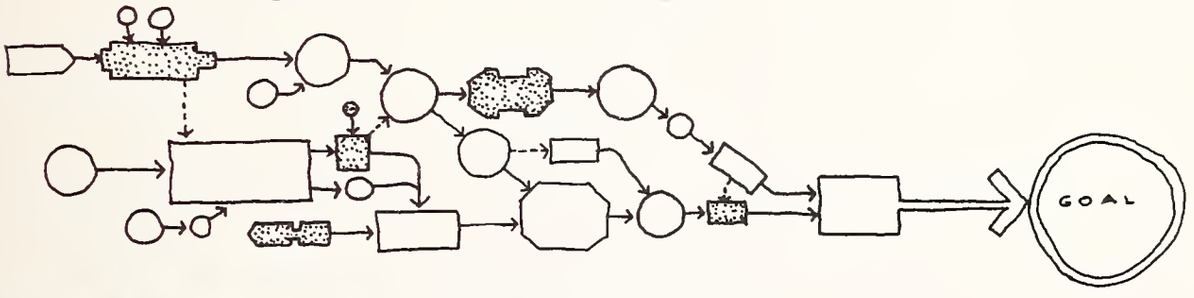


Figure 5. INTRODUCING DRUNS

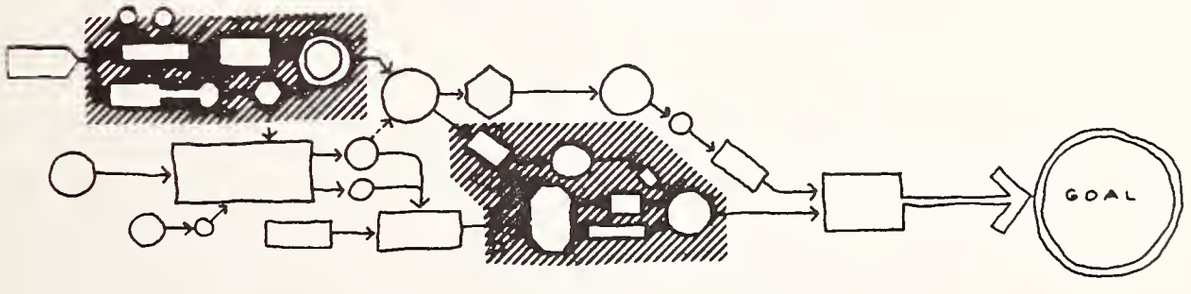
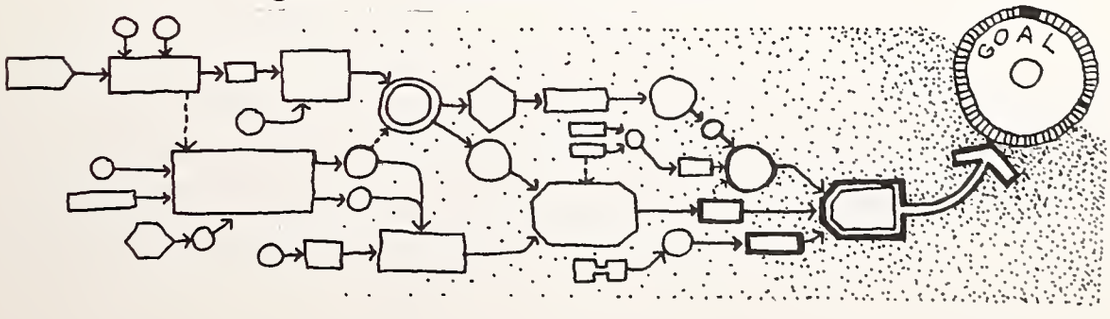
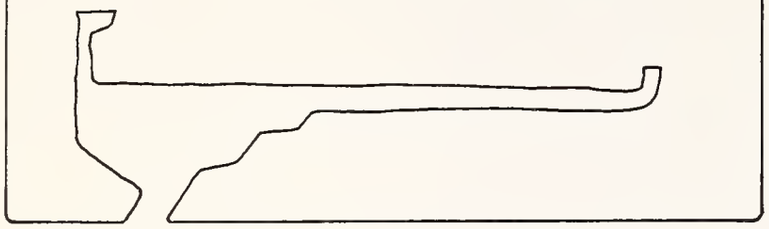


Figure 6. INTRODUCING GLEEBS



DEVISING A RATIONALE AND OBJECTIVES



Immediacy is happiness, because in immediacy there is no contradiction; the immediate is essentially happy, and the philosophy of immediacy is happiness.

SOREN KIERKEGAARD

In this section, we highlight experience in Chicago that may be particularly relevant and interesting to executives in government and industry who have responsibility for initiating and guiding major programs. For them, the aspects of what has been done in Chicago of greatest interest may be how and why the whole effort got started, the strategy developed to bring into reality what had been envisioned, and how objectives changed and new rationales emerged as the project was carried out. How purposes are defined and justified strongly affects the kinds of improvements and amount of effort that can be marshalled to effect improvements. Vision, though impractical, makes new successes possible.

To capture the important learning that can be gained using this point of view, some background on Chicago as an urban mass transit "case" must be reviewed. This provides an understanding of where the IC suburban service found itself in the 1960's, and how the plans for new equipment came into being.

Chicago is a real commuter's town. It is preeminently the city of the railroad, built during the most exuberant period of the railroad age. The Illinois Central Railroad has been part of this development. The Illinois Central's suburban

service is part of a much larger railroad, which extends from Chicago to the Gulf and serves much of the Midwest. The IC has been operating a commuter service south from Chicago since 1856, when the first train ran from the Loop to a then-new community called Hyde Park. The main line trains are powered by diesel engines, but on the Chicago Suburban Service, the entire route was electrified, beginning in 1921. Since 1926 it has had many features that other commuter rail services have yet to develop: almost complete elimination of grade crossings (entirely eliminated on the suburban main line), station platforms flush with car floors, and electric propulsion.

World's fair as an occasion for electvicification

History

Between 1926 and 1928 the bulk of the present IC suburban cars, originally some 280 cars and now 274, were acquired. (Some of the "trailer" cars were actually acquired before electrification and were designed for conversion.) The cars are thus now more than 45 years old. A recent engineering study says their useful life probably could be extended if necessary to 1979. Beyond that, continuing maintenance costs would be prohibitive -- not because the cars would fall apart, but because the quantities of labor and its cost to keep the cars operational can be expected to continue to rise. However, the cars have been maintained in a way that made them operationally better in 1960 than when they were delivered.

"From an operating point of view, the present Pullman M-U cars are now actually better than new."

The suburban service prospered in the 1920's, but suffered a severe dip with the economic depression in the 1930's. In the 1940's, with the wartime shortage of autos, gas, and tires, commuter traffic soared again. During wartime, a peak of about 45,000,000 passengers per year were carried. After the war came America's romance with the automobile and the dream of a house in the suburbs. This produced a radical change in the preferences and habits of commuters, and was reflected in the operation of the IC Suburban system.

Passenger trips declined from the high of 45,000,000 per year to just over 11,000,000 in 1964. Since that time, the number of riders has again begun to increase, as the commuter population has grown in the southern suburbs served by the system, to around 20,000,000 per year.

The profitability picture has been dimmer. The suburban service lost money every year between 1950 and 1963, except for a small profit in 1954. Since 1963 there has been a small amount of annual profit on the line, around 1 or 2 percent. Increased development of the far south suburbs is now in prospect, after a period since before the depression when most of the residential growth in greater Chicago has been to the north and west.

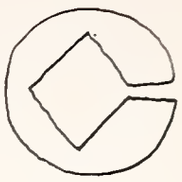
SUBURBAN PASSENGER SERVICE TO MASS-TRANSIT COMMUTER SERVICE

The nature of change is often indicated by the changing labels attached to activities and organizations. The IC Suburban Passenger Service was a part of the Traffic Department of the Railroad that included inter-city passenger services and all of the types of freight services. The Suburban Passenger Service was not an auspicious or glamorous part of the Traffic Department; there was little interest in promotion of growth because the potential payoff seemed remote. Travelling from the suburbs to the central city was formerly more a matter of individual choice. Now this connection is becoming central to the continuing development of the metropolitan region. The issue has changed from the one of the relative performance of a single part of the Traffic Department of a railroad to a public question of a way to meet the demands for transportation of a whole sector of a major urban center. This change of nomenclature is currently pervading the Railroad, including schedules, tickets, maps, and press releases. In this report we refer to the suburban service historically but the commuter service in the future.

What to Do?

In the mid-1960's, the IC Commuter Service faced several dilemmas. Abandoning a growing commuter service would be

courting disaster. The slender profits would be quickly wiped out, the railroad realized, unless costs could be significantly reduced. The other option, to raise the fares, would probably not significantly improve the ratio of revenues to costs, because the ridership could be expected to decrease as a result. One way in which money could be saved would be to reduce the number of operating personnel. This suggested that the ticket collection process be simplified and automated. In the mid-1960's, after considerable debate within the company, the IC decided to go ahead with an automatic ticketing system that had been developed by Litton Industries. In July 1960, IC introduced this automatic revenue collection system (ARCS) which involved electronically coded tickets that could be inserted in a sensor opening a gate to the station platform. This electronic ticketing system would allow a reduction in personnel costs: no ticket punching on the trains, fewer employees in station booths, and (later) automatic vending of tickets. Reducing personnel costs was the consuming interest of the Railroad during this period, and influenced most decisions.



Reduce operating personnel.

Figure 7

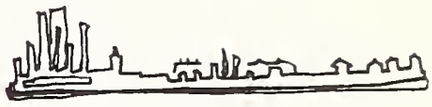
July 1, 1966, was the date on which the ARCS system was introduced. Initially it was a disaster. Gates jammed, people suffered long delays in reaching their destinations both entering and leaving the city; tickets were chewed up in the new machines. Suddenly the IC could seemingly do nothing right and was harshly criticized on all sides. "Why did the IC plunk down $3.5 million for this, when they could have been air conditioning the present cars?" was one of the hostile questions raised. The service reputation of the IC had not been unimpaired before this, however. There had been increasing complaints from commuters, some of whom had formed a protest group called the Illinois Central Commuters Association. While basic maintenance had been performed on the old cars, there were complaints about the quality of the maintenance of the stations, tidiness of the cars, considerable breakage of windows enroute, and problems with internal car temperature -- no air conditioning in the often hot summers and sometimes malfunctioning heating systems in the winter.

The wisdom of the aphorism, let sleeping dogs lie, is validated by these occurences.

AUTOMATIC TICKET VENDORS

Figure 8

The profile of the traffic on the railroad had drastically changed in the years after the electrified suburban service was started. In the early years, the majority of the passengers came from the in-city areas on the South Side. But with the flight to the suburbs, a significant amount of the traffic and almost all of the growth in traffic shifted to the far suburbs. The trains went through an area that had slowly but steadily declined in quantity of traffic generated to and from the Loop, both because of changes in destinations and introduction of alternatives.



The South Side of Chicago became largely a black ghetto where a smaller and smaller proportion of the residents were employed downtown. Industrial and commercial development on the South Side provided new destinations. The construction of new auto expressways paralleling the IC's route changed the relative desirability of railroad versus auto commuting and at the end of the '60's Chicago Transit Authority lines were extended along the Dan Ryan Expressway, thus serving much of the area that was formerly exclusively IC territory.

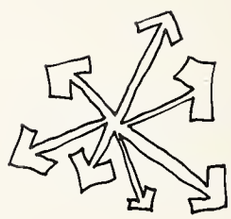
Do Something Fast

After the debacle of the introduction of the ARCS system on July 1, 1966, a cry of "do something" went out from executives who lived in exurbia and were commuting downtown. They were not just a mass of faceless commuters to be served. They were articulate, vociferous, and could make their opinions felt.

William B. Johnson, a former executive at Railway Express, took over as president of IC at this time and was immediately confronted by the commuter crisis. Something had to be done right away. One of the main complaints had been that many of the windows were being broken by rocks being thrown at the trains. Johnson's first action was to order safety glass installed in all the car windows (this was estimated to cost $400 thousand but ultimately required an outlay twice as great). It was also determined that a general improvement in commuter service would be made.

In August of 1967, the Illinois Central announced a detailed plan of action that followed up on Johnson's initiative in the commuter crisis. It was called the Commuter Advancement Program (CAP) and had these features:

- The elimination of obsolete and unneeded stations on the near south side of Chicago (i.e., those stations where passengers had been reduced to a dribble as the traffic shifted to the far suburbs)
- Simplifying the fare structures -- from different fares at each stop to a zone system
- Coordination with the lines of the Chicago Transit Authority so that transfers would be possible from one CTA line to another with an intermediate trip on the IC commuter system.
- Extending the line beyond Richton to Park Forest South, a planned HUD-designated "new town" owned (25%) by IC Industries, the holding company of the railroad.
- Acquisition of new equipment by leasing cars from a public transportation district, which would purchase cars by using a combination of a capital grant from the federal government and IC funds.

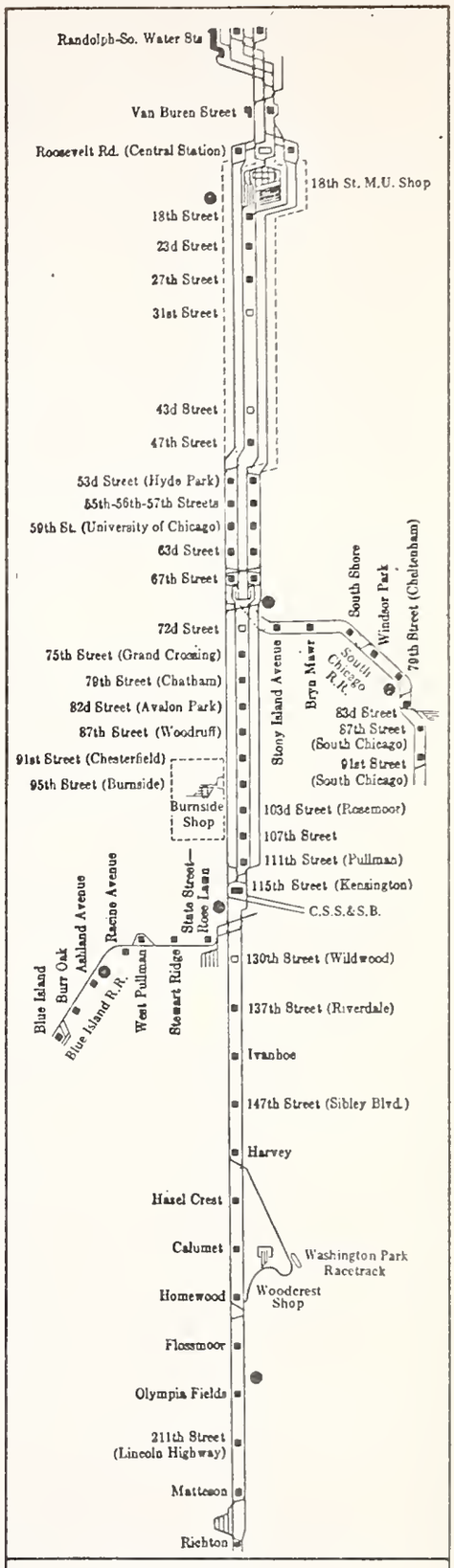


Thus, paradoxically, the crisis created by the ARCS system and the rage of the commuters accelerated demand for and focused attention on the acquisition of new equipment. The impact of these events precipitated diligent efforts to find a way, and reduced, perhaps by several years, the time when new cars would be in service.

A key part of the suburban service's effort to rejuvenate itself was seen as the acquisition of new cars. This would give passengers on the IC commuter service (for the first time in at least 10 years) cars that provided the quality of service prevailing in the Chicago area -- and the first new cars in 45 years. The present cars were still performing adequately, but expectations for service by the commuting public had changed.

A POINT TO NOTE

Until recent restyling of the IC Commuter map the diagrams used were variations of example reproduced to the right. This is interesting because the root of this diagram is the electrical circuit for the electrification program completed in the 1920's. Similar graphic representations are used as diagrammatic maps for other electrified systems -- both rail and overhead -- but not, so far as we know, for systems that are not electric. This serves as an example of the carry-over of practices and conventions from one area to another without regard to the contextual differences.



Schematic Diagram of the
Illinois Central Electrified Trackage
and Related Facilities

--- Former Active Track and Facilities

■ Stations

□ Former Stations

● Substations

Now That We Know What, the Question Is How?

But, where was the money for new equipment to come from? Revenues that could reasonably be expected to be generated from the suburban service would be insufficient to pay for replacement of the fleet. Under Illinois law, the formation of local public transit districts could occur only by referendum, because such districts could have taxing powers. However, it was realized that forming such a district on the south side would never receive voter approval, given the prevailing climate of opinion toward the IC and the prospective addition of property tax overrides. For the same reasons, local tax funds as a form of subsidy for the railroad were an even more unlikely source of financing.

Yet it was also clear that were the IC suburban line to go out of business it would have to turn over its suburban service properties to some public body, because not enough money existed to purchase the IC suburban system facilities. Besides, who would want to take on all those problems? The only alternative that seemed promising was to find some other form of public financing in order to get a new fleet of cars into operation.

Assistance without control.

This was provided by the Federal Urban Mass Transportation Act of 1964. The Act authorized capital grants for the acquisition of new mass transit equipment. The catch was that such funds could not be awarded to private organizations, such as railroad companies, and no appropriate public organization existed for the area serviced by the IC suburban system. Thus the IC recognized that a special public agency would have to be formed to serve as recipient of a grant and probably continue as owner of the cars acquired in this way. For such a public body to be formed by other than a popular referendum, some type of enabling legislation would have to be passed in Springfield, the state capitol. The most expedient route would be to amend the Illinois Mass Transportation Act of 1959 to provide for communities to join in forming a mass transit district by ordinance rather than referendum. If the

authority to create a district by a joint power agreement of the communities could be authorized by amended legislation, there would be hope for actually forming such a district in the south suburbs. Thus it became necessary to guarantee that no taxation would occur in the communities as a result of the establishment of a mass transit district. Funds to operate the District would have to be sought elsewhere.

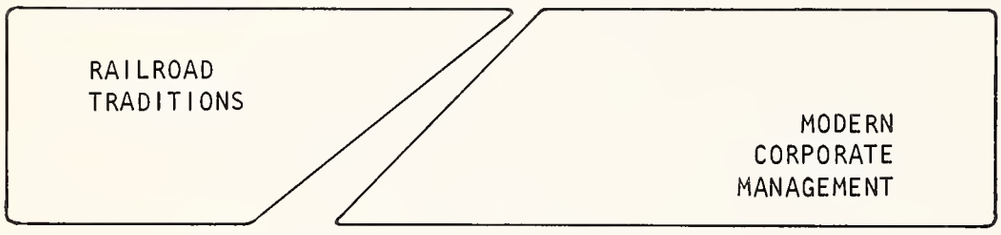
It's hardly ever possible to improve by ordinary means systems that have deteriorated or they would have been kept up anyway.

Manifest Destiny: But, Will They Realize It?

All of these elements came together in the spring of 1967. IC President William B. Johnson made a speech to the Chicago Traffic Club on May 18 announcing the Railroad's plans for upgrading the suburban service. He pointed out that new equipment was desperately needed. New cars would be only a part of a broader program of general improvement in the suburban service. Some combination of public and private sources had to be used. Some kind of public agency would have to be created to qualify for federal assistance. The IC pledged itself to work for these goals.

Another reason why the Railroad wanted to keep the commuter service alive was that it became one part of a to be larger parent company, IC Industries. Incorporated in 1962, IC Industries' first acquisition was Chandeysson Electric in 1965 (traction motors), then in 1968 Waukesha Electric (fuel pumps) and ABEX Ind. America (brake shoes and tire molds), in 1969 Sea & Thomas (real estate), in 1970 Pepsi General Bottlers (the largest Pepsi-Cola distributor), H. F. Philipborn (mortgage banking), Perfect Hosiery (clothing), Dad's Root Beer (soft drinks). IC Industries also has a letter of intent to acquire Midas International (auto suppliers). Together with the Railroad, IC Industries had substantial real estate interests. Thus, the upgrading of the commuter service took on

larger importance: it might support specific types of real estate development in the Chicago central business district and in the far south suburbs, such as the IC Industries development of Park Forest South. Therefore, it was very much in the interest of the parent corporation that the suburban service be kept in a state of vigorous development.



W. B. Johnson touched on all of this in his speech. Here are some of the things he said:

W. B. Johnson's Remarks	Implications - Assumptions
Do we surrender to the automobile the exclusive task of carrying the urban passenger and thereby cause our major cities to continue spreading out in endless small communities, as perhaps best typified by the Los Angeles area? Or do we find other means of keeping the heart of the city alive as the major center of influence and decision-making? . . . Our infatuation with the automobile has caused neglect of our mass transit systems, which happen to be the more efficient form of travel. . . . The cost of building a transit system is staggering. . . . Our riders are asking for new cars -- and they should have them. We are determined to get new equipment. Let me add, however, that we cannot buy those new cars with Illinois Central money, not until we can see such an investment will earn a fair return for our stockholders. . . . Yet, we must have new equipment. How? I am reminded of what Alexander the Great did when he was confronted with an impossible situation. You may remember the story. The legend has it that the man who could untie an intricate knot on the pole of a chariot would become the master of Asia. With one stroke of his sword, Alexander cut through the knot.	Executive audience for the speech should realize that an improved IC is necessary if they want to save the city. There are major benefits to the City in maintaining a quality mass transit system. Efficiency = most rapid movement of individuals as another commodity at least cost. This assumes continuation of mass transit operations under private auspices.

W. B. Johnson's Remarks

. . . We have the sword to cut through our untieable knot. That sword is the Urban Mass Transportation Act. Congress has appropriated funds and they are being spent, and we propose that a Southern Suburban Transit Authority, or something similar, be established under terms of the Act. The capital funds for new equipment would be furnished by federal and local agencies under arrangements acceptable to them. Thereafter, Illinois Central would lease the equipment under a plan that would reimburse local authority for the full cost of its part in the investment. Commuter cars would belong to the authority, not the Illinois Central. We all know that it is imperative to the future of Chicago that its commuter railroads remain in business. Indeed, the time is here for them to start operating at a reasonable profit, so that they can improve their properties and their service.

Implications - Assumptions

Without the capital grants program there will be no new cars. Therefore, you (the executives in the audience) should get behind the drive to create a district to obtain public funds for new equipment.

IC thinks suburban service could be profitable if most of fleet replacement cost is met by funds provided from sources other than the railroad.

Chicago's continued viability requires quality commuter service. If the railroads are to be genuinely interested in this, they will have to make a profit.

Though a great deal remained to be done, a program already was in motion. In the spring of 1967 (before the Traffic Club speech) Johnson had told Rollin Chinn, Illinois Central's mechanical engineer, to work out specifications for a new suburban rail car. This was no sudden decision; new equipment had begun to be part of the IC's thinking several years earlier. Until the early 1960's the fleet had been considered more than good enough by IC top management. Air conditioning and other refurbishing was briefly contemplated, but then deemed unnecessary. It was conceded that the interior appointments of the cars left something to be desired, but the fleet maintenance record and equipment reliability were impressive, and the overall quality and durability of the cars (from an operations point of view) were famous in the industry. In the early 1960's management thinking seemed, indeed, to tend toward maintaining but never replacing the 1920's cars. Instead, the Suburban Passenger Service might just be allowed to die out, perhaps with occasional nudges in the form of

Adequacy is often socially defined.

alternating fare increases and reductions in service. No marketing of the service was contemplated; in railroad tradition, the IC concentrated on handling the business that came in "over the transom" as efficiently as possible.

But some attempts had been made to get the IC to acquire new cars. The Budd Company, for example, wooed the railroad with the offer of a good price on cars to be added to their production run of commuter cars for the Long Island Railroad. But the IC had not bought any passenger cars, even intercity equipment, since 1950, and continued to turn a deaf ear to this possibility until two things happened:

- Spiraling labor costs threatened to wipe out the sliver of profit the suburban service had regained after the dismal 1950's; and
- The automatic revenue collection system (ARCS) designed to cut personnel costs began disastrously.

It was then that the search for ways of regaining passenger favor heightened attention to the idea of new equipment.

Soon followed the word to Chinn to draw up new car specifications, the Traffic Club speech, announcement of the Commuter Advancement Program, and swift moves to create arrangements for obtaining the needed funds from sources other than the railroad.

Now That We're Getting New Cars

As explained earlier, procuring new equipment has been seen as only one part -- though a keystone -- of the necessary refurbishing of the suburban commuter service that started in 1966 with the introduction of ARCS. Behind this renovation is the still unresolved question of what role this part of IC properties will have in the corporation's future, and how much long-term effort and investment the IC will put

into this part of its business. While this question is still being debated, a number of additional moves have been made that are, in effect, extensions of the Commuter Advancement Program. The District, too, has participated increasingly in this further development of system rationale and objectives.

- Preliminary applications have been filed with UMTA for additional cars. The total number needed, according to a study by DeLeuw, Cather & Co. commissioned by the District is 145, or an increase of 15 beyond the present order.

- With some modification to allow for grade level stations on its line, the Chicago South Shore and South Bend Railroad can use the same cars on its system (which runs on IC suburban tracks for the part of its route close to Chicago and shares the Randolph Street terminal), replacing their present ancient cars.

- The IC has proceeded to develop a zone fare system, thus simplifying the communter fare structure.

- A zone dispatch-scheduling arrangement will also soon be in effect, under which both inbound and outbound trains at rush hours will serve limited groups of stations with longer and higher speed runs between the Loop and each station group.

- Automatic ticket vending is being extended and improved with more sophisticated equipment including currency changers, and monthly-tickets-by-mail are being actively promoted.

- Special trips -- to Chicago Bears' home games at Soldiers Field, for theater, for the Washington Park race track, and possibly other events -- are being devised.

- Interconnections with the CTA and bus lines are being more closely coordinated.

- Further reductions in service, including some stations on the near south side, proceed to eliminate stops with minimal patronage. At the same time, extension of the line beyond Richton -- to more of the farther suburbs -- has been applied for.

- The District, meanwhile, is enlarging its scope and rationale, from being solely a legal entity for

equipment ownership to becoming a coordinator of south suburban transit programs. Application to UMTA for acquisition of buses to be operated by SafeWay lines, giving more publicity to its activities and participation in planning for the IC suburban line extensions are all evidences of this trend.

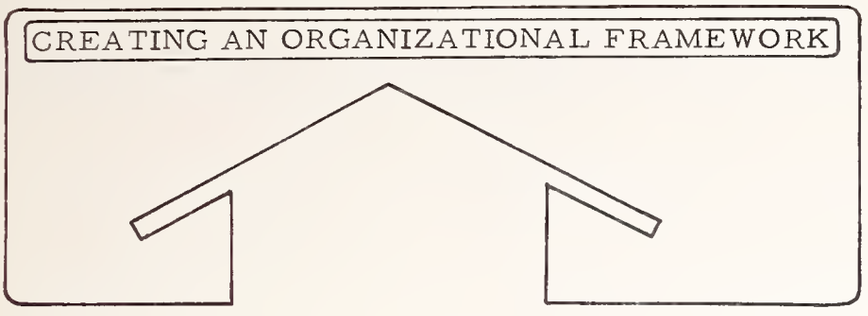
Yet all of these changes and developments -- both by the IC and the District -- still focus on equipment, finance, and operations, rather than upon the invention and management of services. Profit opportunity via service is little considered, because prospects for profit -- under the present definition of the nature of the business -- are not thought to be significant. Extension of rationale and objectives in this direction -- toward "the marketing of commutation as a satisfying experience" -- would be more likely, as we see it, if the IC and the District were really committed to active development rather than, in principle, holding the line until the probable emergence of an integrated Chicago area transit operation under some new central authority.

Continuing Development of Rationale for Commuter Services

Commuters are now experiencing the new car. As one might expect, there are many complaints -- mostly stemming from encountering a change in long established routines. The quality of the commuting experience has been improved by the new cars, but it is still not genuinely attractive.

Attempts to attract commuters to use the improved rail service might include such things as offering credit arrangements plus discounts to commuting shoppers; providing a specialized on-board media to provide news, entertainment, and educational programming; introducing an automated beverage service; and organizing commuter groups to plan recreational pursuits and travel packages.

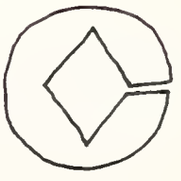
Commuting as a way of life.



All progress is initiated by challenging current conceptions, and executed by supplanting existing institutions.

GEORGE BERNARD SHAW

Well-designed organizational relationships are critical to the successful introduction of new technologies to improve the performance of a system. Garrison noted in his paper (see references) that many of our present institutional forms grew out of solutions to the problems of urbanization. These institutional arrangements often prevent consideration of new approaches to problems that have been redefined by consideration inherent in post-urbanization regional development. Thus, planning bodies and other groups concerned with effectuating improved mass transportation programs should carefully seek and evaluate all of the available options before settling on an organizational framework. Organizations defined by groups that have a direct interest in improved urban transportation systems should be considered in addition to geographically defined organizations. Such organizations might include users of the system, those who benefit from the systems, or individuals and organizations that directly profit from the improved system.



Affilitive, beneficiary and consumer groups might be bases for organizations that would be non-geographic and more likely relevant to the phenomena of the coming era of post-urbanization.

In the beginning, providing commuter passenger services was a problem internal to the Illinois Central Railroad. Within the IC, the suburban passenger service was one of many different types of services that include intercity passenger operations, fast freight forwarding, unit train operations, piggy-back services, and regular freight operations. Organizationally, sales were separate from operations.

The Illinois Commerce Commission regulates levels of service and tariffs. Procedures for petitioning to reduce unprofitable service and request rate increases are time

consuming, formal, and usually consider only narrow alternatives. The IC corporate management and other divisions of the railroad were ambivalent about what should be done with the suburban passenger services. They were proud of the frequency and reliability of the commuter line (the best record in Chicago), but were unenthusiastic about its profitability and the difficulties of running what was in fact an urban transit system under railroad rules. The IC had to follow Federal Railroad Administration (FRA) standards on equipment, change fares according to Illinois Commerce Commission rulings, use operating procedures developed by American Association of Railroads and the Railroad Brotherhoods, and in every way act like a railroad. However, the traffic pattern, station distribution, and expectations of communters for service invited comparison to a mass-transit system. A shelf-full of studies had "proved" the commuter services supported only by the fare box "never" are profitable. Things could be better, but the organizational arrangements kept it from being important to anyone in particular.

It's hard to interest a coach in turning bad losers into good losers.

After IC Industries was formed, the disappointing performance of the suburban division of the railroad became even more of a sore point. The increasing number of non-railroad executives involved in corporate management of IC Industries had a growing concern in strictly financial terms about the suburban division's performance (return on investment never more than 1.6%). Investment of IC-generated funds in the operations of the suburban division were far from promising and potentially disastrous. Winning support for any additional corporate investment in the suburban division of the railroad activities would be next to impossible. Therefore, outside support was needed. Fortunately, some experience was already available to create a mechanism for acquiring the needed equipment: a public mass transportation district.

A good railroad can be a bad subsidiary.

Precedents for the Concept of an Organization to Own Cars

The idea of a District to be legal owner of passenger cars stemmed both from the tradition of special purpose public authorities (pollution abatement, industrial development, sewage disposal, and many others) and from long-standing rail industry practice for procurement and management of other specialized types of equipment.

- The IC itself operated as a "rail pipeline" a coal train wholly owned by a power company.
- Pullman Company leased its cars to operating railroads while retaining ownership.
- GATX tank cars, refrigerator cars, and other special purpose rolling stock are not the property of the railroads and shippers that use them.
- The east coast trailer train (auto and passenger movement to and from Florida) is owned separately form the railroad on which it travels.

Thus the concept did not have to be invented de novo. Pieces of prior experience -- both in public administration and in railroading -- could be put together to create the necessary organization structure to make equipment acquisition possible.

Putting Together the Contemplated Organizations

The capital grants program of the Urban Mass Transportation Administration (UMTA) created by the 1964 Urban Mass Transportation Act could provide two-thirds of the funds needed for new mass transit equipment if: (1) a public body could be designated to receive the grant and therefore be the legal owner of new equipment; (2) the other one-third matching funds could be found from local sources; (3) the proposed new equipment could be shown to be congruent with a comprehensive plan for urban mass transit improvement. The IC began to move swiftly on all these fronts immediately after Johnson's Traffic Club speech.

District. In his speech, Johnson had proposed formation of a new mass transit district representing the communities served by the IC suburban lines. But the Illinois statute on this subject said that such districts could be formed only by referendum. The chances for passage of such referenda in IC-land were, at best, doubtful (given the spectre of new taxation that a vote to create a district would raise, and the IC's shrivelled image as a result of the ARCS debacle). Therefore, another approach was necessary. The Illinois law could be amended to allow creation of a district by local ordinance, if the district had no taxing authority. It seemed more promising to convince the councils of local communities to join together to form a district. But this would have to be done swiftly: the Illinois Legislature was about to be in session, and would not reconvene for another biennium -- that would be an intolerable delay in procurement of the new cars, keystone of the CAP effort to revivify the IC's suburban service.

John Foster, attorney for the IC, drafted the required amendment and adroitly lobbied it through Springfield. Meanwhile, the IC's plans for a Chicago South Suburban Mass Transit District were presented informally to the Chicago Transit Authority; then formally to Chicago Mayor Richard Daley; then, in brisk succession, to the suburban communities. All of this took place in the summer and early fall of 1967. John Foster again was the impresario, assisted by other IC executives, and the business agent for the Brotherhood of Locomotive Engineers (whose membership, unlike the trainmen, stood to gain job security from a healthy suburban service). Details of the program included: formal presentations of the story, much as it had been laid out for Mayor Daley, to groups of suburban public officials and other influentials at country club dinners; preparation of a

People can't be expected to know what's best for them by themselves.

draft ordinance and its presentation "at the right moment" to each municipal government; suggestions, where possible or useful, of community members who would be desirable as trustees of a district; and a good deal of persuasion in living rooms and club lounges into the week hours. Ordinances were passed in September and October in each community. By late fall, these had been forwarded to the Clerk of Cook County, the CSSMTD had been created, and trustees were in office.

Dollars. So far so good. But the UMTA capital grants program, even though it could funnel money for cars through the new District conduit, would still provide only two-thirds of the required funds, and this only if two additional criteria were met: (1) another one-third of the funds would have to come from the railroad; (2) unless the capital equipment being acquired could be shown to be a part of a comprehensive urban mass transit improvement program for the area, only one-half of the money could be from the federal till.

Johnson had said that the IC would provide the required local share by revenue bonds (meeting a further federal requirement that the local share could not be generated from commuter passenger revenues). Upon investigation, this approach seemed impossible; there were insufficient earnings from the railroad as a whole to provide for retirement of such bonds. But a model for another approach was recalled by IC Vice President Paul Reistrup, formerly of the B&O-C&O where he had been involved in planning for commuter operations. During this earlier planning he learned of an instance in Shreveport, Louisiana through his contacts in the Department of Housing and Urban Development (where the urban mass transportation program had been organizationally located prior to formation of the Department

Innovations flow through people.

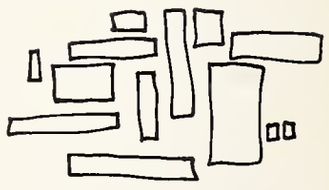
of Transportation). In the Shreveport example, the local share for a capital equipment acquisition had been met by the local transit company making a gift to the city of its required share of the funds. Additional information was then requested and uncovered by IC area representatives. This produced the following innovative proposal for the IC: the Railroad's share of the funds would be provided in the form of prepaid rent to the District for use of the cars that the District would own; the funds for this would come from the general revenues of the Railroad as a whole.

Organizational Relationships from the District's Perspective

The amendment to Illinois law making possible the creation of the District was passed in the summer of 1963. The local communities acted in September and October to pass ordinances to create the Chicago South Suburban Mass Transit District. The locally appointed Trustees met for the first time in November. They were determined not to be merely a creature of the Railroad, but to act independently in the public purpose. The District employed an executive secretary, Mr. Jack Piggot, for day-to-day management and were offered free office space in the City of Harvey, Illinois for a headquarters.

See Figure 9

To make their new responsibilities meaningful, the Trustees organized themselves into a series of committees: equipment, internal management (later, finance), legislative, planning, and IC liaison (later dissolved). (An energetic recreation committee to promote bonhomie also emerged!) The committee labels are significant because they indicate how the Trustees viewed the scope and component elements of their new responsibilities. (This "scoping" is analogous to the way the major headings of a specification for a railcar indicate how the designer conceptualized the solution.)



The pieces presume the whole

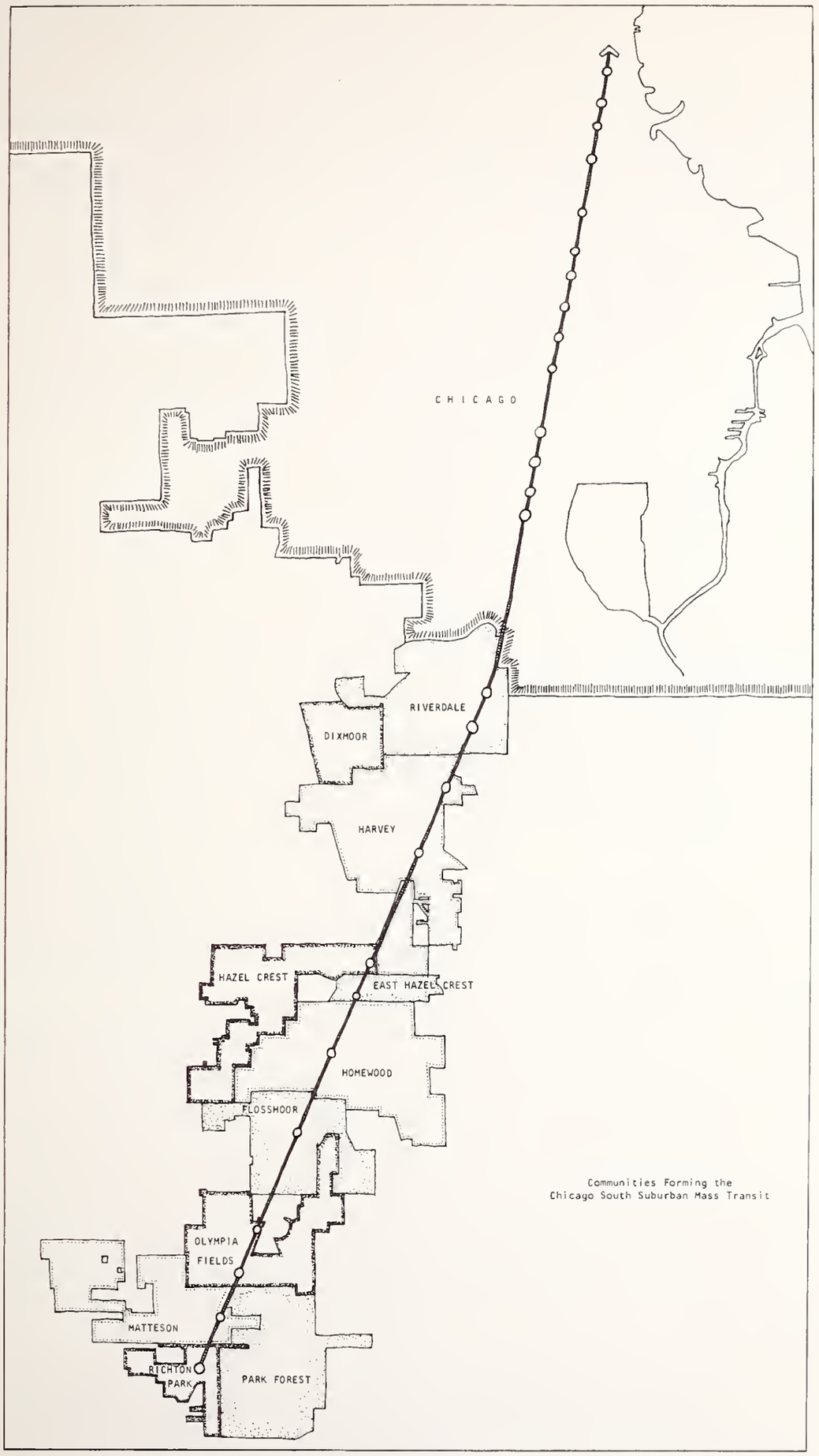


Figure 9

Some interesting points might be noted from the maps of the District. Except for Dixmoor all of the communities are directly related to the IC line although there are another 15 or so communities that could possibly benefit from improved operations on the IC Suburban System. There are additional communities farther south that might benefit from an extended suburban service. The configuration of the communities serve as anacharistic reminders of the circumstances that shaped their development.

Once the District had been created in form, it had to be given substance and life. A "mating dance," as one IC executive described it, went on between the District and the Railroad in late 1967 and early 1968. It was a trying period for both parties -- the eleven menbers of the board of trustees of the District had been appointed by their communities and took their responsibilities seriously. They deliberated about and defined their responsibilities. They wanted to be convinced about the whole rationale for the creation of the District and the need for the capital grant. At first, they seemed to be more like residents of Missouri (the "show-me" state), than of Illinois. They were initially not convinced that the IC would be unable to finance replacement of its commuter car fleet from its own resources. Could not general railroad revenues be used, or air rights over trackage be sold, or bonds floated which would produce funds that would be sufficient to eventually pay for new equipment? In answer to these probings, queries, and misgivings, IC opened its books to the District Trustees, took them to the shops, rode them over the main line, and out on the branches, and talked to them about the nitty-gritty of commuter railroad business.

On the advice of the Illinois Central, the District sent a letter of intent in October 1967 to the Urban Mass Transporation Administration of the new Department of Transportation. Under the federal rules, money for capital equipment could be obtained on the basis of a two-thirds-one-third matching formula. The problem that remained was: how to qualify for two-thirds and not just one-half of the necessary funds for obtaining the cars from federal sources. As already noted, unless the proposed capital acquisitions could be shown to be an improvement within the framework of an overall comprehensive, urban mass transit plan for the entire area, some money would be held out. Some comprehensive planning was needed.

The Trustees of the District, in line with their concept of looking after the interests of all the commuters in their constituent communities, have been branching out -- not in railroading, but in bus transit. Another grant application has been filed with UMTA in which South Suburban Safeway Lines, a feeder and express bus service in the District, will seek to play a role analogous to the IC vis-a-vis the District, with additions to the bus fleet (to which the District would hold title with the bus line as lessee) being sought by the District. This could give the District a role in relating the services of the bus transit system to the improved rail commuter services.

Possible new roles for CSSMTD.

Extension of the rail system to communities farther south and park-n-ride facilities forming nodes for linkage to mass transit services are being discussed. Funding is also being sought for additions to the original 130 commuter car fleet being built for the District, even though options for follow-on orders have now run out. So the District's active participation in the mass transit field can be expected to continue. And further, the District's name now appears on local tax bills, which gives it a potential role in financing further mass transit improvements if this proves to be inevitable.

Probably 15 more cars.

The Railroad's View of Organizational Interactions

Before discussing the planning required to obtain an UMTA capital grant, it is important to note the Railroad's view of what was needed and how responsibility should be divided. This will make some of the statements made in the required planning study clearer. Further, it will indicate how the views of the Railroad changed during the course of this project.

Having very conscientious trustees directing the affairs of the District was a mixed blessing to the Railroad. The capabilities and interest of the Trustees assured that the

District would be functionally self-reliant and not dependent entirely on staff support from the Railroad. However, this independence did cause some delays in getting the grant application together. It was important to the Railroad that a program of improvements for the commuter service begin quickly and that the new rail cars be obtained as quickly as possible.

After the District was formed, and before the lease agreement for the cars was drawn up which would formalize the relationship between the District and the Railroad, the District had no source of income to support even minimal operations. During this period the Railroad advanced the District initially $1000 per month (later increased to $2000 and then to $3000) to support growing District activities. The District became involved initially in reviewing the documentation of the situation and possible approaches prepared by the Railroad's staff.

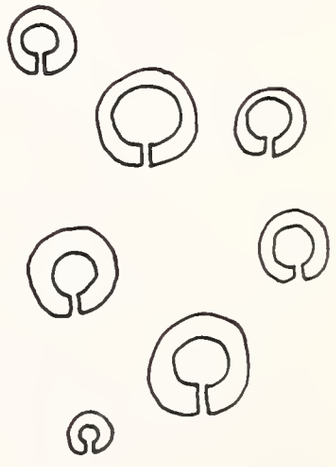
One strong point that assisted the Railroad in its missionary work with the District was that, since the original fleet had all been created during one period, with no subsequent additions for growth, the whole fleet was virtually the same age, and could be replaced as a unit. "We could show them that the cars were all the same kind of bad," as an IC executive put it. The District finally saw the economic, operational, and passenger service reasons for fleet replacement.

But still these conservative business men were reluctant to accept federal money, and they had more than a few ideological counterparts in the communities. They had to be convinced that there was no other way to fund the needed commuter cars, except by federal grant. This made the IC impatient, but in the end the Trustees determined to go ahead. This conviction -- that a federal grant to the District to purchase cars for favorable lease to the IC -- was "the only way to go" proved vital.

Next the Railroad had to assist the District in preparing the application for the capital grant. The formal grant application (weighing some 16 pounds!) was forwarded to UMTA in late summer of 1968, and was initially approved on 27 December 1968. The District and the Railroad were commended by DOT for the completeness of their application, and for the fact that UMTA had been kept advised through the development of the application. Thus federal officials were able to process the application more swiftly than is usually possible.

In retrospect, the IC believes credibility with the District could have been built more swiftly and effectively if the Railroad had arranged at the very beginning for an independent financial study, with the results to be jointly reviewed by the Railroad and the newly formed District. (Later, such a study was made, but this occurred after the capital grant application had been submitted, and in response to a requirement imposed by DOT/UMTA.)

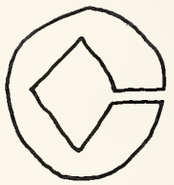
Meanwhile, the IC was working to build good faith through further improvements in operation of the commuter system. A new rush hour train was added. A newsletter to answer questions and complaints of commuters was started. Other improvements were: safety glass in the windows of the old cars, steps to simplify the fare structure (zoned fares), and, after some months of continued struggle, significant betterment of the new automatic revenue collection system. (After the 1967 installation of additional electronic gear -- "a little black box" -- on the ticket recognition feature of the automatic gates, the number of tickets that had to be exchanged dropped dramatically and remained at a low level thereafter.)



Possibly important organization to nurture or create for others who want to improve mass transit.

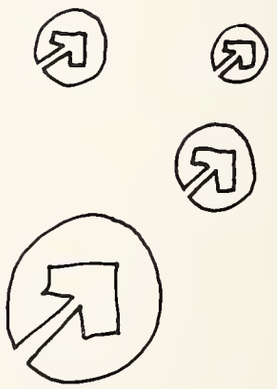
The Illinois Central Commuters Association withered away as commuters became more reconciled to the system and more convinced of the IC's intentions to improve commuter services. And, the system actually began operating better.

The IC then became involved in negotiating its formal relationship with the District that forms the basis for the lease agreement for the cars. Organizationally, the IC has been careful to establish the autonomy of the District and to act principally as a technical advisor. In the bidding and contracting activities and acceptance of the completed cars, the IC has provided technical support and staff support services to the District to assure that the commuter cars would be suitable to be operated and maintained by the IC within the framework of the lease agreement. Thus in most instances, the car builder has been able to work directly with the eventual operator to resolve difficulties. Rollin Chinn has acted as both the chief engineer for the District as well as the Mechanical Engineer for the Railroad without any apparent conflict in his roles. This arrangement has benefitted the District in receiving very favorable bids because the people involved were "known quantities" -- which had not been the case when consultants or public agency personnel were expected by the car builders to play a large intermediary role between the car builder and the personnel ultimately responsible for the cars' operations and maintenance.



Broader Functions for the District?

Could not the District have had other functions that would have involved it in operations, thereby giving it more legitimacy as an organization? Could it have generated revenue of its own by supplying additional services? These possibilities seem not to have been considered, at least in the beginning. The IC, even in retrospect, does not think overall functioning of the commuter system with the new equipment could be improved by a different way of dividing responsibilities and jurisdiction. The Railroad people reason that:

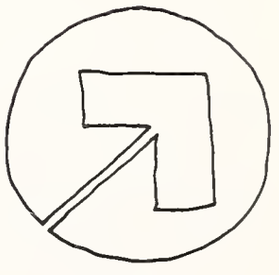


- To move with the required speed, the IC would have to take charge of technical and management aspects of the new car program. Other public mass transit districts that have had larger scope of responsibilities and lack a partnership with an existing railroad have been slower to get started; e.g., BART has existed since 1958 and has yet to put a train in revenue service; SEPTA has been going since 1954 and has only recently begun to run trains.

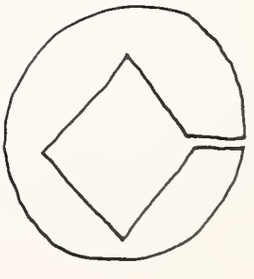
- The capability to operate the south suburban system had grown and developed at the IC for 115 years. It made little sense to try to develop a duplicate organization to perform the same function.

- Since the District, by definition, had to be a municipal corporation composed of citizens who are laymen in railroading and did not have taxing power to finance a staff, it had no technical or financial resources to take a more active role in operating the service, other than the monthly stipend provided by the IC.

In a larger context, the Railroad recognizes the possibility of a future unifying organization being created to act as a coordinator of integrated mass transit services for the entire Chicago area. This organizational umbrella might promote joint use of rights-of-way, joint fares, interorganization use of equipment and facilities, unified maintenance operations, and integrated planning. A unified commuter transportation agency might in the end become involved not only in coordination but in actual operations.



Such further elaboration of an organizational strategy for mass transit services obviously would require major financing both to acquire present infrastructure and equipment and to pay for improvements. Meanwhile, a coordination approach could begin movement toward consolidation. In any case, such possibilities can now be contemplated and invented because of the organizational relationships that have evolved with CSSMTD for commuter passenger service and AMTRAK for intercity rail passenger operations. The



actual kinds of inter-organizational managements that might come into being are probably still unknown; what has come about is a greater openness to possible new strategies and less organizational insularity.

Coordinated Planning and Enlightened Self-Interest

The difference in funding between the one-half available without the framework of a mass transit plan and the two-thirds the IC said was needed from federal sources (or one-sixth of the total amount) was $6.65 million. This additional one-sixth could be obtained only if the acquisition of the new equipment and other changes could be shown to be part of some kind of comprehensive mass transit plan. The south side of Chicago and its environs seemed to be an appropriate and manageable area for such a plan -- bigger than just the IC and not involved with the multitude of issues that a total plan for both commuter and intracity services would have to deal with. Therefore, the District and the Railroad joined enthusiastically in a "comprehensive" study of commuter transportation needs for the entire southward sector of the Greater Chicago area, the so-called "STAC Study." (STAC is the acronym for Southward Transit Area Coordination Committee.) STAC was created by the initiative of the Chicago Commission of Public Works and was composed of: (1) public carriers (Chicago, South Shore and South Bend Railroad; Chicago, Rock Island and Pacific Railroad; Illinois Central Railroad; Penn Central Company; Chicago and Calumet District Transit Company; Gary Transit, Inc.; South Suburban Safeway Lines, Inc.; Suburban Transit System, Inc.; Chicago Transit Authority; and as an observer only, the Norfolk and Western Railroad); and (2) public agencies (Chicago South Suburban Mass Transit District; Chicago Department of Public Works; Lake-Porter County Regional Transportation Planning Commission; Northeastern Illinois Planning Commission; Chicago Area

Transportation Study). The chief consultant for the project was W. C. Gilman and Company, Inc.

The STAC study was undertaken to meet the conditions for a grant: that the proposed capital additions be part of a recognized, comprehensive transit plan for the area. The STAC study also had the effect of drawing favorable attention to the problem of mass transit and highlighted what the IC and the District had previously found out and were already doing to improve the situation.

The salient points of the STAC study for the CSSMTD and the IC in their efforts to secure funding for the new commuter cars are cited below. (These excerpts are from a summary of the full STAC study report prepared by Thomas Buck.)

> The findings and recommendations of the special study conducted by the Southward Transit Area Coordination Committee (STAC) represent a comprehensive short range plan for the greater coordination and improvement of public transportation systems in a large and significant part of the Chicago metropolitan area.
>
> Serving the STAC study area are five commuter railroads, four private bus comapnies, and the Chicago Transit Authority (see Figure 2), the latter of which provides both extensive bus and rail rapid transit services. The extent of the commuter rail operations ranges from the high patronage of the second largest suburban rail carrier in the Chicago area down to two railroads with only a few daily runs left. The four private bus companies provide mostly local transit service within the STAC area, although two of the companies operate express buses to and from the Chicago central business district. Approximately one-third of the Chicago Transit Authority's total fleet of more than 3,100 buses is operated on routes wholly or partially within the STAC area. The

An expedient justification for the new cars.

Transit Authority also operates a new heavily patronized Dan Ryan rapid transit route extending well into the STAC area, as well as two long established elevated rapid transit branches on the northern edge of the area.

A big influence on the prospect for IC's commuter service.

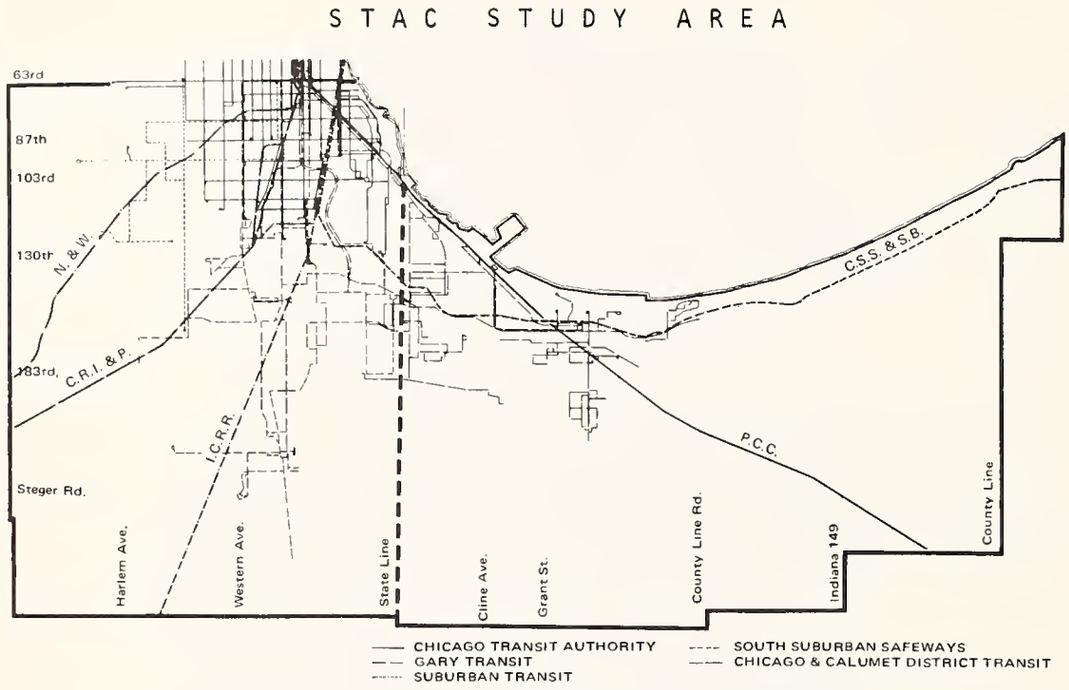


Figure 10. **PUBLIC TRANSPORTATION CARRIERS**

Service Recommendations

-- That the Chicago, South Shore and South Bend Railroad restructure commuter operations to increase ridership and reduce operating costs.

CSS&SBR raised fares and reduced schedules.

-- That operations should be continued on the South Chicago branch of the Illinois Central Railroad either by the railroad company or a successor rapid transit operation.

In the works.

-- That operation of the Blue Island branch of the Illinois Central Railroad be continued unless a satisfactory substitute service, not now evident, could be developed.

Maybe busses?

IMMEDIATE ACTION NECESSARY

The STAC study has found that the ten carriers operating in the study area are making determined efforts to provide high quality service for their passengers. These efforts are being hampered, however, principally by automobile competition, spiralling labor costs, and an inability to replace worn-out equipment from revenues.

The IC can claim this, but what about the other carriers?

PROBLEMS AND OBJECTIVES

-- Ensure that each private carrier be permitted to earn a fair rate of return on investment or be provided with a reasonable operating ratio. (Operating and/or capital public subsidy to be provided if necessary and appropriate.)

Need for innovation dampened by subsidizing existing modes of service.

-- Minimize the negative effects and maximize positive effects of public transportation on the areas through which it operates. (This is to be achieved by making the transportation system compatible with actual and potential land development, physical environment, pollution policies, etc.

-- Preserve free enterprise in mass transportation to the greatest extent possible.

Public breakthrough for a private cause?

-- Where potential is sufficient to justify the additional investment, extend rail or bus routes to serve the areas not now served.

-- Provide for the investment to be carried out with a mininum of additional control over operators.

-- Ensure that all the objectives of the study are carried out with due regard for the economic consequence to all affected parties.

In 1969, the five commuter railroads had a total fleet of 462 coaches, and had a total patronage volume for the year of approximately 30 million rides. Commuter railroads serving the Illinois portion of the STAC area are the Illinois Central, Rock Island and Norfolk and Western. Serving both the Illinois and the Indiana portions are the South Shore and the Penn Central railroads. With more than 20 million rides in 1969, the Illinois Central is the largest volume commuter railroad in the area.

Note: IC has most of the patronage.

IMPACT OF THE DAN RYAN RAPID TRANSIT EXTENSION

The Dan Ryan rapid transit route, which was opened September 28, 1969, generated heavy patronage as an entirely new rail facility built with a two-thirds federal grant and a one-third local matching fund provided by the City of Chicago. Public acceptance of this new facility, operated by the Chicago Transit Authority, was substantially greater than initial estimates had indicated.

A total of 3,050 Dan Ryan riders, or 9.8 percent, had been diverted from commuter rail lines. This division included 1,550 former riders of the Illinois Central, or 5.0 percent of the total Dan Ryan riders.

Patronage can be generated by new routes, but probably at greater cost than higher quality services (not just faster and more frequent) on existing commuter lines.

Of special significance was the fact that 4,320 of the Dan Ryan rapid transit route riders represented entirely new transit patrons. This new patronage accounted for 13.7 percent of the ridership and consisted of persons who formerly used automobiles instead of transit and persons who were using the Dan Ryan route for entirely new trips.

Station Closure Analysis - Counts of passengers boarding at commuter rail stations in the STAC area showed that many stations are accommodating only small numbers of passengers.

The objective of the station closure analysis was to evaluate the impact on operations and ridership if some of the low-volume stations were to be closed. Estimates were made of the costs versus the savings to both the railroad and the riders from station closure.

The STAC study indicated that commuter stations with low passenger volumes should be considered for closing, but at the same time pointed out that any such decisions on station closings should give consideration to social needs and other factors in addition to costs and savings.

Can "social needs" be balanced against operating efficiency: an apple-and-oranges dilemma.

COORDINATION RECOMMENDATIONS

A major coordination objective in developing the recommendations was to strengthen each carrier in order that public transportation, as a necessary and highly important service, can be retained and improved in a safe, economical and efficient manner.

As important coordination recommendations, the STAC study made the following proposals:

-- That new programs be carried out to promote more off-peak patronage and revenues. Such programs could include the promotion of shopper tickets, more transit tie-ins with special events, tie-ins of transit with school pupil travel, the timing of coordinated rail-bus schedules to draw outer-suburban travel away from private automobiles, the publication of a route map for all carriers in the STAC area with "convenience" being the transportation-marketing keynote, the establishment of a telephone center to provide 'round-the-clock' information on schedules, and an overall coordinated information and advertising campaign.

"Convenience" is only the beginning of a better commuting experience.

. . . and (2) Cooperative pooling of electric multiple-unit equipment used by the Illinois Central and the South Shore railroads.

Wouldn't the "old soldier" CSS&SBR really prefer to just fade away?

Station Improvements and Park-'N-Ride Facilities

In general, the STAC study report emphasized a need for more park-'n-ride facilities for stations of the Penn Central, South Shore, Rock Island, and Illinois Central as an inducement for motorists to use public transportation and thus to help reduce street traffic congestion.

-- With more than 3,500 parking spaces, the Illinois Central has the most extensive parking facilities of any of the carriers in the STAC study area, but there still is a need for continued annual expansion of parking at stations south of Kensington. Desirably, the municipalities and the Illinois Central would work together in providing more parking spaces. The railroad may be able to provide the necessary land, and the municipalities could improve the sites and recover the costs by charging modest parking fees.

Why can't the District capitalize parking facilities for commuters, using revenue financing?

Proposed Closings of Commuter Rail Stations

-- For the Illinois Central, suggested station closures include 18th Street, 47th Street, 67th Street and 75th Streets on the main line within Chicago. It was explained that in all instances, reasonably satisfactory alternate means of transportation are available via the Chicago Transit Authority or other Illinois Central stations and that only minor transfer adjustments would be required. The STAC report explained further that the Illinois Central stop at 63rd Street, while not producing more than $80 a day in revenue, still should be retained for the near future as a demonstration location for increasing work-oriented ridership by economically under-privileged groups.

Dangerous Tokenism?

To improve the running time of certain Illinois Central rush-hour express trains to and from outlying stations, it was recommended that the railroad install zoned scheduled operation, at least during the peak hours. In addition to speeding up runs, zone scheduling of trains, it was explained, could reduce power costs significantly and also eliminate track congestion problems involving the South Shore, which shares Illinois Central trackage between Randolph Street and Kensington.

Self-fulfilling recommendations as a route to surprise-free planning.

In the Illinois portion of the STAC area, the study points out that existing or new transit districts offer a medium for obtaining two-thirds federal funding for new transit equipment and other improvements. For instance, the Chicago South Suburban Mass Transit District is contributing the one-third matching funds for a federal grant for the 130 new cars being built for the Illinois Central by using funds provided by the Illinois Central in the form of advance rental paid for use of the new cars.

Table 1 on the following page outlines the recommendations of the STAC study. You will note that the study suggested a different distribution of capital expenditures than has actually occurred. In particular, twice the number of bi-level MU cars have been added. Both the Rock Island and South Shore improvement programs have been less than effectively pursued.

TABLE 1

SUMMARY OF CAPITAL IMPROVEMENT RECOMMENDATIONS

	Rock Island	Penn Central	Illinois Central	South Shore	Chicago Transit Authority
Equipment	50 bi-level coaches push-pull equipped Convert 8 to 10 Diesel units to push-pull circuitry and central electrical generation	6 bi-level coaches push-pull equipped 2 road switcher locomotives, 1 rebuilt standby locomotive push-pull equipped including central electrical generation	25 bi-level M.U. electric cars	30-34 M.U. electric cars In 1971, transfer released IC M.U. to South Shore for temporary use	512 non-A.C. buses 120 non-A.C. buses per year, 4 years, total 480
Equipment Costs	Cars $11,300,000 Locomotive conversion $400,000	Cars $1,250,000 Locomotives $750,000	Cars $8,100,000	Cars $9,000,000 IC car lease (estimated 2 years) $1.1 million per year, total $2.2 million	512 buses $17,900,000 (immediate) 480 buses $16,800,000 (1971-1975) Convert 400-unit bus garage to diesel servicing $1,025,000
Track Upgrading and Station Improvements Including Costs	Approximately 40 track miles (20 miles double track) Upgrading, $750,000	Routine track maintenance	Routine track maintenance New track extension Richton-Park Forest South all components $1,600,000	Routine track maintenance	Rehabilitate 5 rapid transit stations $3,000,000
	Station improvements and consolidation, less salvage, $750,000	Station and platform rehabilitation $100,000	Station improvement and consolidation $1,500,000	Station improvements High-level platforms (4) New station $1,000,000	
Special Projects	-	-	Reverse signaling 5.5 miles Homewood-Richton $650,000	Substation and electrical system improvements $1,150,000	-
	Total Cost: $13,200,000	$2,100,000	$11,850,000	$13,350,000	$38,725,000

	Chicago & Calumet District	Gary Transit	South Suburban SafeWay	Suburban Transit	Summary Totals
Equipment	30 non-A.C. buses 6 non-A.C. buses per year, 4 years, total 24 2 A.C. buses per year, 4 years, total 8	33 A.C. buses 8 A.C. buses per year, 4 years, total 32	80 A.C. buses 9 A.C. buses per year, starting 1973, total 18	10 A.C. buses 4 A.C. buses per year, 4 years, total 16	197 A.C. buses 1,046 non-A.C. buses 55-59 M.U. electric cars 56 bi-level coaches 3 locomotives 8-10 locomotive conversions Lease 60 cars
Equipment Costs	30 buses $1,050,000 (immediate) 24 buses (non-A.C.) (1971-1975) $840,000 8 buses (A.C.) $320,000 (1971-1975)	33 buses $1,320,000 (immediate) 32 buses $1,280,000 (1971-1975)	80 buses $3,200,000 (immediate) 18 buses $720,000 (1973-1975)	10 buses $400,000 (immediate) 16 buses $640,000 (1971-1975)	Buses $ 44,470,000 M.U. electric cars $ 17,100,000 Bi-level coaches $ 12,550,000 Locomotives $ 750,000 Locomotive conversion $ 400,000 Car lease $ 2,200,000
Track Upgrading and Station Improvements Including Costs	-	-	-	-	Special track upgrading $ 750,000 Station rehabilitation platforms, new stations $ 6,350,000 Track extension $ 1,600,000
Special Projects	-	-	-	-	Signaling $ 650,000 Substations $ 1,150,000 Convert bus garage to diesel servicing $ 1,025,000
	Total Cost: $2,210,000	$2,600,000	$3,920,000	$1,040,000	$ 88,995,000 15 Percent Contingency: 13,349,250 $102,344,250

Note: Cost estimates are based upon 1969 unit costs and have not been adjusted to reflect probable escalation during the 1970-1975 period.

Formalizing District-Railroad Relationships

Much time -- about a year -- was spent working out the leasing agreement for the new commuter cars between the CSSMTD and the IC. Many considerations were involved, some of which have already been noted.

- The District Trustees wanted to be more than a paper organization. While they did not want to interpose themselves in the technical details of running and maintaining the cars, the Trustees wanted to build in provisions that would assure good service for the residents of the communities they represented.

- The Railroad wanted freedom to use the new equipment according to its best judgment and an opportunity to make the operation more profitable.

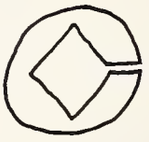
- UMTA (a monitor of the negotiation process because it would provide the major share of the financing for the equipment involved) had to make sure that the IC's share of the capital investment in equipment would not be paid from passenger revenue on the suburban service (forbidden under the capital grant rules).

Initially the District was to provide the local share to be retired by revenue bonds to be paid off by car lease payments.

The main features of the agreement finally worked out were as follows:

- The IC would provide its share of the cost of the cars in the form of prepaid rent. These funds would come from the general capital resources of the railroad, not out of revenues from commuter passenger services.

- Since the District needed operating funds for its administration and had no taxing power for this purpose, the IC initially advanced $5,000 to the District and then made monthly advances (now $3,000 per month) to the District. These funds were to be treated as a credit under the lease agreement.



- Whatever profits might be realized from operation of the new cars were to be divided between the District and the IC on a basis that would provide incentives to both (the details were worked out at the suggestion of both UMTA and the Chicago Area Transportation Study, as reviewing agencies of the grant application and the lease). The profit-sharing arrangement finally agreed upon was as follows:

- First 3% : to the IC
- Second 3% : 60% to a District fund earmarked for capital improvements and 40% to the IC
- Profit in excess of 6% : 60% to the IC and 40% to the District fund.

- The use of the District's earmarked funds for capital improvement was also spelled out. Brzyski summarizes this part of the agreement as follows: "The railroad was given freedom to use half the earmarked funds for whatever capital improvements good railroading demanded (not only cars but also other stationary equipment). The second half of the funds were specifically set aside for long-term fleet replacements, with the Trustees having the flexibility to permit the IC to use part or all of the second half of the earmarked funds for other forms of capital improvements, if they saw fit." (Brzyski, p. 63.)

- The investment base from which profits and earmarked funds would be calculated was set at one figure for the entire period of the lease: approximately $38 million. This figure had been accepted in Illinois Commerce Commission rate hearings and was later validated by an independent study (Report on Engineering and Economic Analyses, Grant for Commuter Railroad Cars, Illinois Central Suburban System, by De Leuw, Cather & Company - Consulting Engineers). This study was undertaken for the District and paid for and required by UMTA.

This last point is significant organizationally: it clearly separated out in terms of capital investment (which is an important dimension in the business world) and Commuter Passenger Service from the rest of the Illinois Central Railroad. Henceforth, the financial performance of this IC division is linked by this lease agreement with the public purpose of the CSSMTD. The Railroad is still responsible for petitioning for rate adjustments and changes in service to the Illinois Commerce Commission. Because of the lease, however, the District is also concerned. It is fortunate, as pointed out in the previously referred to "DeLeuw Report," that for the most part the physical assets of the IC's

suburban passenger service are in fact either physically separate from those used in other railroad activities or are easily prorated. (For example, for bridges on the main lines where there may be four tracks used almost exclusively by the suburban service and six by other railroad operations, the value of the bridge can be divided 2:3.)

Violating Organization Proprieties

All was going smoothly with the capital grant application when the national elections occurred in late 1968 and a new Republican President took office on January 20, 1969. On January 22, IC President Johnson announced that Allan Boyd, the Secretary of Transportation in the Lyndon Johnson administration, had been appointed president of the Illinois Central Railroad. This announcement provoked controversy on all sides. Among the questions asked were: Why this announcement now? What about the propriety of Illinois Central benefitting from a grant by an agency whose chief knew he was about to become the president of the railroad? For a time, the District and the Railroad feared that the previous months of effort would go for naught. Cries for investigation were heard in Congress and from local legislators. The Railroad replied immediately in the public press: Boyd had been approached because of his ability in the transportation field. William Johnson realized that Boyd would be available because of the change in administration and Boyd had been approached after the November election. Further, said the IC, Boyd had been advised that a capital grant application was pending before DOT, and it was suggested he insulate himself from it. The grant had in fact been approved by officials on a lower level than Boyd.

The qualifications for a railroad chief executive seem to have shifted from an operational to a financial to a regulatory background.

To assure themselves that the approval was based on the merits of the situation, the new appointees at DOT reopened the study of the grant application. It was soon realized that many different individuals and organizations of various

political persuasions had been parties to agreements in the development of the grant application. Further, it was recognized that many of the people who were going to benefit directly from this improved commuter service were likely supporters of the new administration. The opposition died away. The grant application was re-approved in late March, but the Railroad and the District went through 60 days of anxiety and uncertainty.

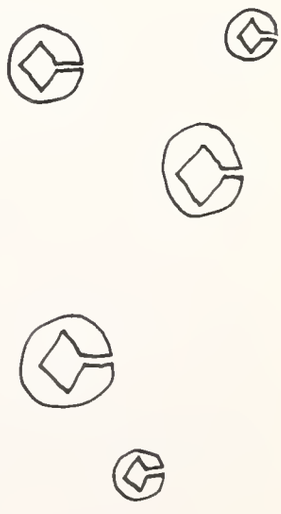
Future Organizational Developments

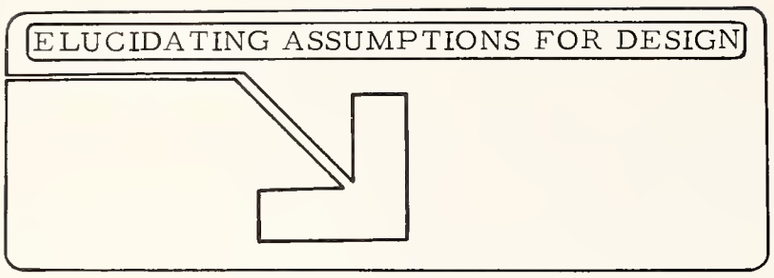
Further blurring of the distinctions between public and private organizational labels can be expected: intricate contractual relationships between operators, owners of equipment and other facilities, concessionaires, local governmental bodies, and special districts. Organizations of commuters might take on new roles in procuring services, owning equipment, and collecting membership fees and charges for services. Exactly what form these organizational developments will take will depend on the particular circumstances.

Possible SMATS, DRUNS and GLEEBS

Merger of the commuter service operations of all Chicago area railroads is a possibility that is being discussed. Also, integrating the railroads' commuter operations and the Chicago Transit Authority's rail system (possibly including the buses too) into a Chicago Metropolitan Area Transit System has been proposed. This approach is primarily advocated by the Chicago Northwestern Railroad, which claims to be making a profit on commuter operations yet has refused to concur in further federal capital grant outlays or other forms of public subsidy unless other common carriers and transportation districts in the area agree to the move toward integrated Chicago area public transportation. Meanwhile the planning requirements for the area to be fully certified to qualify for two-thirds federal funding of transit improvements is about to lapse.

Possible DRUNS





Some people will never learn anything, because they understand everything too soon.

ALEXANDER POPE

Designs for rail passenger cars, like designs for anything, depend on the definition of the "it" being designed. In this case, the it being designed, most broadly defined, was an improved rail commuter service. But almost immediately this broad definition is translated into the design of better pieces for such a system. Cars and an automatic ticketing procedure became the focus of design effort. Frequently the effort and expenditures to effect improvements in such elements of the system do not produce a commensurate improvement in the total system. Careful review of design assumptions, particularly those having to do with the allocation of features and technologies between major elements of the system, can yield significant improvements. In the design of the cars themselves, tacit assumptions, based on years of knowing what multiple-unit, electrical, self-propelled rail passenger cars are, move designers directly to considerations of how to accomplish the design without going through a reconsideration of what is being designed. Time pressures further contribute to this truncation of the design process. In this case skipping the more general considerations was probably warranted. This should be a conscious determination, however.

The given -- the district for a car or cars for a district -- determine the final design.

Actual design work on the new car was proceeding in the Illinois Central's engineering department while the process of forming a mass transit district and preparation of the grant application was going on. It was assumed that the limits of the system being designed were a commuter car. The immediate interfaces (stations, track, power supply) were to be modified as little as possible, if at all. The public relations

department of the IC did consider the possibility of introducing new designs for stations and had some architectural drawings prepared by Stanley Tigerman, Chicago architect. However, it was decided that the costs of major modifications or rebuilding many stations would be "prohibitively costly" (given the prevailing assumptions about the low potential for the suburban service to provide an attractive return on investment). What seems to emerge as a principle is: given limited funds, it is more likely that individual features of a complex system will be improved separately, keeping the definitions of interfaces constant, than for new interfaces to be defined and modifications to be introduced according to revised conceptions of the total system and/or new definitions of system components.

Design Within an Idiom

In the spring of 1967, William B. Johnson of the IC told Rollin Chinn, the railroad's mechanical engineer, to work out specifications for a new suburban rail car. Before he could respond, Chinn felt he had to have only four decisions from top management of the railroad that would be the basic ground rules for the design. The specific nature and limited number of decisions that Mr. Chinn required before beginning design indicates that a conception of what an "up-to-date" commuter car should look like was already formed at the IC and probably among the major car builders. The four design decisions requested were:

Type of Service: Would the new cars be for inter-city and for commuter service both, or for commuter service only?

A lot of consideration was given to using the cars in both the commuter and the inter-city operations. For a while, the IC reasoned that most of the cars would be essentially out of service from Friday night to Monday morning. This raised the possibility that over the weekends the equipment might be

used to bring students home to Chicago from downstate colleges. However, it was realized that a lot of student vacation business would also occur midweek. Since this was a peak period on the suburban service, the two possible sources of traffic would not be complementary. As a result it was decided to use the cars for commuter service only.

Length: Would they be 85' or 72' cars?

An 85' car that had been acquired by the IC for inter-city passenger service was tested on the suburban lines and worked out well. It was realized that much more passenger capacity could be obtained this way, and also the modifications required in the station platforms (several of the stations were on curves) and other parts of the right-of-way (some clearances were more critical with added car length) would not be excessive. In short, an 85' car would mean more seats per car and therefore less cost per seat. The need to alter some platforms and allow for larger displacements of diaphragms on curves and some crossovers could be met.

Capacity: Single deck or double deck?

The advantages of double-deck would be: more seats per car, hence fewer cars needed for a given number of passengers in the Randolph Street station at rush hour; reduced platform overhang (important at several suburban stations bounded by cross streets); and the ability to operate trains made up of as few as two cars. Disadvantages were: the need to increase clearances for platforms and catenary wires at some locations, and the large passenger capacity of an operating pair of cars -- 312 persons -- making adjustment of trains' capacity to demand less precise (the likelihood of too many or too few seats). Since there had never been double-deckers on the IC, passenger reaction was felt too unpredictable. All the larger cars would also have to be

self-propelled (no "trailers"), thereby increasing car weight and cost considerably. IC top management, however, decided in the summer of 1968 that the new cars would be double-deck cars. One major reason for the choice of double-deck was that this had been the type of equipment just then being installed on other commuter lines in the Chicago area, such as the Chicago and Northwestern, Milwaukee Road, the Rock Island, and the Chicago Burlington & Quincy. The double-deck car made 2+2 or individual seating possible, avoiding the congested appearance of 3+2 seating necessary to provide required capacity on the single deck cars such as the new Long Island Railroad equipment. Therefore, for a suburban line in Chicago to be considered up-to-date, it was almost mandatory that double-deck cars be acquired.

Access: Doors at ends of car or in the middle?

Door position is related to pantograph position, since door access has to depend on seating arrangement and this in turn depends on pantograph location. The Pullman Company offered the IC a preliminary design with center doors and no doors at the ends.

Another design had doors at the end with the pantograph in the center. But curvature of the rails at some points would not permit a pantograph in the center; the size of the turning arc would be such that clearance wouldn't be possible in some of the tunnels, either. The design finally developed called for a single pantograph at the "B" (cab) end of each car, placed in a setback in the roof to allow the pantograph to be a little lower, thereby making it unnecessary to make many changes in the height of the catenary. Two seats in the upper-deck had to be removed to allow for the setback, but this was acceptable. This design solution was a contribution from Sundberg-Ferar, the design consultants who were retained to style the car by the District on the advice of the IC. It was more practical to adjust the height of the pantograph than to adjust the height of the catenaries throughout the system.

It was interesting to note that the critical nature of the time required for loading and unloading passengers at stations for more efficient scheduling and utilization was well understood in the late 1800's when the IC purchased the "Sullivan Cars" used prior to electrification. These cars had 12 doors each to facilitate passenger transfer. The limited access to present cars limits faster scheduling. This same design constraint is critical to elevator utilization and has received much attention by their designers. See Figure 11 below.

Figure 11

An idea whose time had gotten out of phase.

Additional Design Decisions Within the Idiom

Various propulsion systems and power sources for on-board equipment were investigated. The possibility of turbine engines, propane gas for air conditioning when out from under the wire, and diesel as well as electricity were all explored. It was decided to stay with the overhead electrical power system, since the investment was already there. Though diesel operation would offer some greater flexibility, it is not really suited to the type of station pattern and frequency of service of the IC suburban system (many stations close together; short headway between trains). However, the IC now plans a zone scheduling arrangement: the direct-line movement of express trains from groups of stations to the central city and vice-versa. Since zoned fares and schedul-

ing are being introduced, this type of stop-stop-stop-long run-stop-stop operation can be expected to increase and was defined as "normal" for either transit or suburban systems that have been used as models to this date.

There was a question about whether the new car couplings should be made compatible with other equipment on the Railroad. Once it had been determined that the new cars would be used only in suburban service and that the old fleet would be replaced completely, the IC decided that the new cars would not need to be compatible with other equipment, but only with cars of the same type. Coupling adapters were available so that the cars could be moved with older M.U. electric cars or diesel engines in the yards or in case of on-line breakdowns.

The decision to procure double-deck cars for 156 passengers meant that a fleet of 130 would not quite replace the capacity of the old single-deck fleet of 274 cars. However, IC hoped to be able to obtain more cars of the same type later and meanwhile to provide the needed seats by more intensive utilization of new equipment. The introduction of the zone system would make tighter scheduling possible and when necessary some trains could be made up of the old cars. Even the old fleet left no margin for error at rush hour; approximately 18 cars were always in maintenance, leaving only about 244 available for the rush hour traffic, and all of these were needed. With double-deck seating, a 6-car train would have 96 more seats than a 10-car train of old single-deck cars.

Dividing Up Design Concerns Between Organizations

Concern with particular aspects of design by the IC and the District came about largely as the result of suggestions by Paul Reistrup, then vice president of passenger services for the Railroad. Reistrup suggested that technical aspects of the cars be the responsibility of the Railroad, since the IC

knew this side of the design requirements in greater detail than would ever be possible for the District Trustees. But viewing the car as a riding environment, from the point of view of commuter acceptability and behavior, would be the special concern of the District. The Trustees agreed with this suggestion and thereafter took an active role in certain parts of the design effort. They visited other rail systems to get background information and ideas, and view various types of equipment in service. They also responded to a suggestion (again from Reistrup) that they hire design consultants for the styling of the cars. Some of the design suggestions that came from the Trustees included adding a handrail to the gallery, some adjustments of lighting, and the addition of tinted safety glass. The styling consultants, Sundberg-Ferar, initially suggested much larger window units to afford commuters a large vista. But the experiences of the railroad with breakage, coupled with the increased airconditioning load that would result from heat gain through the larger windows argued for smaller windows in the final design.

Can consultants make everybody experts?

The Railroad also got extensive advice from a number of other sources in developing a design for the car. One source was its own operating personnel: people in the shops, conductors, trainmen, and engineers were consulted. Engineers wanted to be sure that the entire car would be built ruggedly and that the same type of cab seat that they had on the old cars (a folding seat that enables the engineer to operate the train whether standing or seated) would be retained. They also wanted an air hose for cab cleaning, available on the old cars but not part of the original new car design. The controls were put in almost the identical position as in the old cars, because, as one railroad official put it, "To change around the brake and throttle would be like switching the position of the clutch and the accelerator on an automobile." It was also important that the engineer's cab on the new cars be as compatible as possible with the old cars, because for a considerable time the engineers would be operating both

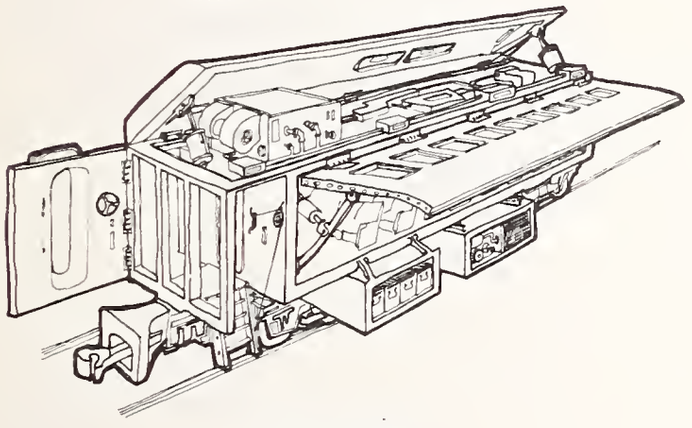
The best is what we had where I trained plus what I've thought of since.

types of equipment. The decision to specify sealed unit air-conditioning units followed from the requirement to have a.c. power on the cars as well as d.c. power for the main traction motors. Sealed unit air-conditioning units promised to be more reliable than belt-driven ones, but required an a.c. power source. IC engineers had found from visiting the Chicago and Northwestern shops that it took a full day to change belts on an air-conditioning unit of the unsealed type.

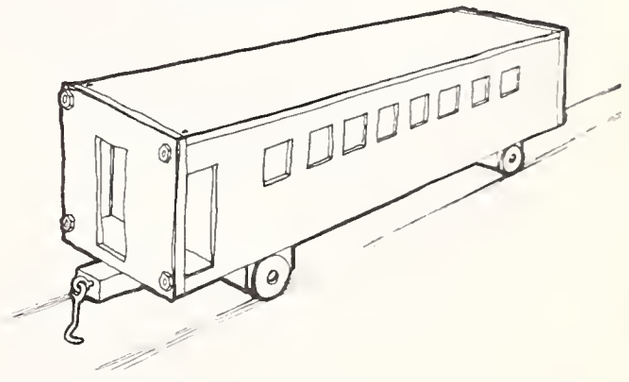
THE PERFECT COMMUTER CAR: ACCORDING TO....

Design is a process of compromise. A commuter service car requires the efforts of many different specialists. The performance of each specialty is vital to the usefulness of the car. But dollars, space, and weight are limited so each subsystem will likely not be exactly what the particular specialist would have designed by himself. Below we present some characteristics of how different specialists might design a commuter car if they could have their own way. These drawings are adapted from drawings by F. Wiegratz provided by Comerford Martin of St. Louis Car.

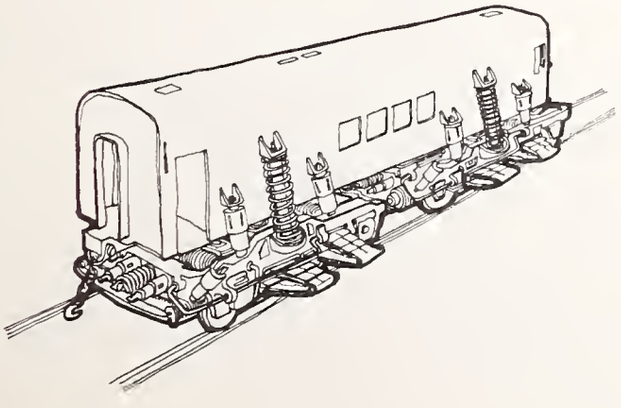
SERVICE YARD GROUP



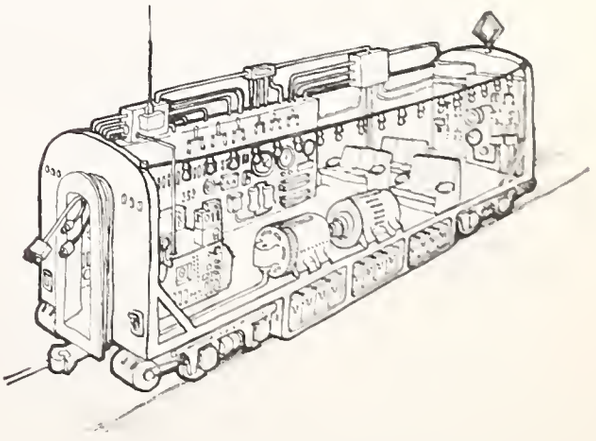
PRODUCTION GROUP



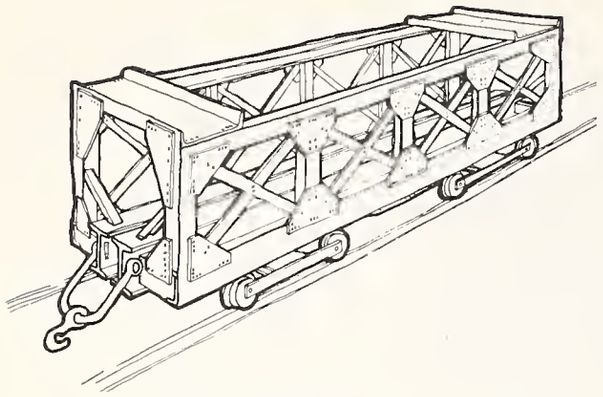
TRUCK GROUP



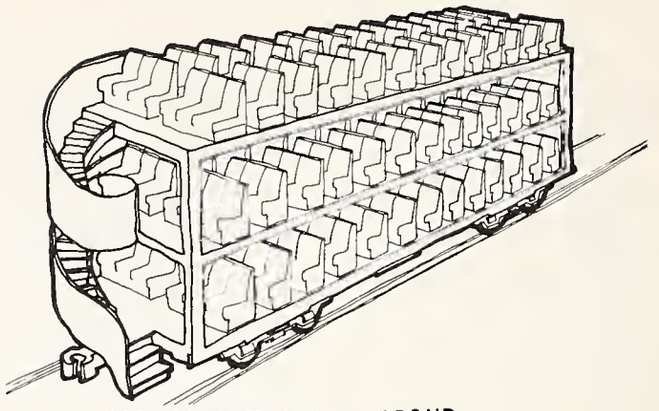
ELECTRICAL GROUP



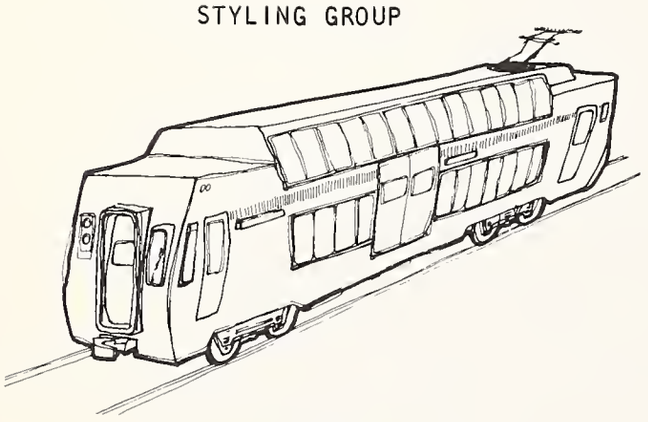
STRUCTURAL GROUP



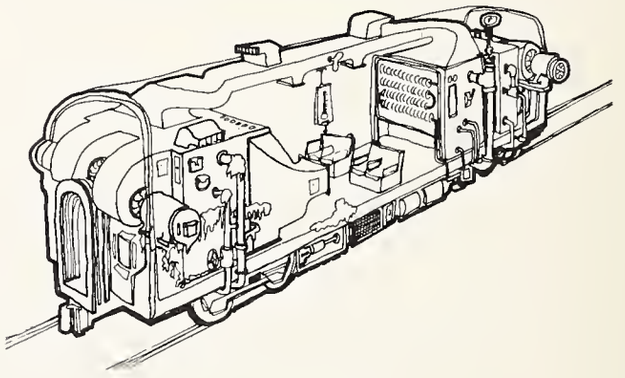
TRAFFIC GROUP (REVENUE)



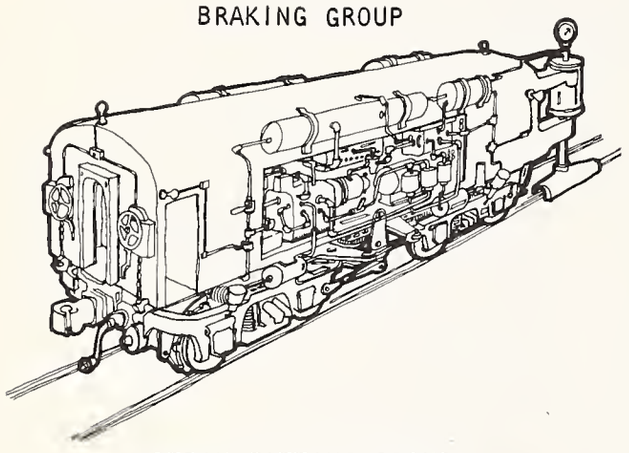
STYLING GROUP



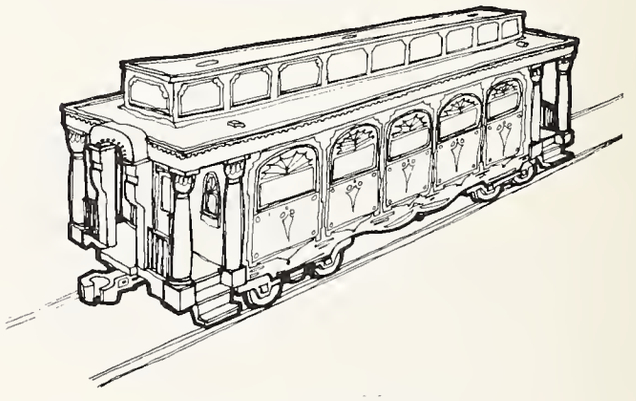
AIR CONDITIONING GROUP



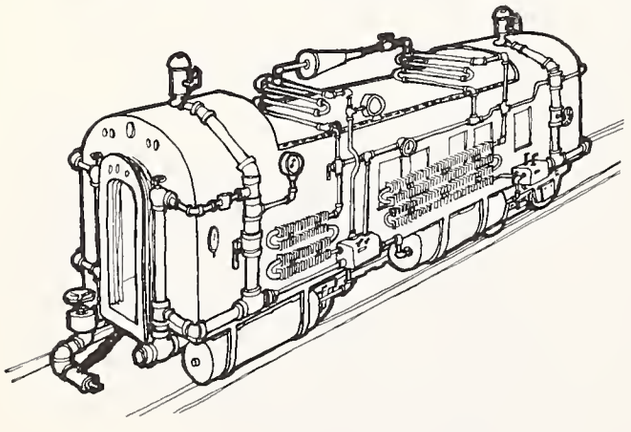
BRAKING GROUP



CABINET GROUP



STEAM FITTING GROUP



WEIGHT GROUP (OPERATIONS)

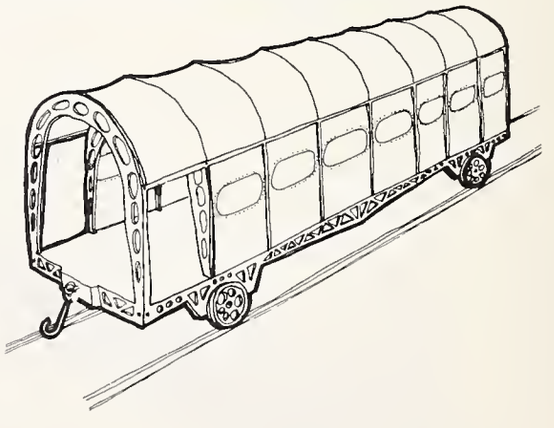


Figure 12

Personal Involvement and Design Emphases

We'd like to comment here about another aspect of the design process (suggested by the preceding paragraph) that seems important not only in rail equipment development but in other types of engineering, architecture, and planning projects. That is the relationship between: (1) how much energy and attention each participant in the design effort is free to invest in the task; (2) what kind of expertise each participant has; and (3) what features of the resulting design are therefore emphasized or ignored.

In the present instance, as in most such efforts, all participants (the District Trustees, Chinn, and the IC engineering staff acting as technical specialists for both the District and the IC, and the styling consultant firm of Sundberg-Ferar) wanted, as Chinn said, "to come up with a good car." Yet everyone could not be concerned with everything. The Trustees, for example, wanted to be active in exercising their public trust by participating as much as possible in the development of the car design. But they could not contribute effectively to aspects of the design requiring a professional engineering background. Therefore, their "free energy" was poured into aspects of the design for which it was assumed a technical background was not needed: to take the role of future passengers and offer opinions and suggestions on the immediate passenger environment of the car interior. It took a lot of additional effort by the "technical people" -- the engineers and designers -- to make this District contribution possible; meetings, trips, briefings, and the like had to be arranged and the results processed. Conversely, the professionals focused their concern on performance, structural and safety features dictated by traditions in their specialties and industry regulations. These emphases -- selected aspects of the interior environment and mechanical/electrical/structural considerations -- left other aspects of the design deemphasized or ignored. One aspect largely

Design tasks expand to use up any available energy.

overlooked was the implications of design decisions for the production process to follow; here the car builders had to fill in what was needed from their special perspective. Another deemphasized -- indeed, virtually unconsidered -- aspect of the design was the opportunity the project afforded for innovative solutions to the problem of how to create more attractive, convenient, or enriched riding experiences for passengers -- hence, derivatively, more opportunities for building ridership and revenue. None of the participants in the design process had this particular perspective.

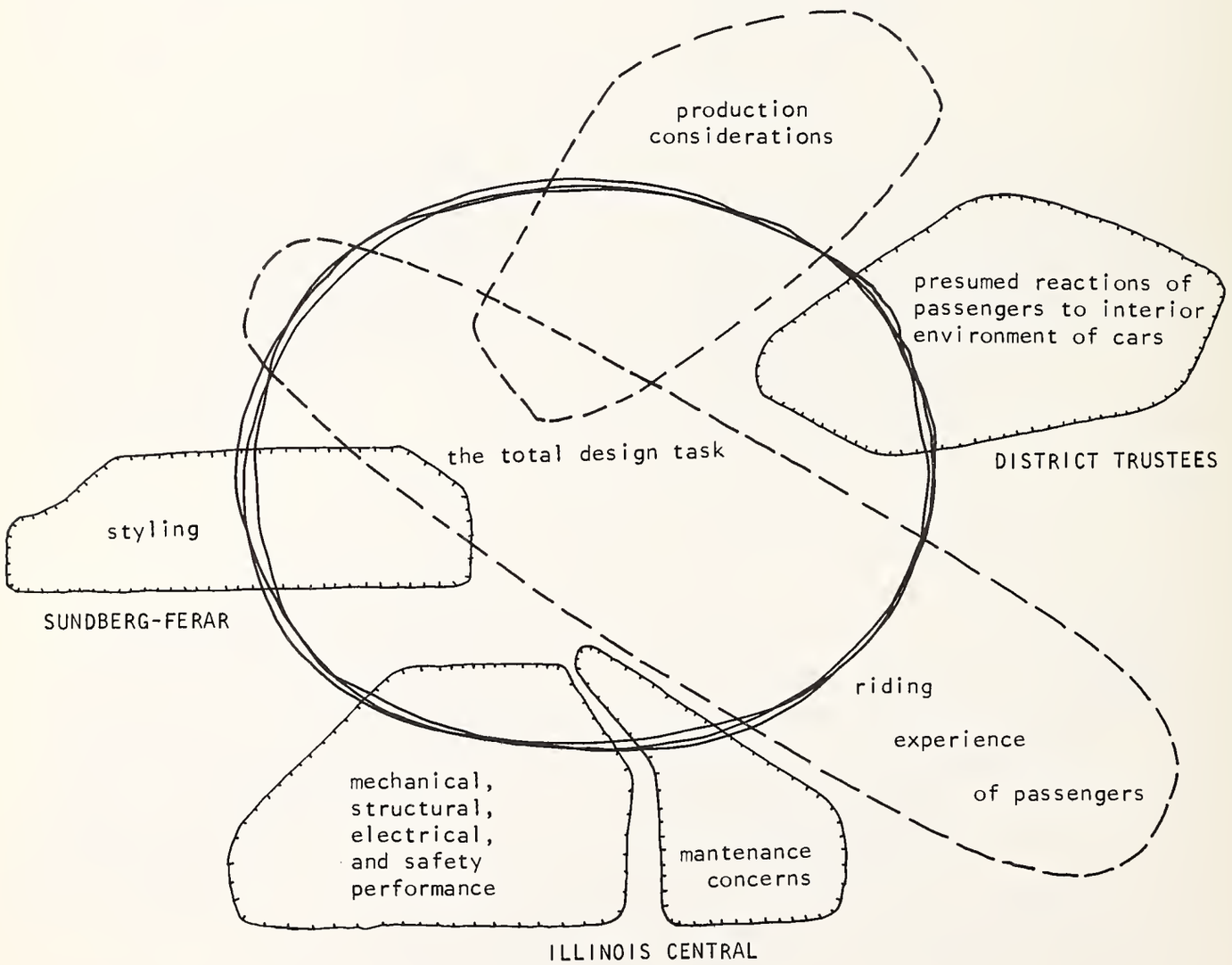


Figure 13

Division of the Car Into Subsystems

The process of developing the design and engineering specifications started with a general outline. Each section was then given to a specialist for detailing of specifications for each different subsystem of the car. Consideration of alternative ways of dividing the car into subsystems is to a large extent precluded by this approach. It means that DRUNS (alternative demarcation of system boundaries) are virtually impossible. The specification book that developed shows that this was a complex process. All of the effort and cost for the design was borne by the Illinois Central. All in all, however, IC top management feels that the design effort by Chinn and his staff was very professional and this led to great reliance on the Mechanical Engineering Department to take the lead in directing this project.

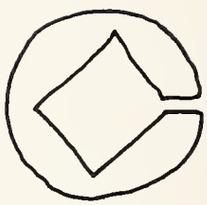
What was developed was a good specification that made it possible for the District to make a 'clean' well-documented application for the capital grant. It also greatly simplified and expedited relationships between District, Railroad, and builder, since Chinn and his staff had full authority to speak for both District and Railroad on technical matters. It has been estimated that if a consultant had been used to develop complete specifications for the cars (as has been done for a number of new passenger car orders in recent years -- see section on Producing the Improvements), probably the cost of each car would have escalated somewhere close to $450,000 which is 50% higher than the roughly $300,000 which was the expected cost of the cars as specified.

The convenient labels one uses in talking and writing about an object are often unconsciously followed in determining the design.

The specification, as finally written, still left a great deal of further design effort to be carried out by the car manufacturer and some demands on the suppliers of subsystems later selected. It was decided, for example, that the air-conditioning units would be the sealed variety, like home refrigerators. However, Trane, the supplier selected, had

off-the-shelf items that would have required time-consuming maintenance and other features that were unacceptable to the Railroad. The problem with non-packaged air-conditioning is that the compressor is located in one place and the condensor is somewhere else, which means considerable piping and greater likelihood of leakages. Trane resisted the introduction of the sealed unit because that would have required an additional design effort on their part, but ultimately agreed.

Considering that the IC car is a double-deck vehicle with propulsion, it is lighter than one might expect. Yet it weighs about 134,000 pounds, and must withstand a structural compression test of 800,000 pounds. The service life is intended to be 20 years. This applies to all of the car's component systems as well as to the basic frame.



Why not shorter-life "throw away" components built for replacement by "improved" units as the car is used in service?

We believe it should be possible to develop the principle of variable performance life and warranties for different subsystems. This would enable improved components to be introduced as the state of the art advances over the service life of a given type of equipment. It would also probably allow some savings in engineering and production costs, hence a lower price for that component and for the car as a whole.

The structural strength requirements came from Federal Railroad Administration regulations. Other sources of traditional practice, such as Association of American Railroad guidelines, Railway Mailcar Specifications, and Interstate Commerce Commission regulations, persist in design of cars. Many of these specifications originated at early stages of safety engineering practice and before materials were available that might permit alternative design configurations. These conservative safety and strength requirements mean added weight.

Table 2

Specification Book for New Commuter Cars

TABLE OF CONTENTS

Chapter	Category	Number of Items
I	General -- Car Body	14
II	Coupler and Draft Gear	6
III	Exterior Finish	4
IV	Interior Finish	12
V	Lighting	13
VI	Air-Conditioning (Heating, Cooling, Ventilation)	5
VII	Motorman's Cab	18
VIII	Trucks	13
IX	Miscellaneous Car Body Items	18
X	Pantograph Traction System	9
XI	Air Supply and Brake System	17
XII	Auxiliary Power Systems	10
XIII	Communication Systems	3
XIV	Materials and Workmanship	11
XV	Drawing, Tracing, Photographs, Models, etc.	12
XVI	Inspection and Testing	20
XVII	Guarantee and Warranty	18
XVIII	Separate Car Items (tools, spares, patterns)	3
XIX	Items to Be Furnished by Bidder (Costs, Drawings, Suppliers, Test Procedures)	9

In the railroad car construction industry, in contrast to major electronic systems or automobile manufacturing, the prime contractor seems to us less able to ask for specific design efforts from suppliers. The design and construction of subcontracted items by suppliers must usually be applicable to several jobs or the special design efforts required would make the item's cost excessive. The prime contractor must then concentrate on designing and building the overall frame and integration of completed subsystems and components supplied by other firms. This results in the following problems: incompatibilities between components that some-

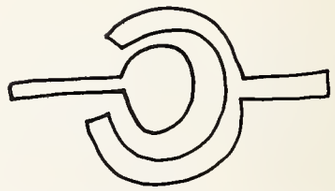
As the volume of commuter car and related transport vehicles increases, this can be expected to change.

times are only discovered in the construction or test stage; less than adequate production drawings or diagrams describing all interfaces; much greater design management effort to deal with each supplier to resolve design inconsistencies between subsystems of different suppliers. However, St. Louis Car, in collaboration with IC and the suppliers, was able to surmount or avoid many of the problems of compatibility and subsystem integration.

Eventually in this field manufacturers may determine design, and operators will select the model that can be adapted to suit them best.

Example of a Design Innovation

The braking system for these new cars is a design innovation that developed along classic lines. In this case, improvement in the particular component (brakes) is directly related to the overall performance of the commuter system -- that is, improvements in performance of the brake result in significant improvements in the carrying capacity and train headway. Often major design and engineering efforts are made to improve the performance of a single component that adds little to the overall performance of the system. Joint development between the IC and a vendor -- New York Air Brake -- produced technological advances and a braking subsystem tailored to the special conditions of the IC commuter service. The technical features of the system are described in the box below.



Yankee "cut & fit" at its best

A New Braking System for Rail Commuter Cars

(Based on an article by S. L. Morrison in the August 1971 issue of the Illinois Central Magazine)

These are the first self-propelled, double-deck commuter cars in the United States. Braking action is one factor that establishes the maximum speed of the train, and it is the determining factor in establishing the minimum interval between trains. The minimum interval between trains establishes the maximum carrying capacity of the system. Signal system block lengths are established largely on brake performance. In addition to the traditional systems for assessing brake performance -- safety and reliability -- there must be repeatability and fast response at all speeds.

Many other factors, such as noise level, passenger comfort, weight, and size affect brake design. The new brake system was established by combining electro-pneumatics, mechanics and hydraulics into one system. Although all of these have been used separately earlier, they have never been combined into one brake system before, as on the new commuter cars. The electro-pneumatic system is essentially an air compressor, piping, and an hydraulic valve which applies air pressure to a piston which in turn compresses the brake shoes on the wheel. The dynamic brake does nothing more than absorb the momentum of the train by means of electrical switch gear which converts the traction motors into a DC generator. The momentum of the train is used to turn the motor armatures, and the power of the train, now electricity, is dissipated as heat in special braking resistor grids. The hydraulic brake is used in conjunction with the electro-pneumatic system to apply the high-friction, flange-type composition brake shoe to the wheel with a hydraulic cylinder. All three systems operate through a blender valve (which has become the key component of this subsystem) that measures the amount of dynamic braking and supplements it with the appropriate amount of electro-pneumatic braking. The electro-pneumatic brake then operates an air oil booster to apply the appropriate amount of hydraulic braking to the brake shoes to give the motorman the amount of braking power desired. Each car has the complete system, and they can be operated individually for each car or in tandem with all the control stations cut out except the one in the lead car.

When the new cars began to go on line, nothing led to more entries on the 'trouble sheet' and more complaint from engineers than the braking system. Yet few (if any) of the difficulties were traced to mechanical or electrical malfunctions: the brakes were performing in most instances as designed and as expected by the IC and NYAB.

The user isn't always right.

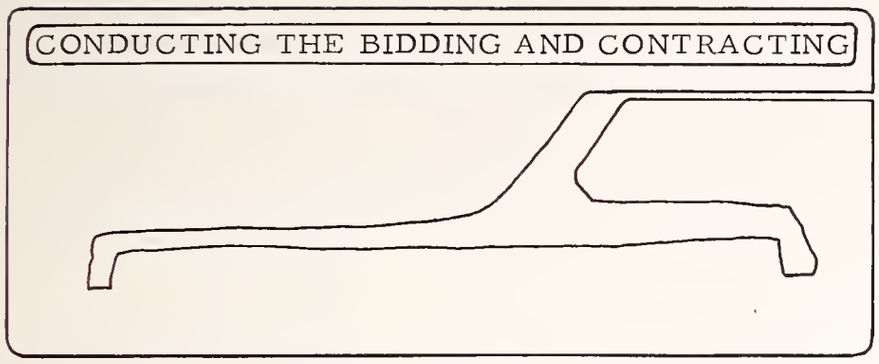
But it didn't feel right, said the engineers. From hundreds of runs into these stations over decades of service with the railroad, operating the old M.U. cars in consists of two to ten, the engineers knew how fast or slow they should be

going at each stage of progress into or out of a station. Braking could be 'hard' and constant -- from 'full speed' to stop in one application (thereby assuring an even rate of deceleration, but contributing heavily to brake shoe wear). Engineers, through long practice, related their operation of the brakes instinctively to landmarks on the track.

> It is recounted around IC how veteran engineer Slotz Smith, known for his ability to bring the 5:18 into Homewood to line up with the fifth board from the end of the platform no matter what, one day overshot by two car lengths. "Somebody moved the damn beer can," he was heard to complain.

With the new brakes, deceleration proceeds smoothly, but with a different 'feel'. And there is a split second, in the transition from the dynamic to the air system, when there is a 'float' sensation. The engineers say that they feel the train "accelerate" at that point, though it is in fact only a slight shift in the rate of deceleration. Sometimes, 'feeling the float', the engineers on the new cars instinctively slammed into full braking, thereby reshuffling a few executive commuters in the cars behind. The brakes on the new cars have now been adjusted to give them a 'feel' that makes the engineers more comfortable.

There were many other assumptions about the design of the car that are too numerous to recount meaningfully here. Most of these additional assumptions are subsumed in the definition of a self-propelled M.U. rail passenger car. The lighting, seating, door, and window arrangements are remarkably fixed. That all of the cars should be nearly alike seems to be taken as a given -- to permit flexible use -- yet there are clearly two peaks in traffic for five days and then lulls for 2 or 3 days which hardly augurs for level utilization. Advances in the state of the rail car art fundamentally depend on pointed questioning of largely unexamined assumptions.



We promise according to our hopes, but perform according to our selfishness and our fears.

LA ROCHEFOUCAULD

Bidding and contracting proceeded in two stages: a "courtship" period, during which potential buyers were invited to submit ideas, and a "grittier" period in which requests for proposals were made and bids evaluated. The invitations to bid were finally tendered on 4 May 1969. The IC and the District wanted to have bids returned by the end of July. Lots of complaints led to requests for an extension; a 30-day extension was allowed. Finally the bids came in at the end of August. It was a tight time schedule in which to prepare submissions, but most of those who intended to bid were already familiar with the project and had done a good deal of preliminary work.

Preparing the Bids

Bids were submitted by St. Louis Car, Pullman Standard, Budd, and Hawker-Siddley of Canada. (Rohr didn't bid, and Budd is now acting only as a major subcontractor.)

Chinn had been made engineer for the District, as well as for the Railroad. This, in his view, involved no conflict of interest, since "the main objective of both was to get a good car." All the actual technical work on the design of the car, of course, had been performed by the Railroad, since the District had no funds for its own technical staff. The equipment committee on the District Board of Trustees was the only District group that took an active role in the design.

PRELIMINARY DESIGN AS A RESOURCE

There ought to be some way to minimize the waste of effort and the expense incurred by unsuccessful bidders. It makes sense, for example, for the federal government to pay for preliminary design for prototype groups of cars, and to test and debug them before selecting a production model, as is done with new types of aircraft. This is being done in a current DOT project in which Boeing and St. Louis Car are building "state of the art" cars for later extensive testing at DOT's Pueblo, Colorado facility and in a variety of other settings.

New passenger rail cars are put into service so rarely that when an intention to design and acquire new equipment is announced, user companies and the public expect delivery immediately. Thereafter, the pressure to get cars built and into service is enormous. The demand for speed in design and construction in turn leads to difficulties. This became evident during the bidding-contracting for the CSSMTD/IC cars. At the time, all rail car manufacturers were eager for work. To strive for the lowest bid, profit margins were shaved in some cases almost to the vanishing point.

Some of these problems could be avoided or reduced if more time and money were invested in preliminary design and testing of prototypes so that a lot of engineering design doesn't have to be thrown away. This again comes back to the relatively sleepy state of railroad technology and to the design-production tradition of car specification by the railroad and manufacture to these specifications by the car builder.

Industry practice in railroad car building is that a good deal of "clout" rests with the suppliers. The car builder supplies the frame and final assembly of equipment provided by others and suppliers do the rest. As already described, some suppliers are reluctant to undertake special design efforts,

preferring to provide off-the-shelf items or minor modifications of existing technology. This is another way in which progress in overall development of rail car technology is retarded. Responders to the request for bid have to get together with subcontractors.

The IC named suppliers for all major systems, to make sure they would obtain equipment from stable companies, with technology that had been proven. On a fleet replacement of 130 cars, they didn't want to take a big gamble on unproven equipment. Yet UMTA rules banned the exclusive naming of specific vendors for subsystems. Therefore the phrase 'or equivalent' had to be inserted in the specifications wherever an item from a particular vendor was named. The potential supplier companies nominated by the IC were "prequalified" by the District. If a bidder wanted a supplier other than those named, then he could notify the District, no later than 30 days before submission of the bids, to request an additional prebid qualification by the District. Under this arrangement, Trane, Safety, and Carrier Corporations were prequalified for the cooling system, General Steel Industries and Rockwell for the trucks, and New York Air Brake for the braking system.

Sometimes, vendors' preferences were resisted. One was the IC's insistence on sealed unit air conditioners, rather than the belt-type equipment that Trane and others would have preferred to sell but would be uneconomic for maintenance. Another example was a 'cam' rather than a 'chopper' control for the propulsion system. GE wanted to sell the latter, which relies on electrical contacts with a servomechanism rather than a mechanical connection in regulating power to the propulsion of the trucks. Test cars using chopper controls were operating on the nearby CTA, and IC had heard that the chopper control "works beautifully so long as the GE man goes along on every run." They elected to

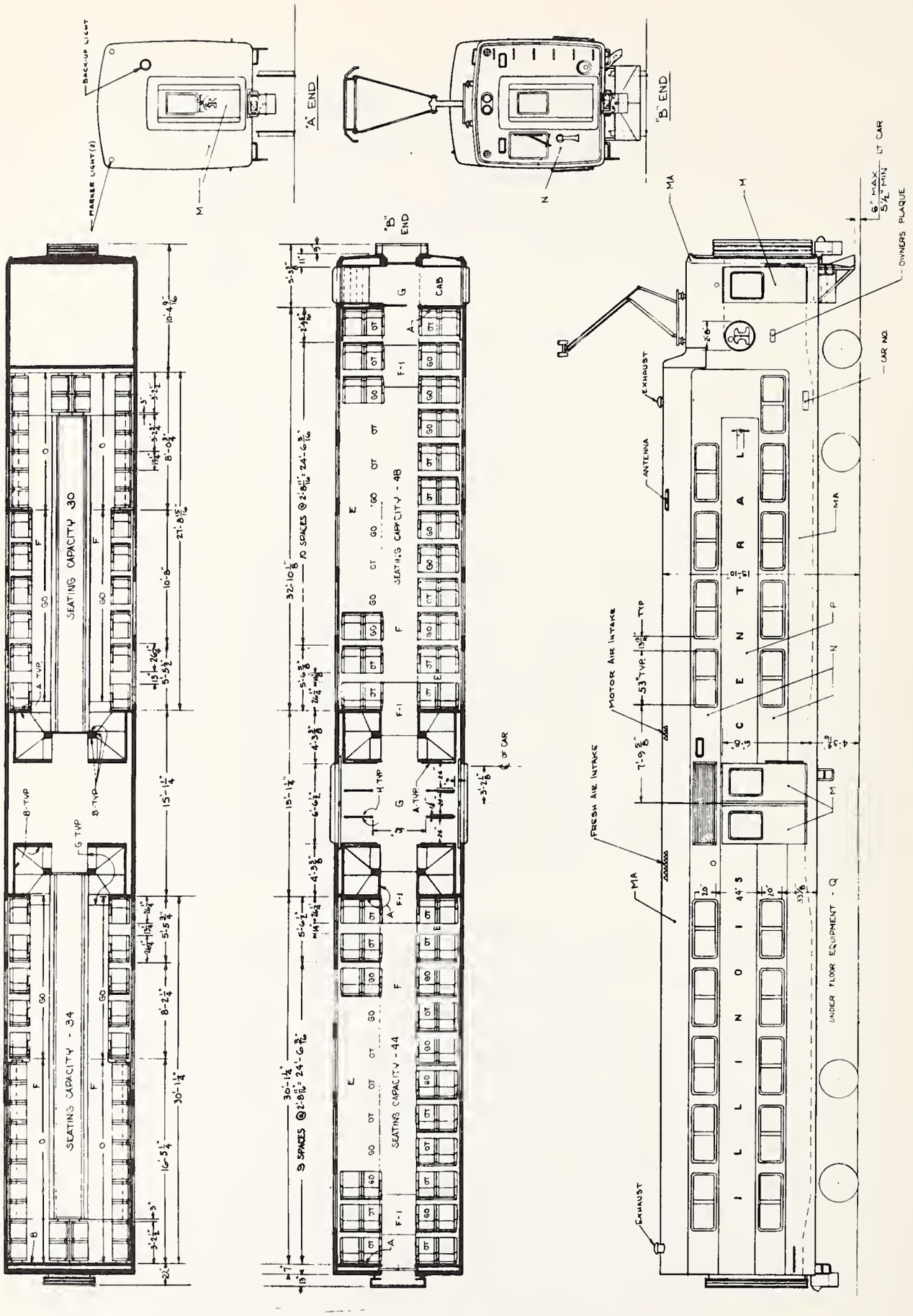

BACK-UP LIGHT
MARKER LIGHT (2)
"A" END
"B" END
SEATING CAPACITY 30
SEATING CAPACITY - 34
SEATING CAPACITY - 44
SEATING CAPACITY - 48
CAB
ILLINOIS CENTRAL
MOTOR AIR INTAKE
FRESH AIR INTAKE
EXHAUST
ANTENNA
OWNERS PLAQUE
CAR NO.
UNDER FLOOR EQUIPMENT - Q

Figure 14

stay with cam controls. (However, the new Boeing-StLC "state of the art" equipment will have chopper controls.)

Evaluations of the Bids

After the specifications named certain suppliers, some flak came up (directed both to IC and to DOT) from other potential suppliers who had not been prequalified. Garrett Corporation, in particular, was vehement in protesting that they had been discriminated against in the specification of the brakes. Their complaint came about because the IC wrote a very "tight" specification on brakes, in effect requiring a system that no one but New York Air Brake could supply (the system had in fact been jointly developed by NYAB and IC, and tested on old IC cars on IC properties). Garrett had a competing English-developed system -- Westcode (English Westinghouse) -- for which Garrett and General Electric are the U. S. licensees. When Garrett complained to DOT, DOT passed the complaint on to Rollin Chinn at the IC. Chinn was relatively unruffled by this. "We were open about this all the way. The main thing is to have a principle that applies to everybody. No private understandings." Garrett was added to the qualified list, but this had no effect on the final procurement decision.

Bidders had been asked to bid both for stainless steel and for high-tensile, low-alloy (HTLA) steel car frames. The latter was ultimately selected, because the lower cost was desirable and not offset by slightly more weight, more difficult fabrication, and greater maintenance effort that would be required.

St. Louis car had the low money bid for low-alloy steel, and the federal rules required that the low money bid be accepted unless there were overriding reasons to do otherwise. IC would probably have preferred to have Pullman selected, since they are nearby in Chicago. The two organizations had often collaborated and were familiar with each others'

operations, and several members of the IC staff were formerly at Pullman.

The table on the following page summarizes the bids submitted to the District.

The most important reason that St. Louis Car's bid was so favorable was the result of a single innovative concept. Tradition in railroad passenger car building practice is that a sturdy platform is built, upon which the car is then constructed. The entire structural integrity of the car is provided by this main substructural platform. In the StLC design for this project, resistance to structural forces was distributed throughout the lower section of the car. This reduced the depth of the old frame (critical because of height restrictions between the rails and overhead catenary) and because of the greater effective depth provides considerable weight reduction.

TWO APPROACHES TO THE DESIGN OF CAR STRUCTURES

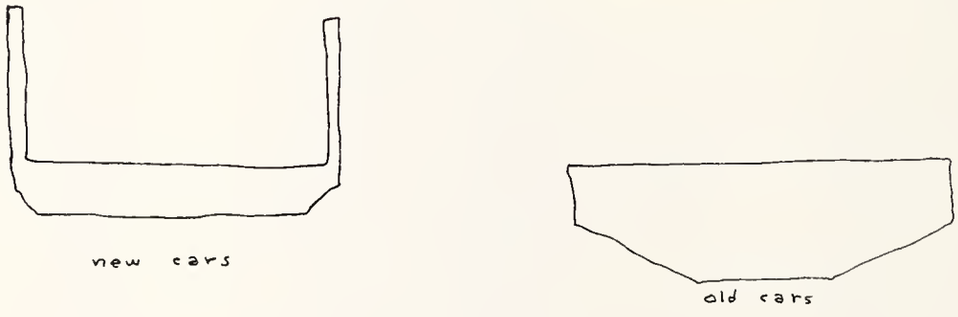


Figure 15

Table 3

BIDS FOR THE CSSMTD CARS

ITEMS	ST. LOUIS CAR	PULLMAN STANDARD	BUDD CO.	HAWKER-SIDDELEY
Base price per car for 120 HTLA cars*	$ 311,000	$ 346,950	$ 362,216	NO BID
Base price per car for 120 Stainless Steel cars*	$ 322,250	$ 359,745	$ 357,527	$ 399,890
Total price 120 HTLA cars*	$37,320,000	$41,634,000	$43,465,920	NO BID
Total price 120 Stainless Steel cars	$38,670,000	$43,169,400	$42,903,240	$47,986,800
Base price per HTLA car for additional cars in quantities of from one to ten	$ 300,000	$ 346,950	$ 352,216	NO BID
Base price per Stainless Steel car for additional cars in quantities from one to ten*	$ 311,250	$ 359,745	$ 347,527	$ 394,840
Estimated weight of HTLA car	130,000#	145,596#	158,310#	NO BID
Estimated weight of Stainless Steel car	126,750#	142,535#	155,810#	153,500#
Weight adjustment for HTLA car - per car	0#	15,596#	28,310#	NO BID
Base price adjusted for weight - HTLA car	$ 311,000	$ 362,546	$ 390,526	NO BID
Base price adjusted for weight - Stainless Steel car	$ 322,250	$ 376,240	$ 386,587	$ 426,640
Adjustment per car for delivery	$ 0.00	$ (2,115)	$ 0.00	$ 8,810
Adjustment per car for price - weight & delivery - HTLA	$ 311,000	$ 360,431	$ 390,526	NO BID
Adjustment per car for price, weight & delivery - Stainless Steel	$ 322,250	$ 374,125	$ 386,587	$ 435,450
Adjustment difference - HTLA	---	$ 49,431	$ 79,526	NO BID
Adjustment difference - Stainless Steel	---	$ 51,875	$ 64,337	$ 113,200

*Budd and Hawker-Siddeley build only stainless steel cars. To have produced HTLA cars would have required substantial retooling and other shop modifications. Therefore, Budd's stainless steel bid was lower than its HTLA bid, and Hawker-Siddeley did not bid at all on HTLA.

Preproduction Preparations of the Successful Bidder

Once St. Louis Car had been selected, work began on translating the design concept developed by the Illinois Central into specific engineering designs and subsequently into production drawings and work schedules. Early in 1970 StLC hosted key IC people for a dinner and meeting in Chicago. Presidents of both companies and counterparts from each firm who would be working closely throughout the contract got together to get acquainted personally -- "So when you pick up the phone you'll know who you're talking to," as StLC put it.

The process of constructing cars after a bid has been won puts pressure on within the car builder's firm to meet the low bid and still make a profit. In addition to the general pressure from the District and the IC to get the new cars, it was very important to StLC that the work get done on schedule, because penalties were built into the contract both for delay in delivery and for variations in the weight of the car as specified by the design. (How much they were victimized by subcontractor performance is not clear.) These penalties were set at: $50.00 per day per car behind delivery schedule, and $1.00 per pound for every pound in excess of the bid weight. As of September 1971, it was estimated that St. Louis Car had accrued about $80,000 in penalites. StLC, on the other hand, believes that virtually no penalties have been accrued to date, because delays encountered resulted from circumstances beyond their control, such as strikes at supplier forms and customer-requested changes. The potential for penalties against StLC exists as long as delays (for whatever reasons) continued.

Table 4

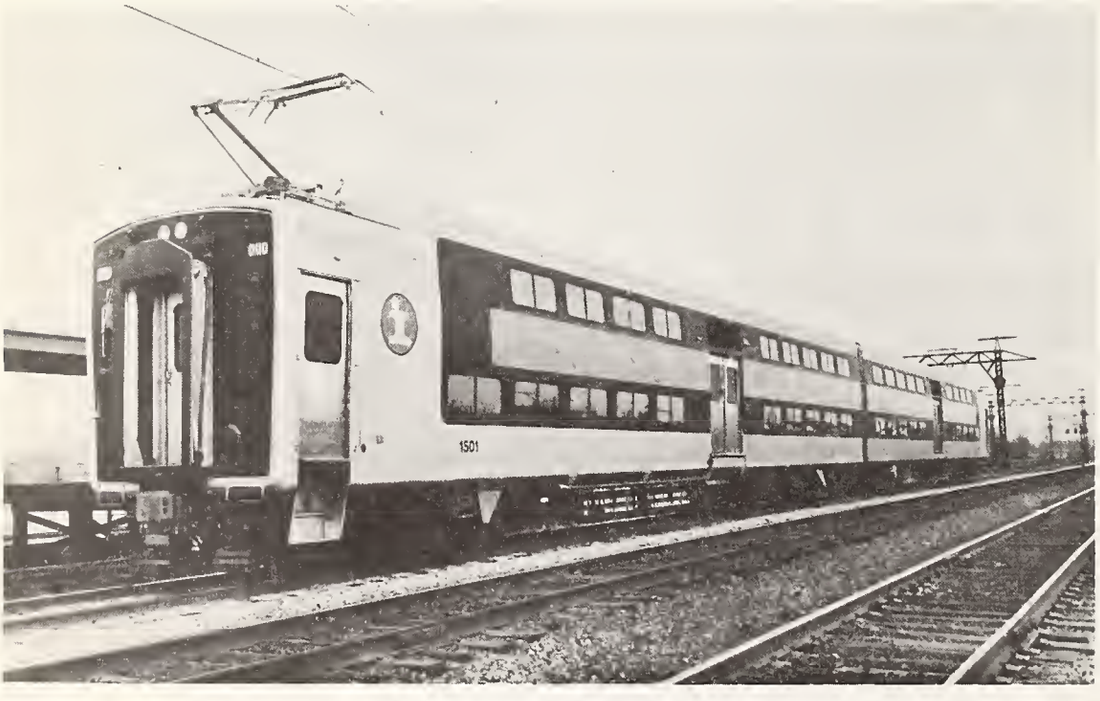
ST. LOUIS CAR DELIVERIES

Month	Per Contract Cars per Month	Per Contract Total	Actual Deliveries Cars per Month	Actual Deliveries Total
December 1970	2	2	0	0
January 1971	4	6	0	0
February	4	10	0	0
March	6	16	1	1
April	8	24	1	2
May	8	32	3	5
June	8	40	2	7
July	8	48	3	10
August	8	56	3	13
September	8	64	5	18
October	8	72	6	24
November	8	80	6	30
December	8	88	8 (?)	38 (?)
January 1972	8	96		
February	8	104		
March	8	112		
April	8	120		
May	8	128		
June	2	130		

The Contract and Building the Cars

The direct contact and mutual respect and understanding of the builder and operator have greatly facilitated contract administration. St. Louis Car found the Illinois Central job attractive from two points of view: they were able to deal directly with railroad engineering and operating people in working out details of the design, and the IC representatives had full authority to speak for the District, so it was not necessary, as is the case on many jobs, to deal with a number of different groups within the customer's organization. In these respects the work for the CCMTD was an exception to what seems to be increasingly the rule in the rail passenger business. Most procurement of new passenger rolling

stock has been by public agencies -- transportation districts or authorities. Such organizations tend to seek technical advice on car design from specialized designers and engineering consultants. These firms, though professionally qualified, often do not have intimate knowledge of either the operating conditions in which the equipment will be used or of the problems of the manufacturer. The result, as a representative of St. Louis Car put it, is that "the consultants are out to give the customer a car that the consultants can be proud of and the owners enamoured of." So, "the consultants write specifications that are detailed and often excessively demanding of performance and overly protective of the customer." Conditions of the sale typically include longer and longer warranty periods, the right of the customer or the consultant to approve all drawings, and liberal provision for requiring changes even after production has started. The car builder has to take these conditions into account in estimating the cost of the work and preparing his bid. The net result in many cases is to raise the price of the car to the customer.



A pair of the new double-deck M-U cars.

Figure 16.

Features of the Contract

Payment Schedule: Forty percent is paid to StLC by the District when "car sets" (the major systems for each car) are available. Car sets include: propulsion system, alternator, air-conditioning, truck, and brakes.

An additional thirty percent is paid when the cars are accepted by the railroad (acting on behalf of the District) at StLC for movement to Chicago.

An additional twenty percent is paid when the car is tentatively accepted in Chicago, after testing, for revenue service. The final ten percent is paid at the end of the entire contract when all cars have been delivered and accepted for service.

An important innovation in design-manufacture-procurement practice took place early in the CSSMTD contract with St. Louis Car. During the fall of 1969, following the contract award, St. Louis Car actively investigated further which vendors would be chosen to supply major systems and components. The companies selected and the items they supplied were:

GENERAL ELECTRIC
Motors, gears, drives, power, and controls

GENERAL STEEL INDUSTRIES
Trucks

NEW YORK AIR BRAKE
Brakes

TRANE
Air Conditioning

VAPOR
Controls for air conditioning/heating and doors

TRANS-LITE
Lighting fixtures; lighting and air diffusers; signs

ADAMS & WESTLAKE
Luggage racks; windows and sash

DRESSER INDUSTRIES
Couplers; draft gears

COACH AND CAR
Seats

SKF - ABEX
Journal bearings

EDGEWATER
Wheels

EXIDE
Batteries

BARCO
Speed sensors

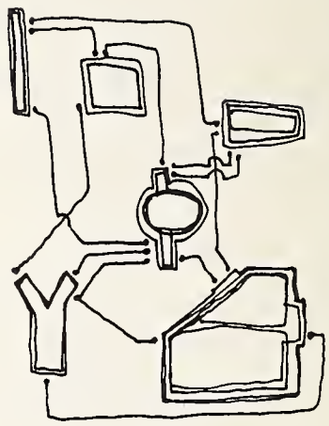
DUPONT
Paint

O. M. EDWARDS
Doors

MOTOROLA
Radio and public address system

U.S. PLYWOOD
Plymetal panels

A meeting in St. Louis was then arranged to deal with interface problems and to exchange information between the vendors whose items had to be compatible, and between all of the vendors and St. Louis Car. St. Louis Car had previously asked each vendor which questions they would need answered in order to complete their designs, and to send descriptions of the equipment they would supply. St. Louis Car also made sure that those attending the meeting from each company would be people actually involved in engineering and manufacture.



The whole purpose was to shorten the design-procurement time by providing face-to-face communication between vendors whose systems would interlock on the completed cars. For example, propulsion controls provided by GE would have to interface with the air brakes provided by New York Air Brake and door controls to be supplied by Vapor Corporation. There are always a number of such interfaces to be resolved, some between pairs of vendors, some between three or four suppliers of subsystems. St. Louis Car planned this meeting so that the questions sent in previously by each vendor were taken up and resolved in the most direct manner possible, by beginning with the less complicated interfaces and progressing to the more complex. Those with relatively simple information needs, such as Barco, needed to be at the meeting only long enough to find out what the design of teeth on the speedometer would have to be to interface properly with the GE propulsion system. Vendors of the more complex systems with many interfaces, such as those supplying control equipment, stayed throughout the two-day meeting.

The aisle of the new double-deck car.

Figure 17.

As a follow-up, St. Louis Car arranged for an exchange of meeting notes among all participants, and resolved remaining questions by mail. The whole exercise proved very effective in shortening procurement time, minimizing what would otherwise have been substantial problems of interfacing systems, and providing, because of face-to-face communications, "a chance to understand the other fellow's problem a little better."

Supplier vs. Seller

Railroad passenger cars have typically been designed by the railroad with the assistance of the builder and built on order for the particular environment. Suppliers would build whatever was asked and promoted their capabilities to be responsive to demands of railroad operators. This may be slowly changing. The designer has become increasingly important in determining the characteristics of the cars. And, potential builders of cars themselves are in many cases developing their own basic models to sell to operators of mass transit services, based on more intensive study of typical operating environments than was the case heretofore.

In the case of Illinois Central cars, StLC was able to learn more about the operating requirements of the railroad -- the service environment -- than is usual. As a result, they were able to produce a car that they believe will more nearly be found to be what the operator was seeking than would be the case if design and specification writing had been turned over to an outside consultant. StLC believes that the result was a lower cost to the IC, to the District, and to the federal government which is paying for two-thirds of the cost of the cars via the UMTA capital grant program.

Extended warranties, with most if not all of the responsibility for reliability placed on the car builder, have had the effect of further raising the price of equipment. Extended warranties also act to discourage learning by railroad personnel (operators and maintenance people) regarding proper use of the equipment. If a warranty extends for four to eight years (as is now customary in some contracts) there is a tendency within the customer organizations to say, when problems appear, "it's the car builder's problem." All this means is that no matter who builds a car and no matter how tightly procurement contracts are drawn in favor of the customer, it is to the interest of the customer to be as specific as possible about the operating and maintenance practices he needs, and to make this known at the time of procurement. As a St. Louis Car representative said: "The warranty can't become a device for walking away from problems. And the use of a design consultant can't become a device for walking away from problems."

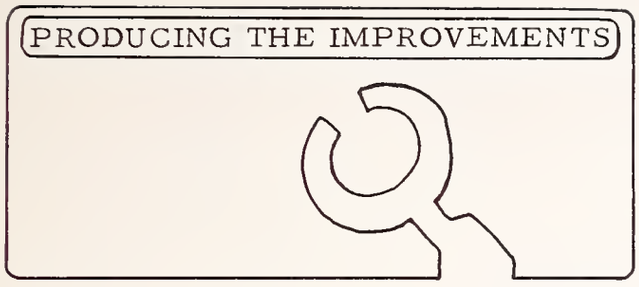
Philip Scott of the Budd Company, in a "white paper" prepared in 1969, recommended these changes in current procurement practice:

> The specifications contained in today's invitations to bid have become a mixture of definitive design specifications and of performance requirements. It is quite reasonable that the specifications should cover elements of decor, appearance and the general parameters of the car. However, when all the elements of a subsystem are specified and the performance of the subsystems is also specified, the car builder may find it impossible to meet both requirements. We believe that the purchaser should either specify the engineering details and accept the resulting performance, or he should state the performance required and let the car builder determine what is necessary to achieve that performance. We have found that where a contract has a combination of performance and detailed specifications, situations arise where a performance requirement actually conflicts with the detailed design specification. This has resulted in additional expense to the car builder. It should be added that such conflicts are not discovered prior to bid submission and only show up as the design progresses or the car is built.
>
> As a standard practice for the industry we believe that the performance specifications should be controlling, and that any design specification should be subordinate to the performance specifications. If the customer insists on detailed design specifications, that part of the specification should clearly state that the customer accepts in advance the resulting performance.
>
> . . . The specifications developed by the consulting engineers are generally complete and adequate for the purposes of procurement. The car builder, in preparing his bid, has only the specifications on which to base his tentative designs and in obtaining quotations from his suppliers and, therefore, he must assume that the specifications describe the car which the customer wants. Obviously, any later interpretation by the engineer which has the effect of changing the specifications can, and does, create havoc with the car builder. Such interpretations often occur late in the design and manufacture, at a time when the engineer can see, with hindsight, what his specifications have produced. We believe that the car builder has the responsibility of building a car to the specifications upon which his bid and the contract was based. At the same time, we believe the customer must take the responsibility that the car specified in his inquiry is the car which will be delivered. This latter can, of course, be softened by an equitable change procedure.

Alternative Approaches to Contracting for Cars

Imbedded in present bidding-contracting procedures is the largely unexamined assumption that what should be procured is a piece of equipment to which the operator or his surrogate (e.g., a public authority) has legal title. The whole objective of procurement can be differently conceived: to provide a marketable, effective urban travel experience. Under this premise, the cars and all other features of the system would be viewed as means to the end, rather than the objective. This premise has the further effect of making it possible to conceive of subsystems on the car in a different way: not as pieces of purchased property, but features of the travel environment that can be provided as services for definable time periods. Under this arrangement, the operator (a public transit district or a railroad) might sign a service contract for temperature-controlled air (rather than buy air conditioners); lease accommodations for seating customers (rather than buy seats); arrange for keeping cars lighted (rather than owning lighting fixtures and wiring). Under this type of arrangement, purveyors of services (who also own the equipment necessary to provide the service though it is permanently in place on the car) would, for an appropriate consideration, provide all maintenance, replace worn-out equipment, and introduce improved equipment as the state of that particular art progressed. (Incidentally, the trend toward extended and stringent warranties, noted earlier, means that suppliers are being forced into the role of lessors -- since they are held responsible for equipment performance over extended periods -- and the risk they assume is reflected in higher equipment prices.) We recognize that such a radical revision of technology procurement and management practices would involve far-reaching legal, accounting, and organizational changes. But it could also stimulate a tremendous amount of innovation and development in urban mass transportation.

PRODUCING THE IMPROVEMENTS



In business the keeping close to the matter and not talking of it too much at once, procureth dispatch.

FRANCIS BACON

Actually building things is always different from what is expected. We're not sure that what's learned from one job in one situation will ever be applicable again. Principles in this area are as often aphorisms as insights. Some people believe slogans about how they did things and why they were successful, that are little affected by actual experience. Yet somehow some things are getting built better and faster at lower cost. So obviously there has been some learning. Exactly what to learn is not widely agreed upon, but it seems worth the effort to at least say what seems to go on, and what we think it means.

At the time St. Louis Car won the IC bid, the firm was in the "famine" part of the feast-or-famine cycle that has become typical of the rail car business. The difficulty had come about as follows:

- The New York City Transit Authority, StLC's steadiest and biggest customer in recent years, delayed a large expected follow-on order in order to design a significantly different car. The StLC shop suddenly ran out of work, after being geared up to produce more of the subway cars they had already built in considerable numbers.

- To fill the void, the StLC sales force pushed hard to bring in additional business. The firm undertook to modify some Santa Fe freight cars for the Penn Central, got a contract for Vert-a-Pak, a new type of automobile transport car, and won a contract for Skydock, a mobile passenger access ramp for aircraft.

- Engineering was thus loaded with work, while the shop was comparatively idle. Then, when the IC engineering was complete and the car was ready to go into production, shop space was at a premium because some of the earlier gap-filling work, particularly the Vert-a-Pak job, was still on the line.

- As a result, there were delays in getting the IC car into production. Even after production started, the whole line could not be set up. The first few cars were built at a few stations, with various equipment installation and construction operations occurring at single locations. This was a crowded and delay-producing procedure.

Preproduction Preparations of the Successful Bidder

The design drawings for making the bid are far from engineering drawings for making rail cars. StLC had to translate the design drawings into production drawings, and this was no easy task. For one thing, because of the feast-or-famine nature of the industry, an inexperienced drafting force had to be added quickly. Many were not knowledgeable about shop practices in railroad car manufacture. As a consequence of the feast-or-famine situation, the same shortage of experienced manpower prevailed in the shop, where a number of workers not experienced in rail car building had to be added. This resulted later in many production delays, and much work had to be handled and paid for on a piecework basis, to correct for errors. Material waste was also higher. It has been suggested that to improve production the line could have been extended and that workers could be kept on the same or similar tasks for more consecutive days.

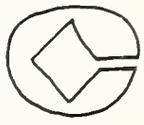
Frank Doscher, project engineer for StLC, says that if the planning and design of the car could be done again, he would insist on these differences in procedure:

- More detailed planning of the design and production sequence. Both the design work and the flow of the job through the shop were PERTed, and "critical path" procedures were worked out on the computer. Subsequent experience has shown that some steps were omitted or could have been arranged in a different sequence.

- A better balance between detailed specifications from the customer and items left to the builder to resolve.

- Enough time and resources in the contract to permit construction and testing of a prototype, to clarify unresolved questions in engineering and manufacture and to permit smoother production of the bulk of the order. This would probably yield a substantial saving in cost per car. "The goal is both to avoid problems and to get a desired result," Doscher remarks. "But it's clear that you can't develop and build an entirely new car in fourteen months. Even for that period of time great overlap in design, engineering, and building steps would be required. To do the job in less time would require a different kind of contracting."

The case for construction of prototypes as standard practice in passenger rail car procurement was made effectively by Philip Scott of the Budd Company in the "white paper" cited earlier. He also had some recommendations on how prototyping should be carried out to realize its benefits:



> (Prototyping) is a real improvement in the procurement pattern for complex cars. Not only can the prototype program, if properly used, lead to a better car, but will in our opinion actually save money for the customer. We applaud this trend and, in order that it be successful, wish to stress some measures which should be incorporated in any prototype program.
>
> First, in a procurement contract the prototype should be for the purpose of shaking out any problem in design. Frequently engineering can be faster and cheaper if a prototype is built first than when the first production cars are in fact the prototypes. Manufacturing and field retrofits can be avoided by the availability of a prototype. Needless to say, anticipated cost savings resulting from a prototype should be reflected in a better price to the customer.
>
> Second, the time available in the contract for the prototype program must be sufficient to allow the knowledge gained to be incorporated in the production cars. If time is not available then the prototype program is useless.
>
> Third, if a prototype program has as one of its purposes the further development of specifications by the customer, then an equitable change procedure must be in the contract.

Fabricating and Assembling the Cars

To the pre-production delays caused by new workers and conflicts with other work in the shop were added some production difficulties caused by the complexity of the car and design innovations that had been introduced but for which there was little shop experience. These included:

- Curving side panels which buckled when window holes were cut before the panels had been formed. The difficulty was largely corrected by cutting the window apertures after forming.

- Air ducts from the top of the car to a plenum chamber below that provides air for cooling machinery underneath the car were designed with many bolts and fittings attached to other structures. Many of these connections leaked when water-tested, at a stage in car manufacture when all basic framing is complete. Correction of this difficulty required expensive repairs and reassembly.

Inspection Problems and Performance

Various inspections occur throughout the procurement-production-delivery sequence.

- First article inspection, performed by the Quality Assurance Group at StLC, involves assessment of vendor-supplied components at the vendor's plant.

- Receiving inspection is carried out both by the District/IC and StLC when these same items are received at StLC, chiefly to check for possible damage enroute from the vendor.

- Continuity inspections are made during construction. This was extremely detailed and stringent in early stages of the production, producing many delays and requiring the builder to make many unanticipated corrections of errors. Now the inspection process is flowing more smoothly and the District/IC inspection staff at StLC finds that StLC procedures and performance are resulting in higher quality and fewer repeats. (StLC has its own inspection staff, of course, working in tandem with the customer representatives.)

- High potential testing of all the electrical systems except propulsion at a final stage on the production line.

- Proof testing at StLC and at the IC shops prior to customer acceptance.

On the last inspection/test stage the greatest improvement has been achieved. The first cars' proof test took six weeks, whereas for the last few cars delivered proof tests and final inspections averaged around four days.

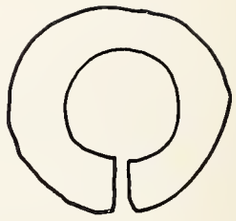
Another source of production delay and expense were changes introduced at a time when manufacturing had already begun. These included:

- A need to replace some steel for side panels with a heavier gauge over jacking locations. The IC "spec" had called for eight such locations; these locations required a heavier gauge steel in the side panels above them. When the IC mechanical department checked StLC's drawings and calculations, it was discovered the StLC design provided for only four such locations, and the discrepancy was not caught until the lighter steel had been ordered and received in St. Louis. The cost was increased by the need for a separate order of the heavier gauge; in addition, there was a resulting surplus of the lighter gauge steel. (The surplus was sold to the IC, but -- after some discussion between the two companies about where the material should be shipped and after the unneeded steel was temporarily misplaced! -- it was held at the StLC shops, to be shipped to customers designated by IC as soon as resale could be accomplished. The net cost to StLC was $6,000-$7,000.)

- A requirement by the IC, not in the original specifications, that a metal structure be installed beneath the transition piece connecting the two sections of roof at the 'B' end (beneath the pantograph). This is to provide added protection to the passengers at that end of the gallery should the pantograph suddenly collapse. IC Mechanical Department felt the added protection was called for even after StLC presented data on fiberglass impact resistance and conducted a special demonstration for Chinn, dropping a bowling ball on the transition piece from the roof of an StLC shop building thirty feet above the top of one of the cars. (We may well have remained unconvinced, too: damage from a pantograph being torn loose at 75 m. p. h.

might well exceed that created by a bowling ball in a 30-foot free fall!) The issue was created originally partly by the fact that the material for the transition piece was never called out in the original "spec" -- IC assumed it would be steel because all cars have always had steel roofs. While there were some additional material, engineering, and shop labor costs as a result of this particular customer requirement, no weight penalties were incurred by StLC.

Strikes are never anticipated. In this contract there were three critical ones; (1) a General Electric strike that included engineering as well as production personnel during the critical preproduction preparation phase of the work; (2) a trucking strike that interrupted delivery of several items for many weeks; and (3) a strike at General Steel Industries (parent company of StLC) where the trucks are being fabricated. A further difficulty has been that basic testing of the propulsion system could only be accomplished in Chicago, since 1500 volts DC current, the kind used on the Illinois Central's system, was not available at the StLC plant, nor did StLC attempt to have it installed. This was a seemingly unacceptable expense, but in the end resulted in costly delays. Also, StLC probably made a mistake by electing to assemble cars at fewer work stations. But, if they had taken the time to convert to a well designed assembly-line arrangement of work-flow, it would have delayed the delivery of the initial cars. At the time, this was felt to be too time-consuming, because the District and IC pressure for delivery was so great. On the other hand, undertaking more extensive work at each station resulted in many delays. These were caused by workmen getting in each other's way, crowding because of equipment and parts for different stages of the work piled up near the car, and related difficulties.



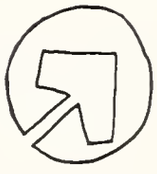
Production Procedures, Incentives, and Results

Looking back on production experience so far, the IC believes that StLC should have set up more work stations earlier, so

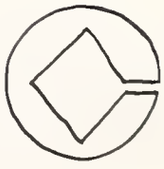
that cars could have been moved along more readily and cars on the line that developed special difficulties could be moved aside to avoid impeding the main flow. StLC's view is that cars have moved along about as fast as could be expected, and that more costs would have been incurred in increasing the number of work stations than could be made up through improved productivity and more rapid movement.

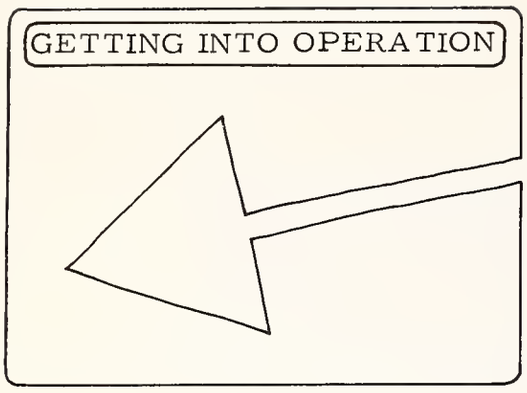
Our view, admittedly not based on careful analysis of the production engineering, planning, and control details on this particular job, is that detailed thought needs to be given to the type and extent of work implied by: prototyping, number and location of work stations, amount of manhours at each work station, and accomplishing consecutive production tasks at the same station but on different shifts vs. movement to the next station for the next operation.

A mixed strategy might be adopted: (1) build one or two cars on a 'custom' basis at single work stations while the line is being set up elsewhere; (2) get these first two cars out while production line procedures are being smoothed; then (3) build the rest on-line. This might result before long in cars 'spilling off' the line, rather than being 'dragged off' the final assembly work station to get payment and clear up-line congestion. A further inducement to such a procedure might be to arrange payments for "production flow rate achievement" rather than for discrete units, at various stages of production (e.g., a progress payment when the main line is "ready" rather than when a unit comes off the line).



Flow could also be enhanced by subfabrication of some assemblies (e.g., clusters of under-car gear) that could be held in disposable racks until insertion time on the main line. A part of such subsystems might be a piece of interfacing structure (e.g., part of the car paneling for some under-car assemblies). This would minimize time consuming and costly "cut-and-fit" procedures that can clog main production line flow.





A great many people, maybe most people, confronted by a difficult situation, one in which they don't know what to do, get nowhere because they are so busy pointing out that the situation should be remade so that they will know what to do.

JAMES GOULD COZZENS

Introducing new cars to revenue service occurs about once every forty or so years and can be expected to yield some negative reactions and a few surprises. As curiosities, reactions to the first few cars in service cannot be seen as indicative of how well they fulfill the commuters' expectations for improved service. The train crews and maintenance personnel can be expected to react with displeasure to any discontinuities. Some situations that were not anticipated in design show up as awkward or disfunctional features when a new system comes into use.

Delivery Schedule Performance

By mid-October 1971, it was finally possible to run the 14-car test of the new equipment on the IC lines (a train of 1090 feet -- the longest MU electric car consist ever operated in the U. S., with a gross weight of more than 9000 tons). But this still represented a real lag in the delivery schedule. Currently (December, 1971), deliveries should be eight cars a month, but are hovering around 6 per month, and total deliveries are 50 cars behind plan.

Delivery Procedures

Once the commuter cars are completed and approved at StLC's plant they are pulled to Chicago on their own wheels. Coupler adapters (12 were purchased as part of the total order) lock the cars to any standard freight car, caboose, or locomotive. The new equipment is shipped from StLC to Chicago by the Terminal Railroad Association of St. Louis and the IC. The contract requires StLC to deliver the cars

at IC's Woodcrest shops in Chicago, but the method of delivery was left to the car builder. Illinois Central bills StLC for delivery according to the Interstate Commerce Commission's schedule of charges for this type of freight movement. It was found that IC could clear about $400 if the cars were shipped in units of three and more if the shipment were larger, but that it would lose $400 if only two cars at a time were shipped. This is because each car movement requires a special train: crew, caboose, and locomotive, and a security guard. So far StLC has delivered no more than two cars at a time. When StLC begins to meet its delivery schedule, the IC can expect to profit from this freight business. One StLC representative rides with each car, to correct malfunctions that might occur enroute (the cars are not powered, but brakes and lights need to be in operation). These "passengers" of course have to be ticketed -- a regulatory curiosity.

Getting them there should be simplified - particularly as the volume of such cars in the US increases.

After they arrive at the Illinois Central's shops, they are tested and taken on "proving runs." (This term became de rigeur -- replacing "debugging" -- after a memo from Vice President Davenport on 28 March 1971.) The following tests are performed on each car:

At St. Louis Car Plant

- Water test (for leaks in the shell)
- Air cooling system
- Electrical systems (except propulsion)
- Air heating system

At Woodcrest

- Propulsion system
- Braking system
- Pantograph
- Radio communications system

After the checks at Woodcrest are completed, the cars are accepted by the District and simultaneously leased to the Railroad for operation. This system has been cumbersome and has led to difficulties. An example:

In mid-September two new cars had been undergoing final tests on the IC lines. One remained stationary and the second was taken up the line to accomplish tests of the brake system, which were successful. On returning to be coupled to the car that had remained behind prior to final acceptance, the car that had just been tested, under circumstances still under investigation, crashed into the stationary car at perhaps 30 m. p. h., causing very extensive damage and seriously injuring two StLC employees aboard. In addition to the misfortune of personal injuries and damage to the new equipment, a further difficulty has emerged concerning liability. The cars had not yet been formally accepted for the District by the IC, therefore were still technically the property of St. Louis Car. Both IC and StL C personnel were aboard. But the IC people aboard were contract employees to StLC, paid by the car builder for purposes of the testing program. This arrangement for manning cars for testing had been set up to accommodate to the splitting of tests between St. Louis and Woodcrest, due to the unavailability of 1500 volts DC at the car builder's plant. Thus an awkward division of the testing program has resulted in unanticipated difficulties.

The New Car Committee

Illinois Central appointed a coordinating committee to oversee the new car project as the cars began to arrive and be put into service. This included representatives from passenger services, operations, engineering, public relations, the Company treasurer's office, and training. There was also a member from the labor union. At the May 3 meeting they had a discussion of "train-tripping" or car marching -- the practice people have of walking through the cars; from one end of the train to the other. The railroad is trying hard to discourage this, because it creates piling up at certain doors on the platforms, and many passengers have said that it's annoying. They're talking about locking the doors between the cars to prevent "train-tripping" during service. It puts a big load on the air-conditioning as well.

Committees are set up to provide answers to problems of everyday use that were not considered in design.

Revisions from Testing and Operations

It was found that the air conditioning equipment made a loud roaring noise, which was deafening under the sheds at the

Randolph Street station. The noise on the platform made it impossible to hear train announcements and was generally annoying to passengers. A baffle arrangement to mute the noise is being proposed, but a fully satisfactory solution to this problem has not yet been found.

A view of the lower level of the new CSSMTD cars.

Figure 18

It was found, too, that there was insufficient capacity in the plenum chamber beneath the car (where air drawn through a duct from the car roof is mixed and shunted to cool the motors on the trucks). Diffusion plates within the chamber had to be repositioned and the shape of the chamber changed. It was too late to do this on the first eight cars; all will have to be retrofitted at the IC shops. This is the kind of change, everyone recognizes, that could have been handled earlier and more easily if the prototype approach had been followed.

Retrofit and a change order for later cars, costs of which StLC will have to absorb, involves the hand brake lever in the control cab. The brake has been designed and built by StLC in a way that makes it impossible to remove the brake

for oiling and inspection (as is required yearly under ICC regulations) without costly removal of paneling and other procedures in the shop that will cost a lot of time and money in years ahead. The IC is requiring StLC to change a crucial fastening bolt so that an Allen wrench can be used to remove the brake handle, also requiring the nut for that bolt to be welded in position. This somewhat jerry-built adaptation could have been avoided, IC says, if a crucial phrase in the specifications had been read more carefully by StLC: that the car to be built must be designed to comply with all applicable Federal Railroad Administration and Interstate Commerce Commission regulations.

Catchall phrases are no substitute for check lists finishing with the phrase "... and any other situations where the regulations would be applicable."

Tinted glass was specified for all the glazing on the cars to reduce the air conditioning load and to provide greater comfort to the riders. This included the main entry doors. At night tinted glass in the doors reduces visibility from the brighter car interior to the outside. This means that trainmen often have difficulty seeing the names of the stations. Tinted glass may be replaced by conventional glass in the doors.

A minor modification will be effected to revise the location of a check valve under the car. In its present position, it can be operated, but there is insufficient clearance to a pipe above to permit the valve stems to be removed for maintenance.

As the new cars came into service, it was realized that many more minor adjustments had to be made. A conflict developed with the maintenance personnel at Woodcrest because of vacation schedules. As a result, only the most important items were checked so that the cars could be put back into service. A series of conflicting orders came from IC's Passenger Service Division: to hold all new cars until they were absolutely perfect before returning them to service; to get them all into service immediately; and a compromise between these two positions -- do both. (This is a bit like the baseball manager's admonition to his relief pitcher in a tight situation: Get it over, but don't give him anything to hit.)

The entry vestibule in the new cars.

Figure 19.

The division of the door opening into three lanes is designed to discourage the standing in the vestibule of passengers who are known to block all but a single lane on cars designed with undivided door openings.

The Railroad also found headways between new-car trains difficult to meet due to slow passenger movement. In Hello, the publication for commuters put out by IC, it was said that customers were so "enthralled" with the new cars that they were moving slowly in getting off. More commuter cooperation was requesting in remedying this situation. Separating partitions have been designed to divide the car door opening into three lanes. This design is to prevent passengers exiting or entering from loitering and standing in the doorways and reducing their effective opening to one lane. Experience has shown that the net effect of these vestibule partitions is to retard passenger movement.

Orienting the Patrons

On July 28, 1971, Mr. Davenport sent a memo to his assistants, Chuck Condon and Paul Oppenheim, about the assignment of the new cars to operations. Basically, he felt that the cars should not be rotated throughout all trains but should be used for certain specific trains. This was needed for passenger education, to inform people where they should stand on the platform, to familiarize passengers with entering and leaving the new cars, and in general to reorient the passengers to a new setting. "It may very well be that if we assign the new cars to certain specific trains during the rush hour we can assign supervisory personnel to specific platforms to aid in this education, in an effort to improve loading times. We may get some criticism for this," Davenport added, "but I think we have to go this way unless the new car committee can figure out some way to get around it."

Orientation and competing for new riders might be accomplished by the same kind of publicity.

Commuter Behavior -- Smoking

In the spring of '71, Bob O'Brien of the IC public relations department, in an effort to establish what the smoking policy should be on the new cars, did a survey of practice on all the other commuter railroads in the Chicago area. He found that everyone had a problem with maintenance and dirt as a result of smoking in their cars. He recommended that IC have no smoking in the cars, since it's starting off with a new fleet. Preventing smoking could be justified solely on the basis of reducing the cost of car cleaning and air-conditioning maintenance. Possible burns to vinyl seat upholstery is also a consideration. No-smoking rules, said O'Brien, need not be based on moral or health grounds. "It's what's best for the riders on our trains and what's best for the railroad," he added.

System Modification and Engineering

To adjust to the new cars a number of modifications had to be introduced into other parts of the IC suburban system. One

change was the creation of a new electric substation at Matteson (a town at the south end of the system), to improve the voltage delivery on the line. There have been some delays in equipment for the substation provided by an English vendor. Catenary and platform clearances also had to be adjusted at a number of stations. It turned out that these adjustments could not just be made as a matter of course. For instance, at the 42nd Street bridge, a restriction existed on a catenary on Track 1, and the maintenance crews reported that, "We tried to make this change twice, but each time the crew was stoned by the natives."

Other property changes for the new suburban cars included (in addition to the substation at Matteson): catenary adjustments, modification or addition of yard isolation switches, power outlets for MU building, a new car washer, track and platform alterations at Randolph Street, Roosevelt Road, Flossmoor, and for South Chicago Branch stations, and extension of one track at the Randolph Street Station -- the terminus of suburban lines at the Loop.

Training

When Davenport prepared a memo in the spring of 1970 to activate a New Car Committee, he listed a number of agenda items for the group:

- New uniforms for train crews
- Training of operating engineers
- Training of train crews
- Training of station personnel
- Training of maintenance people
- Programming of zone schedules
- Preparation of new equipment manuals
- Public relations to enhance community use of the new equipment and the Railroad's public image
- Testing and acceptance of new cars

The training effort began in September of 1970 when four people experienced in railroad operations, two engineers and two conductors, were selected to consult on development of the new car and received orientation training by visiting St. Louis Car's plant. These operating people then worked out an outline of what training would have to be covered, and for whom, so that this could be ready by the time the new cars started to be delivered. At that time the IC and the District still felt there might be some deliveries in late 1970. As it turned out, the first new cars were not delivered until March 9, 1971.

Training continues to be planned for and done, but is largely ineffective.

Battelle Memorial Institute, after a study in November of 1970, advised that a complete training program be developed for all personnel involved with the new cars. The electrical maintenance people, for example, needed training not just in electrical systems, but in electronics. General Electric set up a special three-week training program at their plant for IC personnel to meet this need. The courtesy program for orientation of trainmen and conductors was held up by union-management negotiations about pay for people while taking the course. These negotiations went on until January of 1971.

Training efforts have not been fully satisfactory. Much of the early orientation was done with diagrams and pictures, no equipment being available. It is fairly clear that this was not sufficient. Inspectors of equipment, for example, had to get the "feel" of the car itself before they felt comfortable with the various procedures that had to be followed. Therefore, retraining was needed when equipment at last became available. Difficulties resulted in the handling of the cars because the personnel were not sufficiently trained at the time the new equipment began to be introduced.

Some of the critical nature of personnel training was revealed by an accident that occurred at the Randolph Street station on September 7. A six-car train consisting of the new equipment, with a relay engineer at each end, moving out of Track 1 (a track with a rather steep grade as it leaves the station) out to switch over to Track 2 and then back into the station on Track 2. The engineer on the south of the train thought that his partner was in the rear and would control the train as it started back into the station. However, without telling the man at the front of the train (despite the existence of voice communications link), the man at the back of the train left his post to take care of equipment difficulty on another track (the emergency occurred during the outbound rush-hour). Thus, as the train moved out of the station, two errors were made: 1) the relay engineer at the front (south) end thought that the switch had been cleared and the train was free to back in on Track 2; it had not in fact cleared the switch and therefore would return on Track 1 if backed up; 2) the man on the south end felt that his partner was at the north end of the train and could take the train back into the station. The south man therefore released the brakes, and as the train started to move he assumed that the train was under the control of the man at the north end of the train. In fact, the north man had left the train and it was rolling freely. Since it has excellent ball bearings, rather than friction bearings, and because of the steeper grade on this track, it was free to roll. Therefore, it sent back into Track 1 and crashed into a bumper at the end of the track at about 15 miles an hour. The shock tore off the bumper and part of the platform and smashed the motor end of the lead car, resulting in perhaps $100,000 damage.

"Post-acceptance dynamic testing."

Security

In order to protect the new cars, it was necessary to put up fences around the yards and some surveillance equipment. It was determined that this would cost an additional $4000,

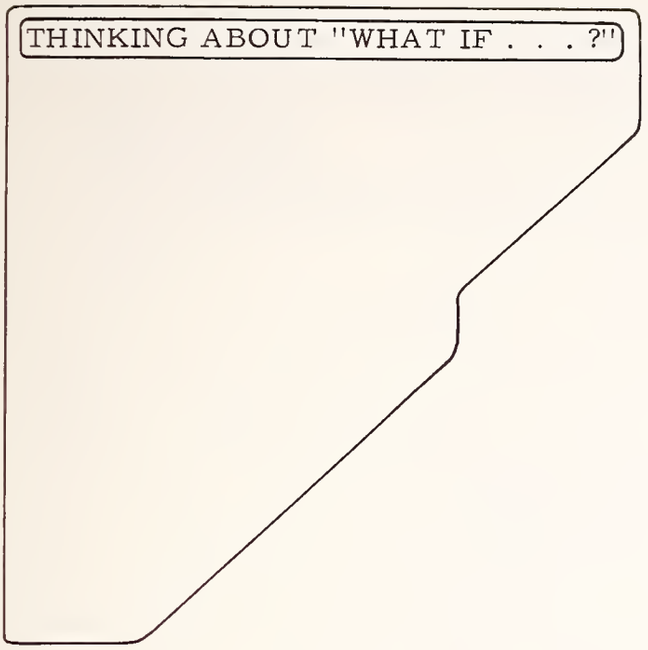
to be paid for by the Railroad. So far the Railroad's experience with the new cars in traversing the "war zone" from 43rd Street to 107th Street has indicated that the reduced percentage of glass area has probably reduced breakage. Possibly the location of windows in the dark area of the car's side panels has also helped. The Railroad detectives have undertaken several efforts to discourage hostile acts against the trains. The greater speed and reduced noise of the trains made up of the new cars has possibly made the cars less objectionable and give less notice to potential vandals. "They're doing more looking and less throwing so far," an IC staffer observes.

This phenomenon of convergent synthesis is characteristic of the history of invention in all fields, but it is not always conspicuous. Many writers, too, ignore the phenomenon. They present the history of science or technology as a movement from the implicit to the explicit, so that they describe the sequences of events as closely organized linear sequences stemming from a single center of implication.

Some perspective on what all this might mean is provided by a historian of technology Robert S. Woodbury

In the sixteenth century, we find two clearly distinguished points of initiation. There is an approach through the mathematical analysis of curves and the geometry of motion. There is, also, an empirical approach through the efforts of clock makers to produce machines to cut gears for their wheel work. Both lines of development proceeded with little direct contact until the close of the eighteenth century, and unusually long period of slow convergence.

The convergence of theory and practice came, in this field, (gear cutting machines), after the development of heavy engineering work for the application of steam power. Castings and hand-cut wheels were used in the early years, but the extension of transmission systems in the field of prime movers called for major improvements in gear-cutting engines. The theoretical work of the eighteenth century was adapted to the needs of engineers by a group of writers, happily called the translators. The outstanding figures were Hawkins (1806) and Willis (1841). Buchanan's manuals of 1806 and 1833 simplified the treatises of Camus and de La Hire sufficiently to make them available to competent shop men, without engineering training.



Every day is a miracle. The world gets up in the morning and is fed, and goes to work, and in the evening it comes home and is fed again and perhaps has a little amusement and goes to sleep. To make that possible, so much has to be done by so many people that, on the face of it, it is impossible. Well, every day we do it; and every day, come hell or high water, we're going to have to go on doing it as well as we can.

JAMES GOULD COZZENS

As the preceding pages have shown, many different experiences in the course of the CSSMTD-IC car project have pointed out opportunities and suggested alternative approaches that might be useful to others engaged in the planning, design, development, financing, and management of mass transportation technology. Each section of the report has dealt with one of six different points of view, six ways of looking at many events, a considerable number of which took place in the course of the project. Activities and the timing of events from one aspect of the program affected other aspects. If the rationale and objectives had proceeded to different premises, possibly different approaches to creating organizational relationships would have been followed, or if different production practices had been devised this may have suggested a new bidding and contracting process, and so forth. Experience seen in this way is not bound to its specific context, but can be used wherever it fits -- a kind of collective hindsight.

Besides specific experiences and insights, this project has produced still other results -- new ideas, revised ways of

thinking about a problem, possible new approaches, and even some pure hunches. These come out of the project as a whole and also need to be reported, even though most have not been tried out in the project we have been describing. These additional observations have occurred not only to those who have participated in this project but also to us, the authors, in the process of reviewing the total experience with the participants, and then reflecting about what we were told and not told.

Hunches are the seeds of innovations.

"Making use of experience" therefore should include not only paying attention to what was done but also to what might have been done, how different assumptions about what needed to be done could have led to different and perhaps more satisfactory outcomes, and what those who were involved might do if they had a chance to start again with what they know now. Here may lie some of the most valuable information and stimulation for those who yet have a chance to devise better solutions to the same or similar problems.

Below we recount what might be done differently in improving commuter passenger service on an existing commuter system of the IC type. This includes ideas beyond just new cars. These suggestions are made narrowly to operators of equipment and to the designers and producers of it, more broadly to those considering ways to improve the operations of commuter services, and still more broadly to those involved in national policymaking for and support of mass transportation programs, such as the UMTA administrators.

A system study of what urban transportation might be could provide a new decision context within which to reach feasible compromises.

There's a strong feeling that proposals to improve urban mass transportation could be considered more completely if UMTA were to develop a systems study to serve as a decision context. Such a study might include concepts for improvement in all the characteristics of:

- A commuter car system -- physical characteristics of the vehicle itself, the track, the station, the signal equipment

- The operating environment -- timing and scheduling of the trains, maintenance, weather factors and speed, characteristics required by the particular route, and finally,
- The people involved -- customer accounting, customer behavior, and preparation and orientation of the passengers.

The context for decisionmaking that would emerge from such a study would be flexible enough to provide guidance for the majority of conditions that can be expected to be encountered on urban mass transit systems in the U. S. Once this systems context were developed, the federal capital granting agencies could require that proposals for particular improvements follow the procedures for defining and justifying particular requirements. Design parameters following the guidelines could be supplied to manufacturers who would have helped in developing them. This in general terms follows the history of procurement in the aerospace industry, where broad parameters of the mission (performance specifications) are translated into guidelines for design, production engineering, and appropriate testing.

It might also be desirable to extend the idea (implicit in the DOT Pueblo test facility) of having standardized testing equipment and facilities available for use on a lease basis to the industry as a whole. Such facilities would be designed to prove out basic components in accordance with the parameters to be developed in the type of systems study sketched above.

The beginnings of such a systems study were provided recently by the Boeing Company under a contract with DOT. This was a study to develop a request for a proposal to delineate systems approach to transit districts' problems and was apparently socio-technical in its approach. We have been told, however, that the time and funds allowed did not permit a comprehensive analysis of the kind that would be required to produce operationally useful general guidelines. Such overall

Better urban transportation may not depend on advanced vehicle designs.

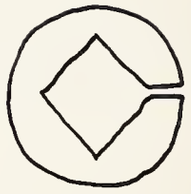
specification criteria are needed, because the specialists in each part -- the managers, the designers, manufacturers, and the marketing specialists -- are wedded to the partial perspectives shaped by "their thing" as the governing consideration in shaping the total system.

For a balanced, sufficiently comprehensive picture of "what's practical" to emerge is a difficult undertaking at best. So the team that develops such a study would have to be broad-based technically and headed by a widely experienced generalist.

Specific Improvements in Car Construction

With regard to production of the cars, these suggestions were made:

It should be possible to schedule cars more realistically, to get prototypes to a testing stage before proceeding with the rest of the order. Of course, the pressure to get cars into service is tremendous, and this is difficult, but conversations with car builders indicate that 16 cars are needed for the car builders' normal learning curve to be achieved. In the case of the BART system, 10 cars have been ordered for debugging before going ahead with the rest of the order. This might mean that a great deal of money would be spent on the first 10 cars, but it would be a saving in the long run, perhaps as much as 25% less per car in the remaining cars. In the case of the CSSMTD/IC cars, because of the pressure to get all equipment on line, cars were rushed into production at the plant without prototyping. There has instead been 'de facto' prototyping of the first few cars, with procedures and problems now smoothing out as a result of experience gained on these early units.



Final engineering and production procedures could be rearranged to improve the process.

Some retrofits and changes cannot be pushed through fast enough to get them on the first cars at StLC and so some of the catch-up is being done in Chicago.

MODULARIZATION

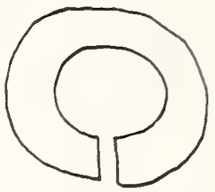
Equipment should possibly be repackaged into components that divide the rail car systems into functional modules. The decision as to what to include in which breakdowns would consider function, size, and weight, cooling requirements, maintenance and repair staffing, manufacturing sequencing, and procurement considerations to determine the actual composition of each module. Each module would contain components, devices, and subassemblies that would be completely interconnected with all necessary terminations using quick connectors. The make-up of each module would be shaped by maintenance and servicing, e.g., to make possible:

(1) removal of the module by not more than two workers;

(2) removal (or replacement) of the module in less than one hour; and

(3) testing of modules separately from the car.

The concept of modularization when initially applied to the construction of complex systems can dramatically increase costs. This is frequently the result of grouping items into modules based on theoretical premises of similar function or common source of supply. We suggest that the determination of modules be far more pragmatic and consider groupings because of common or compatible heat exchange requirements or on the basis of similar cycles for testing, maintenance, or replacement. Using these more sophisticated pragmatic criteria modularizations may raise initial cost but can usually be justified by savings in operating costs. The proposed modifications for the new Metroliner cars include similar proposals for modularization.



SMATS from the metroliner experience.

Another difficulty in getting from design into production, the IC says, has been that for wiring and other aspects of the total system, the drawings have been inadequate. Drawings and wiring diagrams exist for each of the subsystems in the car -- for example, air conditioning, motors, braking system, etc. -- but there is no overall wiring system diagram, showing interfaces.

One who has been close to the development of the IC cars makes this general comment: "Things are getting too complicated. You lose your reliability when you get into all this gadgetry. You can get away with it if you have a good maintenance force, but without that a nickel item costs $1000 worth of trouble."

The design of equipment housing may seem trivial, but more detailed consideration of these items might yield important advances in reliability and maintainability. First consideration of equipment housing might reflect additional thinking about how systems should be subdivided and devices packaged together. This has been discussed under "modularization." The housing design can incorporate features that provide for the proper coupling, ventilating, and protection from adverse environmental hazards such as water, dirt, sand, ice, and salt. Access and component removal should be facilitated by design. Features to assist in routine maintenance (such as well located partial openings or tubes to direct cleaning sprays) and checking (such as confirming circuits or continuity records) could be incorporated into the design of the housings.

A housing can be more than a covering -- a home for components.

One useful innovation that could be used more extensively is a picture book of Polaroid camera shots, taken by IC staff at St. Louis Car at different stages of the production process. This has been useful to recall problems encountered at different stages, to document events and details of production, and also as an educational device for the District. In order to give the District Trustees evidence of progress in the cars, it was better to show and explain the pictures than to show them numbers on a piece of paper.

New Premises for Urban Transport System Development

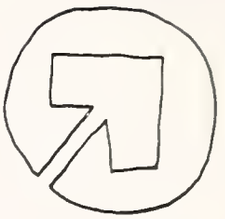
At several points earlier in this report we have raised the possibility of using travel experience, rather than equipment, as the point of departure for planning, designing, contracting

for and introducing new technology. A recent study of commuter motivation by psychologist Ernest Dicter (see References) provides some indication of how this kind of premise for mass transit technology might be explicated and tested.

There is a growing awareness by the commuter, according to Dr. Dichter, of his

> . . . individual power . . . organized resistance . . . dissatisfactions with his role as a helpless victim of the transit industry . . . and a fast-growing impatience . . .

with the unresponsiveness and unimaginativeness of presently available mass transit services.



The urban mass transportation experience is one-tenth of many users' lives, which suggests that the means may be as important as the ends.

When commuting is looked at from the commuter's point of view, as was done in the Dichter study, it becomes evident that he perceives

> . . . the daily trip as a "mini-world," and as such, psychological factors are attempts to control the commuting environment.

The Dichter study identified ten kinds of 'motivators' for the commuter on his daily trip to which mass transit services and facilities are so far generally unresponsive. The crucial conclusion of the study is that it is a certain kind of experience that the passengers seeks, not a particular mode of travel. Therefore engineering and economic costs and benefits of various travel modes (e.g., Lang and Soberman, Urban Rail Transit -- see References) are largely irrelevant if the objective is to encourage choice of one travel mode over another (e.g., to switch from private automobile to mass transit). The implication of Dichter's research is that such shifts in travel modes used will occur only if features of the system seeking to increase its market are conducive to creating the kinds of experience that the study shows commuting travelers seek.

View of the upper level interior of new CSSMTD-IC cars.

Figure 20

To illustrate how mass transportation system (rolling stock and other aspects, too) design might be affected if the "motivators" and the "mini-world experience" were taken as points of departure, we present in tabular form the aspects of travel experience that Dichter identifies as important to commuters, matched with system design features that would create or reinforce such experience.

Designing Mass Transportation to Enhance Commuter Motivation

Types of Experience Sought by Commuters (Dichter)	Salient Transportation System Design Features
Increased participation	– Group ticket sales – Discounts, privileged access or customized availability to other products and services – Participative pastimes enroute – Reserved areas for regular riding groups

More control of the (personal) environment	– Reserved seat sections – 'Elective' sections to vary enroute activities (reading, conferences, sleep, refreshment, exercise) – Privatized areas on some cars – Multichannel seatside media outlets for individualized choice
More individual satisfaction	– Greater freedom of movement within car – Rental equipment for work or pastimes – Information services – Snacks, hot towels, restoratives, coffee – Reservation services for city events
Use of the travel experience for self-enhancement or identification	– Specially designed 'character' for individual trains (the 8:06 for eggheads; the 4:45 for swingers; the 5:20 for Bright Young Men) – Cars designated for particular communities – Special access and egress to the station for 'regulars' – Personalized tickets – Executive Club (fee) with ID card good elsewhere
Use of travel as an intermission/transition (time alcove) between home and work	– Provision for continuation of work or home preoccupation as needed – 'Decompression' and 'energizing' routines – Variety of car decors for individual choice – Telephone or recording services for those who need elastic work time
Use of travel as an opportunity to escape	– Closed-circuit programming – Hobby information – Educational services (e.g., language study via cassette or conversation groups) – Windowless areas with restful decor – Restricted access for some trains and riders – Gym/sauna car

Using the travel mode as a symbol of dynamic security (life mastery)	– Personalized space in reserved area – Lockers aboard or in stations for private supplies or papers – Privileged access to special events or other services
The travel mode as a psychological extension of home or work	– Employer-paid travel as a prerequisite or fringe benefit – Stock market information – Community bulletin board – Home-related information services (gardening, tax advantages, sales in local stores, ideas for family gifts)
The travel mode as a symbol of diversion	– Club group privileges – Entertainment – Also, see "Escape" design features above

Note that not all riders seek all types of experience; some of the 'motivators' are antithetical. Yet a variety of motivators, attracting different kinds of riders or meeting varying needs, can be provided by conscious design.

Most of the examples of experience-enhancing design features we have suggested have related to the vehicle interior and to the ride itself. The same premises, however, could be followed out in rethinking or inventing other system components such as station design and location, ticketing, sale of other products and services, personnel training, scheduling, aesthetics, maintenance priorities, and equipment replacement. The basic strategy being proposed here is to use social, psychological, and marketing criteria for the development and management of transit technology rather than using as a frame of reference for design some engineering performance specifications that may push system use and rider behavior in directions that discourage satisfaction, fail to build ridership, and hence decrease opportunities for financial profit.

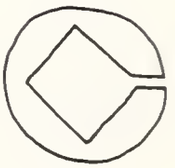
Ton-miles of human cargo
vs
a rolling phantasma

Now we'll return to the prosaic to suggest a couple of ideas that represent limited innovation, but which are likely to be of increasing importance. The cost of maintenance over the service life of high technology transit vehicles can be ex-

pected to continue to rise relative to the cost of the vehicle. The rising cost of labor together with increasingly complex equipment suggests the need for specialized equipment for performing diagnostic and inspection tasks more efficiently. In many instances test equipment is presently procured for testing systems during the the production process. This test equipment can probably be modified and elaborated to be able to perform diagnostic and inspection tasks for the operation after the cars are put into service. Thus the same equipment built for production testing can subsequently be used to improve maintenance procedures.

In many instances it would be helpful to have a system to perform selected diagnostic and inspection routines built into the car itself. Pressed plate hydraulic logic circuitry that might be more suited to the metal technology and adverse operating environment should also be considered as well as electronic devices. In some instances fiber optics and special lighting might be sufficient to inspect regularly points of wear or possible failures that cannot be made easily accessible.

Excess heat produced by the normal operation of the car -- chiefly the propulsion system and the dynamic braking system -- might be able to be used to power an adsorption air conditioning/heat exchange system to provide climate control to the passenger compartments. Adsorption air conditioning -- usually powered by gas or steam, but in this case electrical heating elements -- is known for long service life with minimal maintenance. During long runs, if there is insufficient heat from the propulsion system alone, some additional power could be drawn from the main electrical source to provide sufficient heat. After acceleration the power requirements for propulsion of an "express run" are enough lower than peak load to permit this use. When frequently accelerating, braking would also be occurring to generate heat for adsorption air conditioning units. If experience with buildings is a guide, an adsorption-based system might initially cost 30 to 50% more, but the increase in the car's availability for service, reduced maintenance, and longer service life could possibly more than offset this cost.



Symbiotic intercomponent relations

Evidently, present regulations for the UMTA capital grants program cannot be used to match expenditures for spare parts, special cleaning and maintenance equipment, diagnostic and inspection equipment, or special jigs, positioners, and supports for repairs and overhauls. This equipment is expensive but increasingly necessary to reduce operating costs. In some cases -- such as Chicago -- it may be possible for a jointly operated shop facility to provide support for the cars of several transit system operators. Jointly operated facilities are not without difficult problems of administration and responsiveness. However, these problems may be more amenable to solution than the problem of rising costs to operate separate, low technology - high labor maintenance facilities because the quality of services performed is insufficient to warrent heavy capital expenditures. Means for offering financial incentives to develop improved maintenance programs should produce a high ratio of benefits.

Over the life of the car, maintenance cost will be much more than the original purchase price.

SUMMING UP

The world ain't getting no worse; we've only got better facilities.

KIN HUBBARD

The preceding account has shown that the main partners in the development of new cars for the Illinois Central Suburban Service each had a different point of view, different emphases and perspectives. The significant learning from this is not that one perspective was more "right" than others, but rather that the differences in emphasis complicated the design-development-production-testing-operations sequence, leading to overweaning concern with some features of the total effort and the underplaying or avoidance of other options.

The Railroad saw the new equipment as part of a general strategy to upgrade its service to a point where losses would be less severe or even to a level where profits might be realized. It also wanted to be well though of as a "good neighbor" or at least not actively opposed by that significant part of the commuter group in the far south suburbs who were influential in Chicago business and politics. And the new equipment would make it possible to maintain or enhance the value of other IC assets, such as land along the right-of-way and developments such as Park Forest South and others contemplated nearer the Loop.

The District Trustees had as their main concern the attitudes of the commuting public, their legal responsibility as owners of the equipment, and the riding environment in the cars. Lacking technical staff and lacking a prototype to test on the line, they could do little to make this interest effective beyond offering suggestions at an early stage in development of the cars.

Public officials need a new vision of what is possible for urban mass transportation and assistance in implementing their choices.

The manufacturer's concern was to get the car built sufficiently close to the bid price to produce a profit. This naturally pre-

vented them from being involved in such considerations as the performance of the car from the point of view of the riding public, ways in which the car might be designed to compete with other modes of transporation, or the basic conception of the car by the IC engineering department with its built-in assumptions.

These multiple perspectives, combined with the tight time schedule caused by the District's and the IC's desire to get new cars into service as quickly as possible, made it highly unlikely that the new cars could incorporate advances or innovations that would significantly improve the process of urban mass rail transit. Each party mostly had to "go with what they had." And although some aspects of the new car's configuration and equipment represent incremental advances in the continuity of improving the state of the rail car art, more might have been done had two conditions obtained: (1) more time for design and prototype testing to explore different ways of configuring the total transit system of which the car is only a part; and (2) a way of managing the total project in which there could have been more balancing and reconciling of the separate interests and requirements of passengers, the Railroad, the District, the manufacturer, and subsystem suppliers.

The best commuter car ever produced may not be good enough to catch up with the public's rising expectations.

To repeat: This has been neither a history of the CSSMTD/IC cars, nor an evaluation of the project. Rather, it is several versions of the experience gained, very selectively reported to emphasize those results of the total effort that may be of most interest to those who are or will find themselves in similar circumstances.

The total experience looks different depending on what one wishes to emphasize. We saw at least six ways in which the total story can be understood:

(1) From the point of view of the total objectives and rationale:

- The situation in which the IC found itself in the mid-1960's, particularly with respect to the equipment, traffic, and revenue prospects of the suburban service.
- How new equipment was seen by the IC as part of a general strategy to upgrade service, and by the commuters as at least a partial answer to their complaints about the ARCS system and other features of the suburban service.
- What had to be done to justify, procure, and pay for new equipment.
- How these developments related to other events and trends in the communities served, the political arena, the corporate development of IC Industries, and other mass transportation services south of Chicago.

(2) From the point of view of the organizational and management framework that evolved:

- The formation of a mass transit district (CSSMTD) and the definition of its role by the District itself and by others.
- Development of relationships and working procedures between the District, the Railroad, other carriers, and local, state and federal government organizations.
- The special role of UMTA as (at various times) patron, coach, gadfly, innovator, and facilitator.

(3) From the point of view of the design of the car itself:

- What design assumptions were made, and what design options were considered and not considered.
- What were the consequences of what was done and not done in design and engineering, both for production of the cars and for their performance in service.
- How the design of the car relates (or might have related) to other facets of the total system: e.g., passengers, railroad employees, stations, ticketing, maintenance.

(4) From the point of view of the bidding and contracting for the equipment:

- The division and merger of responsibility of the District and the Railroad.
- The role of consultants in styling.
- Pre-bidding "romances" with potential car builders and equipment vendors.
- How bids were solicited and evaluated.
- Establishment of ground-rules such as customer control, post-bid work by the contractor, scheduling of payments, and contract management during production.

(5) From the point of view of actually getting the cars produced:

- Production engineering and the solution of shop preparation and scheduling problems.
- Working out relationships with vendors, and the interfacing of subsystems.
- Detailing, queuing, and adapting the various parts of the final design-engineering-production-delivery process.
- Producing, assembling, and testing the cars.

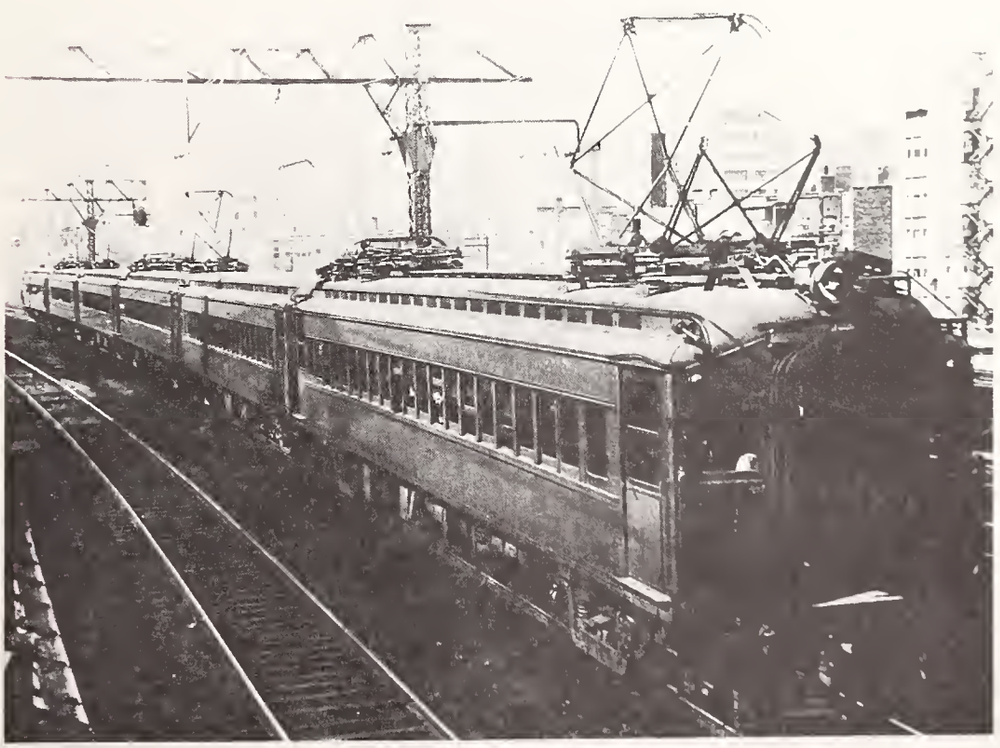
(6) From the point of view of getting the cars into service:

- The amounts and kinds of personnel training, maintenance shop alterations, testing, and debugging anticipated and actually needed.
- Adjusting the system to permit effective operation of both old and new equipment while deliveries continue.
- Problems and required changes in the equipment that did not become apparent until it was actually placed in service.

There is still another way of looking at the total effort, apart from these six versions. That is to step back from the experience, as we did in the section of the report just preceding

this one, to suggest a number of issues, problems, assumptions and concepts for the future that occurred to those involved as a result of their experience or which occurred to us in hearing about and seeing what has been done. The key questions here come under the general heading: "what if. . .?" What would have happened, for example, if:

- More attention had been paid to active competition with other transit systems in marketing the riding experience to present and potential IC patrons (devising rationale and objectives)?
- A different basis for organizing the District had been used (creating an organizational framework)?
- Design and engineering had been considered interfaces other than station-car, and the use of behavioral and experiential criteria for designing car interiors (elucidating assumptions for design)?
- Other kinds of ground rules had been developed for procurement (bidding and contracting)?
- Prototyping and production scheduling had been altered (getting the cars produced)?
- Steps for putting the cars into service had been organized on a different basis (getting the cars into service)?



The Old Cars

Figure 22

We have not developed these alternative approaches and points-for-others-to-consider in any great detail within the present report; to have done so would have been outside the scope of this study. But it is here that others who have a stake in similar rail technology developments or in mass transit generally may find some points of departure for their own planning and action.

The idea of this report, as we have said, is to record and transmit experience gained on this particular project in a way that will help others to find their way through similar problems or exploit hitherto unrecognized opportunities. This is possible, in part, by careful and critical attention to what has already been tried, or partially developed, or even only imagined by those involved in the Chicago experience. A sampling of these kinds of results has been presented in the preceding pages.

It is as if the participants in the Chicago project had been on a long safari and seek to report, through us, what those who are undertaking similar journeys need to watch out for, could do better, or might achieve by taking an alternate track across the veldt. Many such safaris, after all, will be taken in the future, and the lessons from each should be passed on to those who come later. This report has been one such selective account of experience. More are needed.

Experience is more than what happened.

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