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Technology + Economics, Inc.
129 Mount Auburn Street
Cambridge, Massachusetts 02138
617 491-1500

Submitted to:

URBAN SYSTEMS PROJECT OFFICE
Johnson Space Flight Center
NASA
Houston, Texas

URBAN CONSTRUCTION AND SAFETY PROJECT

Second Quarterly Report
May-June, 1975

Contract # NAS9-14529

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PREFACE

This report describes the activities of the Urban Construction and Safety Project at Technology + Economics, Inc., during its second quarter of operations, from May to July, 1975.

The objective of the project is to apply technology developed by the National Aeronautics and Space Administration (NASA) to problems identified in urban construction and safety. The project is supported by the NASA Technology Utilization Office and monitored by the Urban Systems Project Office of Johnson Space Center under contract NAS9-14529.

NASA Staff involved in the project is as follows:

Carely Lively, Contract Manager.

William L. Smith, Technology Applications Division.

Andrew Sears, of the Technology Applications Division, serves as principal government technical advisor.

James Hankins of Marshall Space Flight Center, serves as technical advisor on matters related to the flat conductor cable project.

Technology + Economics contract staff is as follows:

David J. MacFadyen, Project Director
Allan D. Ackerman, Operations Manager
James R. Simpson, Senior Scientist
W. Curtiss Priest, Senior Analyst
Peter T. Hogarth, Analyst
Robert F. Stone, Economist
Eli Castro, Documentation
Margaret M. Bucciero, Secretary

INTRODUCTION

This report has three main sections. Section 1.0 is a background statement describing the general nature of the Urban Construction and Safety Project's activities. Section 2.0 describes the main technology transfer activities that occurred during this quarter. Section 3.0 presents a set of operational considerations for future conduct of the project that have developed out of this reporting period.

1.0 THE TECHNOLOGY TRANSFER PROCESS

"Technology transfer" is the application of products or techniques developed for special purposes in one context to needs or opportunities perceived in another. It takes a need or opportunity from one context and matches it with a relevant technology developed in another context. This process can occur spontaneously, or it can be deliberately and systematically hastened.

NASA's Technology Utilization Program works deliberately and actively towards the full technology utilization promised in the National Aeronautics and Space Act of 1958:

> The aeronautical and space activities of the United States shall be conducted so as to contribute...to the expansion of human knowledge of phenomena in the atmosphere and space. The Administration shall provide for the widest practicable and appropriate dissimination of information concerning its activities and the results thereof.

An important component of NASA's program to meet this mandate has been the establishment of Technology Application Teams (TAT's) designed to actively match problems in specific applications areas with NASA solution technologies. The Urban Construction and Safety Project (USCP) at Technology + Economics, Inc., (T+E) is one such team.

Technology transfer is never a cut-and-dried process that proceeds according to a set pattern. The constraints and opportunities presented by each transfer project are unique, and define their own appropriate operational style. Nevertheless, in every completed transfer project, there are certain basic logical elements that always occur and that can be identified in some form. These basic elements are the following:

- An identifiable and definable <u>problem</u> in the applications sector.
- An identifiable potential <u>solution technology</u> within the body of NASA technological resources.

- An ongoing assessment of the feasibility of the proposed problem/technology match, and of ways to improve this match.

- A user -- governmental, institutional, or commercial -- who can specify exactly the performance and cost requirements of the solution technology and who can motivate the needed applications process.

Although they are not logically inherent to the process, the following elements are also generally present:

- An applications process involving developmental work on the part of NASA, users, and/or private manufacturers to transform the "raw" technology into a form appropriate for the new application.

- Ongoing implementation management on the part of the TAT to facilitate communication between the various interest groups and to overcome the obstacles to the innovation that may develop.

These elements interact in a complex and varied pattern. Sometimes different parts of the process occur simutaneously; sometimes sequentially; and sometimes iteratively. An iterative process is frequent: initial work toward implementation of an identified problem-technology match often requires the UCSP team to re-define the problem and subsequently consider alternative technologies.

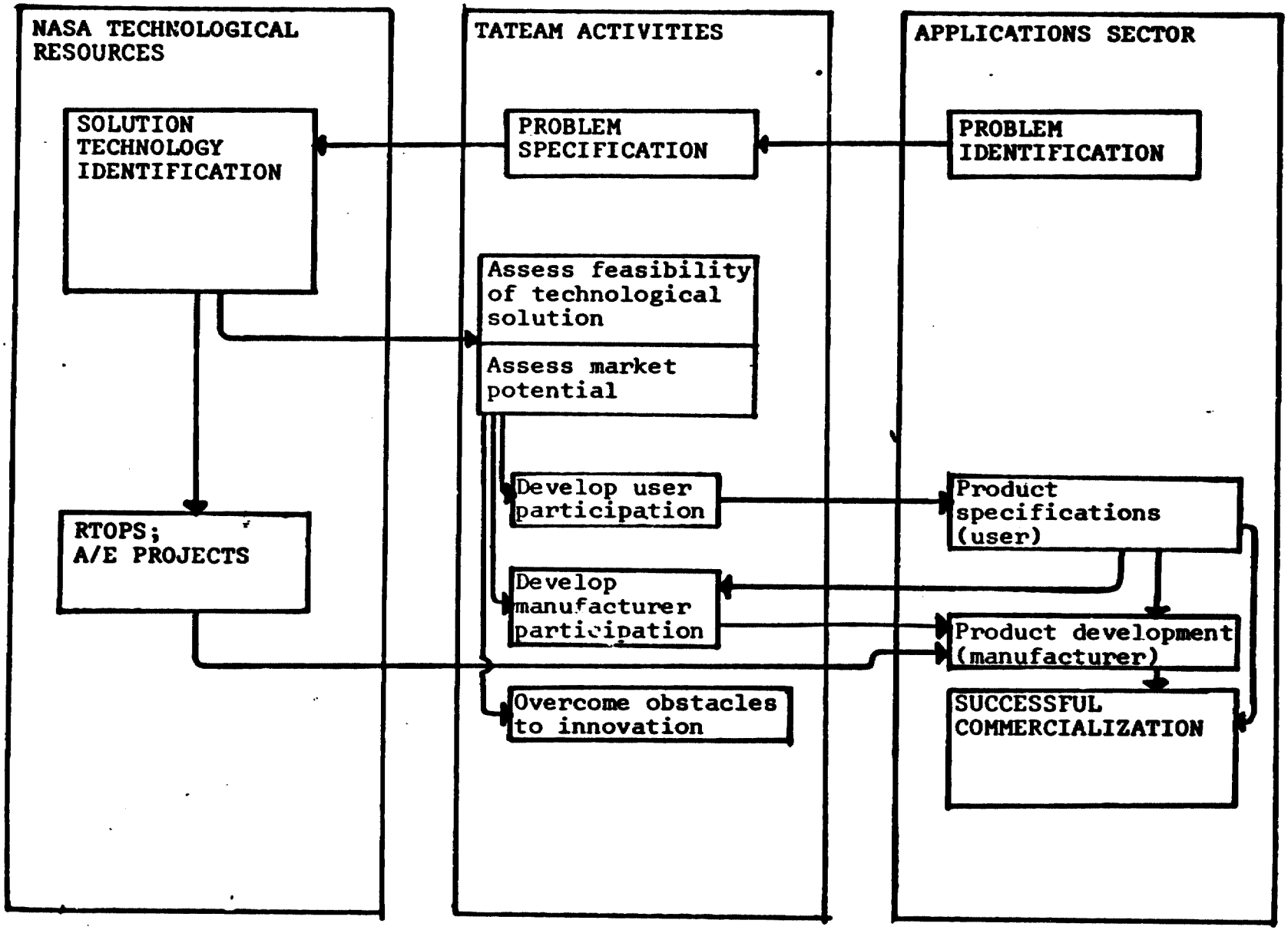
The most significant type of variation between different transfer activities lies in the direction of the impetus to transfer. This direction determines the basic structure of the transfer process. A fundamental dichotomy may be identified between tech transfer in which a known problem exists for which a technological solution is sought; and in which a promising technology exists for which an application is sought. These two processes may be termed respectively "market pull" and "tech push". An example of a "market pull" process from current UCSP work is the problem of the high cost of flood insurance studies for which a NASA-developed solution is being sought; an example of a "tech push" project is a diesel engine controller developed at Johnson Space Flight Center for which the UCSP is assessing the market potential. The accompanying two charts respectively schematize the characteristic forms of "market pull" and "tech push" transfer processes.

It will be seen that the basic elements of each process are similar. What is different is the direction of flow of the process which engages these elements; the difference is symbolized by the reversal of the direction of many of the arrows.

This brief overview of the technology transfer process as it has been pursued by the T+E UCSP is highly abstract. The next section of the report will present the UCSP team activities from a more operational point of view. It will show some ways in which the abstract process called "technology transfer" actually occurs, and indicate what the present project is achieving.

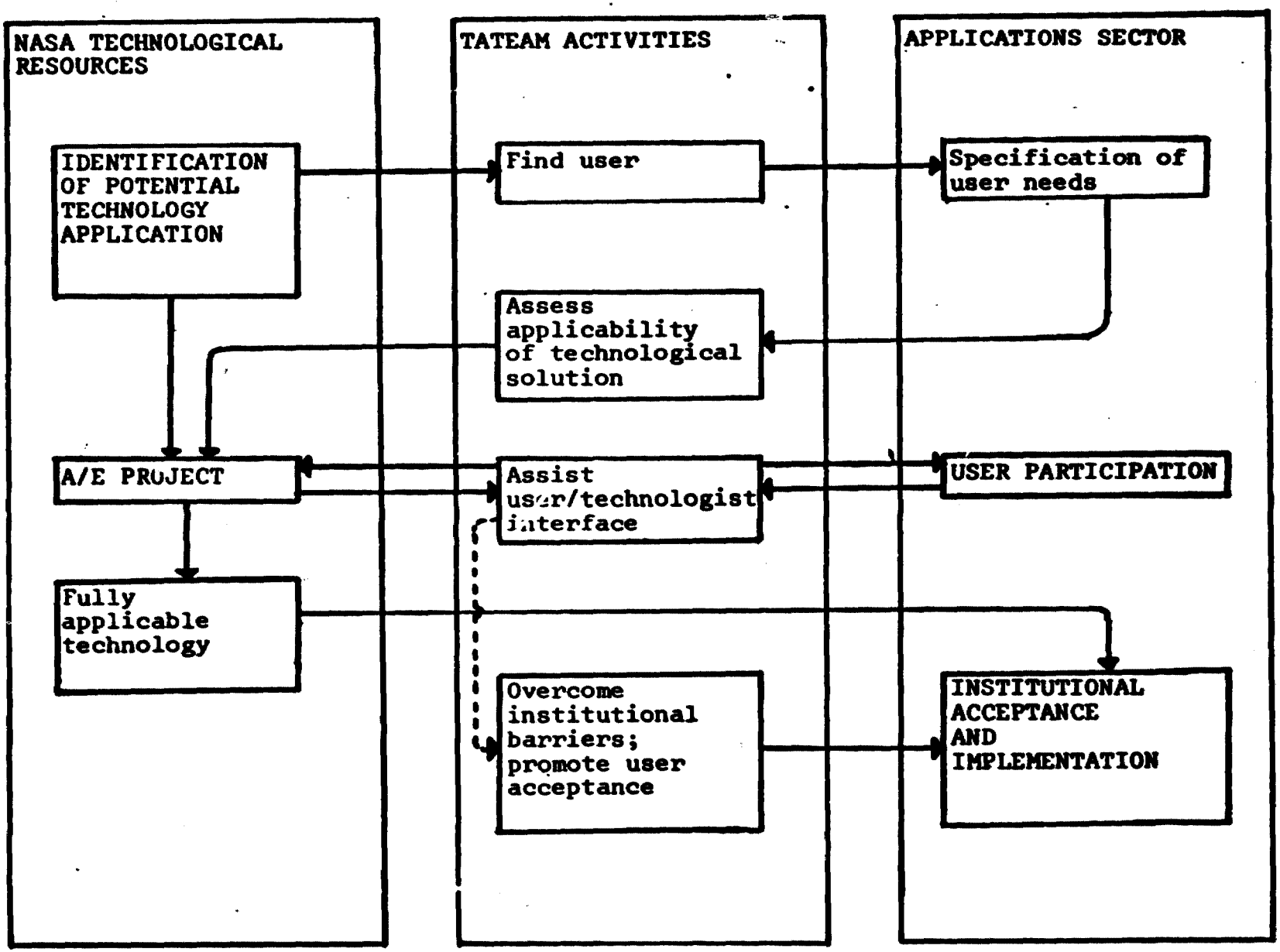
THE TECH TRANSFER PROCESS

I. PROBLEMS IN SEARCH OF SOLUTIONS...



THE TECH TRANSFER PROCESS

II. DEVELOPMENT OF TECHNOLOGIES WITH COMMERCIAL POTENTIAL:



2.0 IMPLEMENTATION PROJECTS

This section of the report discusses the five main implementation projects with which the Urban Construction and Safety Project has been involved in this quarter. They are:

- Flat Conductor Cable
- The NASA House and Compendium
- Flood Insurance Studies
- Tornado Studies
- Controller for Stationary Diesels

2.1 FLAT CONDUCTOR CABLE

2.1.1 Background

The major implementation project now underway of the T+E Urban Construction and Safety Project involves applying Flat Conductor Cable, as developed for spacecraft wiring, to building applications. Flat Conductor Cable (FCC) permits the development of very low-profile electrical systems that are suitable for surface mounting on the floors, walls, and ceilings of buildings. FCC systems are intended to achieve major cost and system-flexibility breakdowns in building wiring.

Two separate systems are being developed: an undercarpet system and a baseboard system. The undercarpet system employs a flat power cable, shielded by a grounded metal foil, that terminate in floor-mounted receptacles. It is designed to interface with a flat-conductor cable telephone system that is being concurrently engineered by Western Electric. The advantages of the undercarpet FCC system lie in its elimination of expensive underfloor ductwork in new buildings, and in vastly simplified system revision in existing buildings. The baseboard system involves a flat power cable, mounted in a plastic surface-mounted baseboard raceway, with baseboard-mounted receptacles. It also has provision for foil-protected wall- and ceiling-surface runs. It has strong cost-saving potential for renovation work and for concrete and masonry construction.

The present implementation project for the undercarpet power system is the result of several years of effort to find manufacturers and users interested in commercializing the system. The undercarpet project is now moving forward rapidly, largely on the strength of the interest shown by two large users -- Western Electric/Bell and the U.S. General Services Administration. Their interest has resulted in the involvement of eight manufacturers in the necessary system and hardware development work.

The baseboard system project is at a less advanced phase of development than the undercarpet system, insofar as manufacturers and users have not yet shown a comparable degree of interest in it.

Technical development is proceeding, however; its locus is Marshall Space Flight Center. A viable prototype system has been developed that is available for testing and for product development.

Both the baseboard and undercarpet projects are focussed upon obtaining approval of the 1978 National Electrical Code (NEC) for use of the systems. Significant changes in the NEC will be required, and are expected to involve drafting of a new Code article. A Code change proposal will be due in early 1977. The attached chart details this schedule.

Fact-finding studies are underway at Underwriters' Laboratories (UL) at Melville, Long Island, for both FCC systems. These studies will provide a background of test data and analyses that will enable the NEC panel to assess the safety and durability of the systems.

The T+E Urban Construction and Safety Project is involved in sponsoring, managing, and coordinating the Code proposal and the UL studies. T+E's role in the undercarpet project has passed from an initial advocacy role to a complex implementation management task involving the technical coordination of ten private organizations plus NASA. With the baseboard system project, the management role is simpler, because there are fewer participants. There are, however, ongoing advocacy requirements to be met for this system, in order to generate the needed level of industrial involvement.

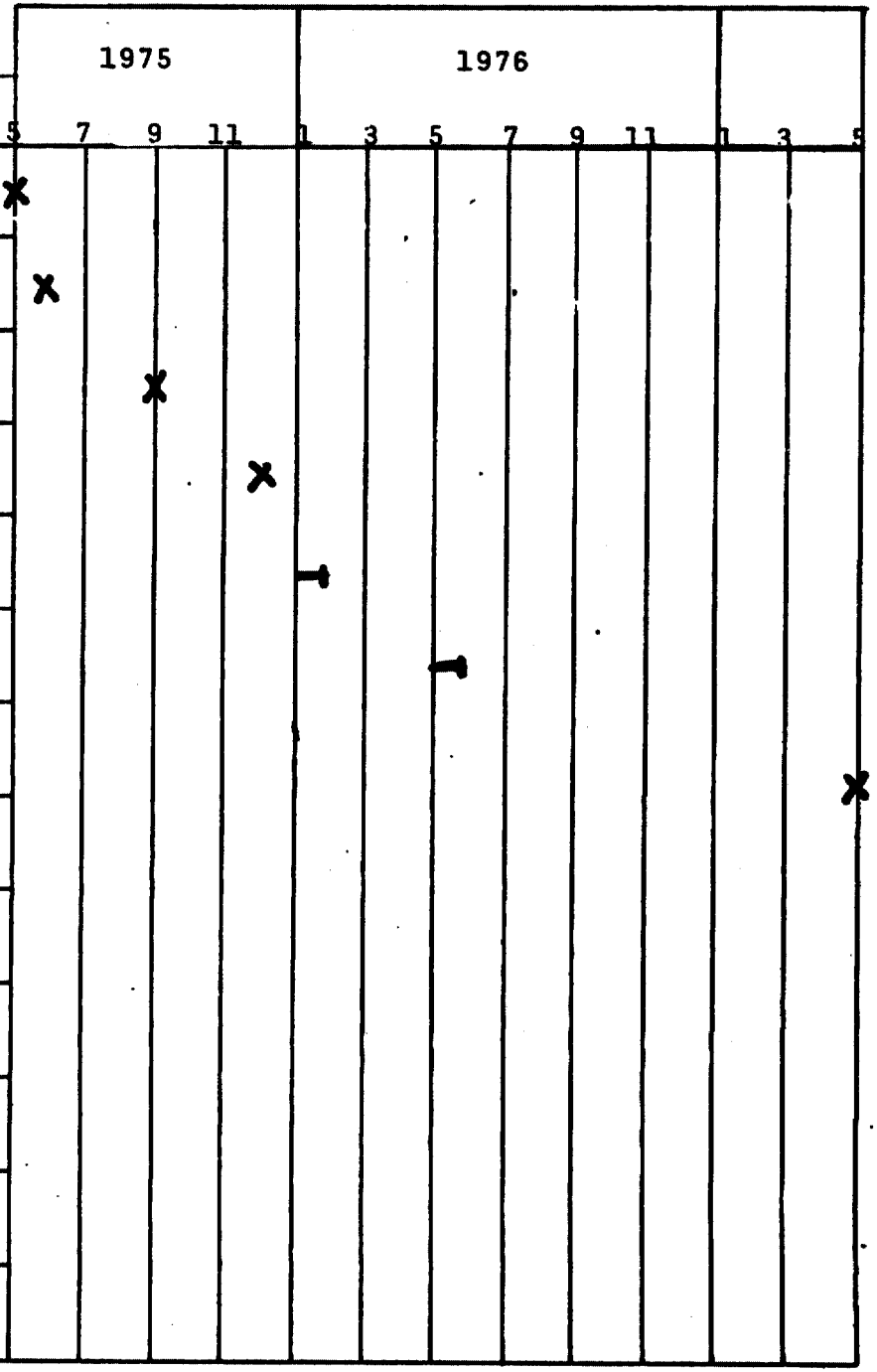
Present FCC project activities are directed toward gaining the required Code change. As the Code change issue is resolved, however, other issues will come to the forefront. These future issues include the following:

- If the 1978 NEC permits FCC systems, it will still be necessary to facilitate acceptance by local and city codes, and by local electrical inspectors.

- The present UL Fact-Finding Studies will address viability of FCC systems from a conceptual point of view. It will still remain to obtain approval by UL of individual system components. It will be the responsibility of the individual manufacturers involved to obtain these approvals.

UNDERCARPET FCC SYSTEM

REF	TASK
	Request to UL to initiate a fact-finding study
	Undercarpet hardware to UL
	Above-carpet hardware to UL
	Deadline for Code change proposal
	Proposal considered by committee
	NEC preprint of proposed changes available
	Final decision on proposal



- Electricians' unions will have to accept FCC systems before it is practical to install them on a widespread basis. At issue will be what impact the systems have on electricians' work time. T+E has authored a study that addresses this issue.

The accompanying chart diagrams the major steps involved in carrying out the FCC implementation projects.

2.1.2 Chronology

February-April

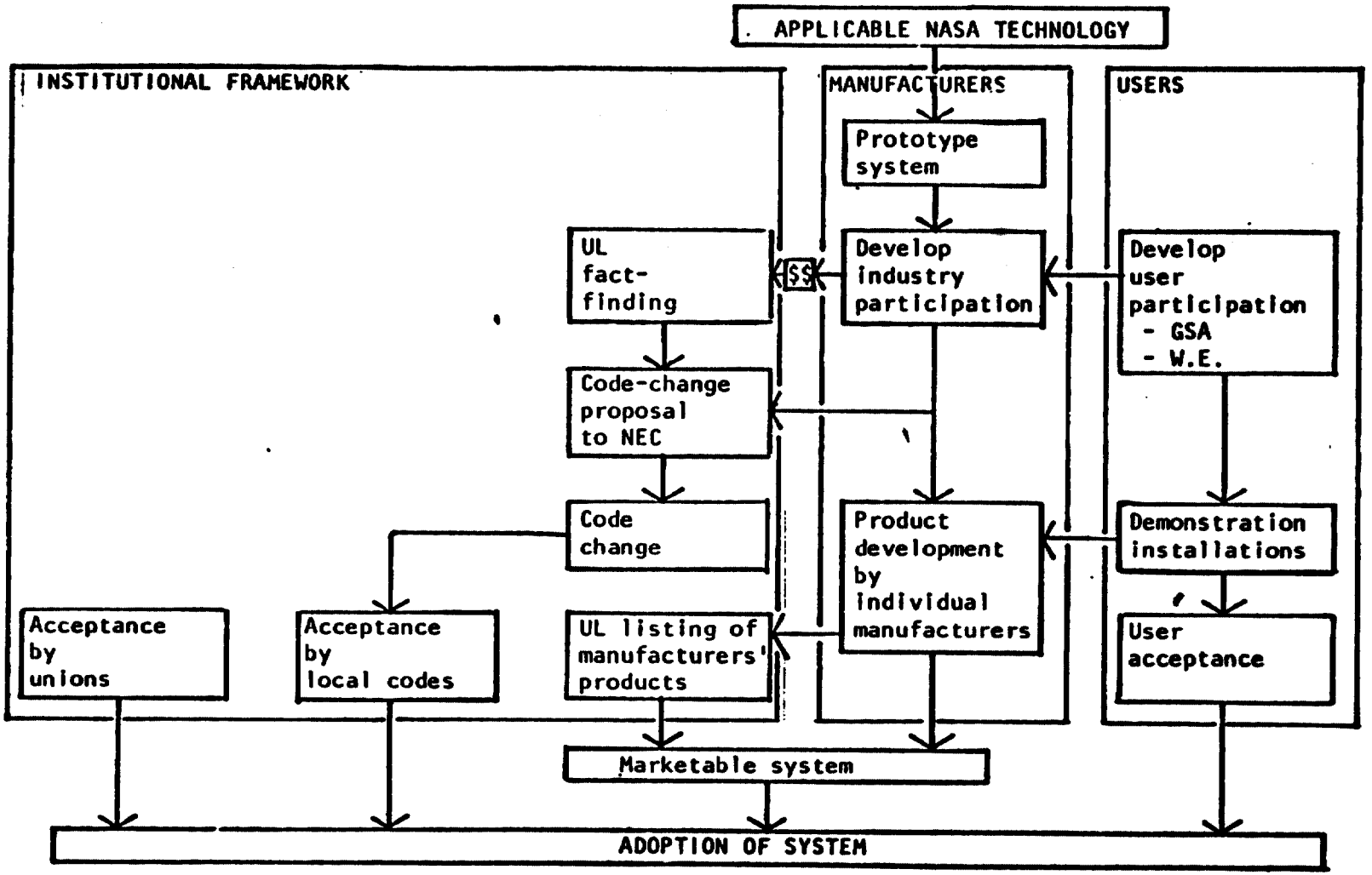
The UCSP flat conductor cable activity in February and March primarily consisted of a review of project status. It was clear that the project had been following a discoordinated course of development in the preceding several months. The problems related to:

- Standardization of cable size.
- The possible feasiblity of a two-wire system incorporating a fail-safe ground fault interruptor.
- Coordination of hardware development by different industry participants.
- Understanding of the process of gaining approval for FCC systems.

The form that the project would take in the coming year was defined during this period. It would primarily involve development of a proposal to change the National Electrical Code (NEC) to permit FCC. A fact-finding study at Underwriters' Laboratories (UL) would be appropriate, at least for the undercarpet system, and perhaps for the baseboard system as well. This study would provide background data and analyses for the NEC proposal. A further requirement would be the development of overall system specifications, to ensure system safety and component compatibility.

The need was identified for a general meeting of interested parties to address the major issues and to develop momentum for an effective project. This meeting was held in Washington on April 9th; a second meeting of interested industry participants occurred on April 24th.

FCC UNDERCARPET SYSTEM PROJECT -- APPLICATIONS PROCESS



The April 9th meeting included participants from NASA, the Department of Housing and Urban Development, the National Bureau of Standards, the General Services Administration, and private industry.

The main issues that were discussed were;

- Ground Fault Circuit Interruption (GFCI) capacitance leakage compensator.
- Cable standardization: metric vs. English.
- Procedure for accomplishing National Electrical Code (NEC) changes.
- Coordination of development efforts.

The conclusions of the meeting were as follows:

- A special GFCI with variable capacitance compensation should be developed. A private sponsor is needed.
- Cable should be sized according to the English system--specifically, by AWG sizes.
- Procedure for Accomplishing NEC Changes: The deadline for submission of a proposal for a Code change is December 1, 1975. The customary procedure is to ask UL to perform a fact-finding study in advance of any proposed Code change. It was proposed that the cost be shared by a number of organizations. This approach received general approval.
- Coordination: NASA should provide the technical leadership for the continuing cooperative effort necessary to accomplish the Code change, since no one of the vendors or prospective users could comfortably take such a central role. T+E should provide the mechanism for collecting the monies and arranging the contract with UL; the participating organizations should pay for the UL study through T+E.

The April 24th meeting was a working session of industry participants to prepare for a meeting with UL to be held early in May. The meeting dealt almost entirely with the undercarpet system. The following objectives were accomplished:

- Cable dimensions and specifications were provisionally set.
- Dimensions and configuration for the protective foil were provionally set.

- Different receptacle designs were discussed, and a pigtail device was chosen for UL submission.

- GFCI/compensator: possible locations in the system were discussed.

- UL submission of the baseboard system was discussed; it was not supported by industry representatives.

- The schedule and mechanics of submissions were again outlined; hardware and financial contributions were provisionally allocated.

May

Undercarpet Project

The month of May marked the initiation of a working relationship with Undersriters' Laboratories (UL) to obtain a fact-finding study on the system. In addition, four new manufacturers became involved in the project.

As a result of the May activity, manufacturers are available to supply all currently needed hardware and materials and a firm groundwork had been laid for the necessary system validation and approval.

The highlights of the month's activity were two meetings with industry participants in the project. On May 7th, a meeting was held with UL at Melville, Long Island. It was attended by representatives from:

- AMP, Inc.
- Dupont Co.
- Thomas and Betts, Inc.
- UL
- Western Electric
- T+E

This meeting followed the submission through T+E of a formal request to UL for a fact-finding study. The meeting accomplished three primary purposes:

- To introduce the UL personnel to T+E and the industry participants.

- To reach agreement on the system configuration to be tested.

- To clarify the steps required for completing the fact-finding study and submitting a Code change proposal.

UL responded to this meeting with a letter dated May 19th outlining the testing program they say as appropriate and a detailed list of the materials and hardware required. The cost of the under-carpet study was set at $18,000.

During this same time period, a search for additional industry participants continued. Two potential participants in the project (General Electric and Leviton) decided early in May not to participate for the time being. Their loss was balanced, however, by the entrance of four major new participants:

- Brand-Rex Co. (a cable manufacturer)
- Lamotite Products (a foil manufacturer)
- Millikan, Inc. (a carpet manufacturer)
- DuPont (Film Department--for insulating films)

On May 28th, a second meeting of industry participants was held at Newark Airport. The attendees were:

- Brand-Rex
- DuPont Co.
- Lamotite Products
- Paperfilm Associates (an insulation supplier)
- Thomas & Betts, Inc.
- Western Electric
- Technology + Economics, Inc.

The meeting was, in effect, an elaboration of previous meetings: it introduced the new participants to the project and assessed their possible contributions to it. The willingness of Brand-Rex, Lamotite, and DuPont to contribute materials was established. Certain remaining technical questions were addressed; in particulat, the final configuration of the protective foil was determined, and Lamotite agreed to fabricate and deliver it.

Baseboard System

Despite the lack of substantive industry support for the baseboard system at this time, NASA decided to initiate a project through T+E to be carried on in parallel with the undercarpet system project. Accordingly, a request for a UL fact-finding study was received at UL on May 1st. The first part of the hardware submission was delivered to UL by Marshall Space Flight Center on May 30th.

June

The main role of the UCSP team in June was to finalize the funding of the UL studies, and to coordinate the production and delivery of hardware to UL. The month's activity pivotted around two meetings at UL, dealing respectively with the undercarpet and baseboard system projects.

The undercarpet system meeting was held on June 18th and attended by the following organizations:

- AMP, Inc.
- Brand-Rex Co.
- Collins and Aikman (a carpet manufacturer)
- DuPont
- Lamotite Products
- Parlex
- Thomas and Betts, Inc.
- Western Electric
- JSC-Urban Systems Project Office
- MSFC
- T+E

One of these organizations, Collins and Aikman, was a new participant to the project. There were two purposes to the meeting: to give the industry participants an opportunity to present and describe the system hardware to UL; and to allow UL to further outline their testing program and requirements in light of the companies' hardware descriptions.

The baseboard system project meeting was held on June 19th. The attendees were MSFC, UL, Leviton, and T+E. At this meeting UL outlined its proposed testing program for the baseboard system, including the wall and ceiling extension components. This study is

simpler than the undercarpet system study because there are precedents to the baseboard system investigation -- notably the Johnsonite surface-mounted non-metallic raceway, and the preliminary investigation of flat conductor cable that had been sponsored in 1974 by the Urban Development Corporation. The only completely new part of the system is the wall and ceiling extension component. A cost for the baseboard study of $12,000 was quoted.

On the basis of these meetings, the UL testing programs and the participants' responsibilities were finalized for the July 1st hardware submission deadline. For the undercarpet system, the list of financial contributions took shape, although the distribution of funding did not become finalized until July.

July

Test installations at UL were made for both FCC systems in July. The undercarpet system installation occurred on July 11th, and was performed by the industry project participants. The baseboard system was installed on July 29th by Jim Hankins and Jim Cardin of Marshall Space Flight Center.

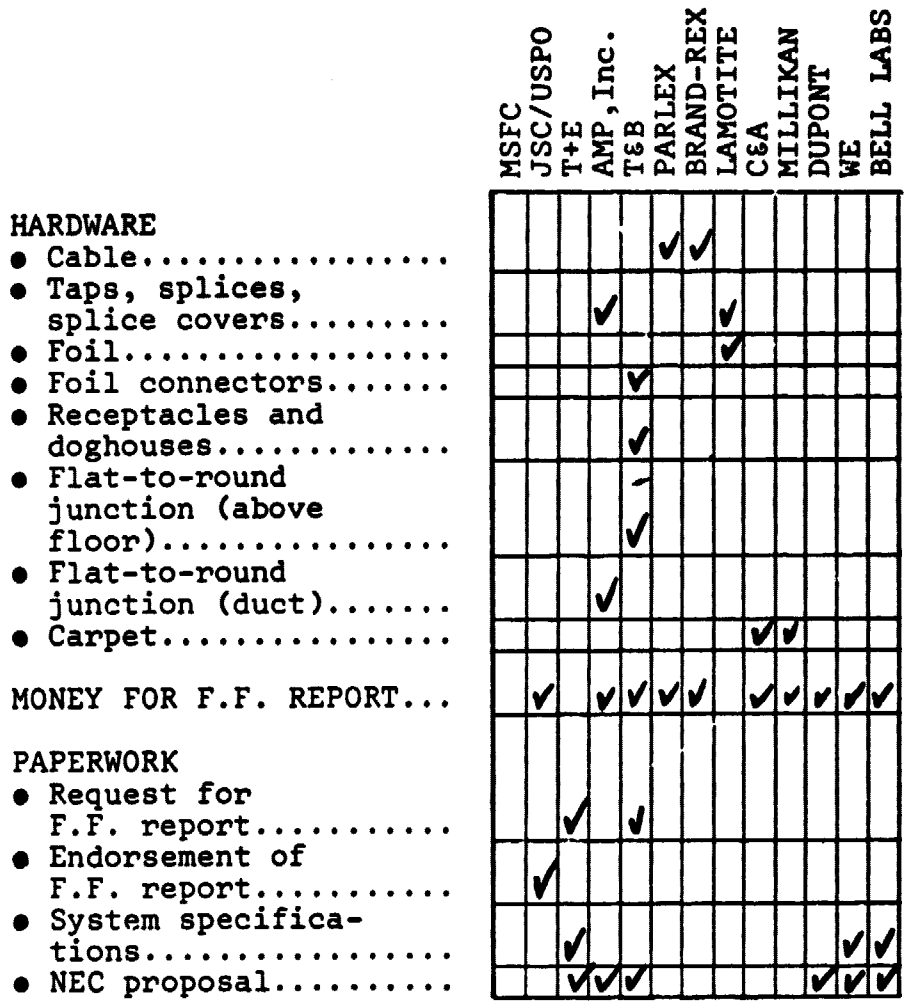
The installations went smoothly. The one problem that was noted at the time was with the undercarpet system: the installed system is excessively thick at splices and taps. This situation arose as a result of independed decisions by manufacturers to make their products slightly thicker than was specified. This problem does not affect UL testing, but will require future refinements in the design of certain components.

The distribution of financial support of the undercarpet system UL project was finalized this month, and the supporters were billed. The accompanying chart shows the distribution of financial as well as hardware and paperwork contributions to the UL and NEC efforts as they stand at the end of July.

It was not possible to generate any industrial support for the baseboard system study by the end of July. As a result, NASA is bearing complete responsibility at this time for supporting this effort. However, project participation continues to be explored, notably with Leviton Corporation and Hi-Temp Wires.

UNDERCARPET SYSTEM

HARDWARE/MONEY/PAPERWORK CONTRIBUTIONS TO UL AND NEC EFFORTS



A study that is related to the UCSP FCC implementation projects is beginning in July at the Center for Building Technology of the National Bureau of Standards. The study is being sponsored by the Department of Housing and Urban Development (HUD). Its specific topics are non-metallic sheathed cable (Romex), and flat conductor cable. The parts of the study that have relevance to the FCC project are:

- A literature search and evaluation on electrically-caused fires.
- Evaluations of parts of National Electrical Code (NEC) relating to prohibitions or restrictions on FCC.
- Laboratory investigations of fire and electrical safety aspects of FCC.

The HUD/NBS study will aid in increasing knowledge of and visibility of FCC systems. It will also provide documentation for the proposal to be submitted in December to change the 1978 NEC to permit use of FCC.

NBS plans to hold a symposium in the near future on FCC and Romex, in order to start a dialogue among industry, NAHB, unions, code bodies, etc., on these topics. T+E will be invited to make a presentaion. The symposium will also serve as part of a lobbying effort with the NEC Code panel aimed at gaining approval of our Code change proposal.

A final aspect of the July activity was an economic study on the effects of FCC on the demand for electricians in office construction. This study explores the interaction of three effects on electricians' time that are expected to result from the use of flat conductor cable in place of round wire. These three effects are:

- Alteration of electricians' time per installation as a result of a different installation process;
- increase in the amount of new and retrofit office construction occurring due to reduced electrification cost; and
- increase of the electrical component of building construction.

The conclusions of the study are:

- Although the total per-desk cost of power and communications wiring is reduced by use of FCC, the amount of electrician labor involved in unchanged.
- The reduction in electrification costs will increase office construction (and office electrification) by 4.1%.
- The reduction in electrification costs will increase the amount of electrification per office by 24%.
- The overall effect will be a 26% increase in electricians' time.

2.1.3 Summary of FCC Project Participation

URBAN CONSTRUCTION AND SAFETY PROJECT

Technology + Economics, Inc.

- Advocate project participation to industry.
- Assure that system as developed is user/market responsive.
- Coordinate hardware development: assure hardware compatibility.
- Interface between UL, industry, and government: hardware delivery, finances.
- Oversee drafting of system specs and NEC proposal.

GOVERNMENT PARTICIPANTS

Johnson Space Center -- Urban Systems Project Office

Carely Lively
Ted Hays

- Financial support for BB[1] and UC[2] systems.
- Letters of endorsement to UL.
- Advocacy of NASA/TU interests.

General Services Administration -- Public Building Service

Charles C. Law
James King

- User of UC system.
- Potential supporter of UL fact-finding.
- Demonstration installations

[1] "BB" = baseboard.

[2] "UC" = undercarpet.

Department of Housing and Urban Development -- Field Operations

Pierre Brosseau

- Potential user and supporter of BB system.

Department of Housing and Urban Development -- Policy Development and Research

Jim McCollom

- Funding for NBS investigation of Romex and FCC.

National Bureau of Standards -- Center for Building Technology

Lawrence Gallowin
William Meese

- Conduct HUD/PDR-funded study on Romex and FCC
  --laboratory studies of electrical and fire safety
  --performance standards for FCC
  --coordination with UL BB system study

New York State Urban Development Corporation (inactive)

David Pellish

- Initial advocate of surface-mounted wiring for masonry or concrete multi-family residential construction.
- Prototype installation.
- Corporation financial trouble curtailed involvement.

City of Baltimore

Tom Golden (GSFC)

- Possible user of BB system for renovation.

New York City Housing Authority

Eric Nadel

- Possible user of BB system.

INDUSTRY

AMP, Inc.

Jim Fleishhacker
Chuck Schaal
Ed Bunnell
August Kastel
Joseph Neigh

- Develop connectors, splices, taps, terminations for UL submission and marketing.
- Develop UC telephone system components.
- Provide FCC system cost information.
- Financial support for UL fact-finding.

Bell Labs -- Whippany, New York

Len Sessler

- General technical advice.
- Advice on Code proposal.

Brand-Rex Corporation

Irving Dwyer
Edward Brandeau
Joseph Marshall
Ken Brownell

- Cable for UL submission.
- Development of alternate cable constructions and materials.
- Cable testing.
- Financial support for UC fact-finding.

Collins and Aikman, Inc.

Lester Votava

- Carpet for UC fact-finding.
- Technical assistance on carpet/UC system interface problems.
- Financial support for UC fact-finding.

DuPont

Cutter Palmer

- Technical advice on insulation specifications.
- Assist UL and NEC efforts.
- Financial support for fact-finding.
- Manufacture insulating material.

General Electric (delayed involvement)

Tom Swetman

- Potential manufacturer of UC system components.

Hi-Temp Wires

Bill Stant
Bill Frogner

- Possible participation in BB system UL/NEC effort.
- Possible technical assistance in cable development.
- Possible marketer of cable.

Lamotite Products, Inc.

Robert Jackson
Robert Underhill
James Powers

- Specify and provide foil and non-metallic underlay for UC system.

Leviton

Saul Rosenbaum

- Develop GFCI/compensator systems.

  --in receptacles for BB system
  --in round-to-flat junction boxes for UC and BB system

- Financial support for BB system fact-finding.
- Potential developer of baseboard system.

Millikan, Inc.

Tony Williams
James Hester

- Carpet for UL fact-finding.
- Technical assistance on carpet/UC system interface problems.
- Financial support for UC fact-finding.

The Montgomery Company

James Devine

- Wire manufacturer.
- Possible assistance in cable product engineering.

Parlex

Chuck Surat

- Cable for UL submission.
- Cable testing.
- Market cable.
- Nominal support for fact-finding.

Thomas and Betts, Inc.

Ed Eldridge
David Beers
Manny Bromberg
Ray Piasecki

- Original request letter to UL for fact-finding study drafted.
- Develop foil connecting system and receptacle/doghouse for UC study at UL.
- Technical coordination with UL during fact-finding.
- Possible manufacture of cable through Ainsley subsidiary.
- Draft Code changes.
- Financial support for fact-finding.
- Ultimately intends to develop complete UC system for marketing.

Underwriters' Laboratories

H. E. Reymers Ed Coffey
Dick Gloyston Ed Krawiec

- Develop testing program and issue fact-finding reports on FCC systems.
- Advice in drafting Code proposal.

Western Electric -- Engineering Research Center

Jack Balde

- Critical catalyst -- large potential user, knowledgable, farsighted.
- Presentation of relative economics of FCC vs. conventional wiring.
- Assist development of industry participation.
- Assist development of system specifications.
- Technical advice on conduct of UL testing.
- Facilitate power/telephone system interface.
- Financial support for fact-finding.

Western Electric -- Plant Design and Construction

Harvey Mumford

- Potential user of UC system; system specifier.

2.2 THE NASA HOUSE AND COMPENDIUM

The NASA House, or "Project Tech" house is a concept for a house to be constructed to demonstrate applications of NASA technology and other state-of-the-art innovations to residential construction. The House is currently being evaluated for possible construction at Langley Research Center early in 1976.

Urban Construction and Safety Project team members have participated in this effort since its inception in 1974. Inputs to the project have included:

- A matrix of House components and functions versus sources of applicable technologies.
- An initial compilation of possible NASA technologies for inclusion.
- Advice on design philosophy and the criteria for including various technologies.
- A background paper by James R. Simpson, "Recent Demonstration-Type Houses in the U.S.A. -- A Brief Review".
- Assistance in soliciting inputs to the House from the various centers.
- Arrangement for the participation of the National Association of Home Builders (NAHB) Research Foundation in the design of the House, and of the Consumer Product Safety Commission (CPSC) to define needs for safety technologies.

An ongoing UCSP activity related to the NASA House project has been the development of a Compendium of NASA technology. The NASA House project has involved a survey of NASA technology applicable to homebuilding. In our own data base survey work, we have extended the scope of the search from homebuilding to general building construction and safety applications. The anticipated result will be a well-structured compendium document. Activities to date related to the Compendium have included:

- A preliminary scanning of all tech briefs to select those with possible applications to construction.
- Solicitation of general building-related technology inputs from the NASA centers in conjunction with the search for NASA House technologies.

The USCP has been involved in the following NASA House/Compendium relation activities in the past quarter:

- The UCSP participated in a May meeting between CPSC, NAHB Research Foundation, NBS, and NASA. The emphasis of the meeting was on the development of appropriate criteria for technology inclusion based on life-cycle costing concepts as well as consideration of relatively intangible criteria in areas such as product safety.
- Steps were taken in July to initiate a subcontract with the Research Foundation of NAHB to provide design input and general technical and evaluative assistance to the Langley project.
- As part of the UCSP team's July visit to Marshall Space Flight Center, a presentation of the NASA House project was made to a Systems Engineering Faculty Fellowship Program underway there this summer. The focus of this program was design for energy conservation. We met with the faculty members involved in the residential section of the program. We first presented a general introduction to our technology transfer activities and to the NASA House project. Then a discussion was held to solicit approaches and technologies for the Langley project. A broad discussion developed, concerning overall residential energy conservation strategies and the implications of the evolving structure of the residential construction industry.
- Jim Simpson visited Mr. Orville Lee of HUD as a followup to David MacFadyen's letter to him about the NASA House. Lee expressed interest in contributing ideas. He presented two ideas in particular: The first is a manufactured stud. The second is a scheme for providing plans for future alterations

and additions to "builder houses" at the time of first purchase. These plans would have the purpose of assuring safe and workable design of future modifications.

Future work on the NASA House project will depend on the form the House project takes, including the organizational structure for accomplishing it. For the time being, the UCSP's primary interface with the project, beyond participation in project meetings, will be via its NAHB Research Foundation subcontractor. Active work to develop the Compendium is planned for the coming fall and winter.

2.3 FLOOD INSURANCE STUDIES

As a consequence of recent legislation, the Federal Insurance Administration (FIA) of the Department of Housing and Urban Development (HUD) is required to perform surveys of all flood-prone communities in the United States in order to determine what flood insurance rates should be set for different areas of each community. In coming years, up to 20,000 communities will need detailed surveys, at a total cost of up to $750 million. Less than 1,000 communities have so far been surveyed. The remaining surveys will have to be performed quickly, to high standards of accuracy and in the face of formidable pressure to control the costs.

The FIA is seeking help from NASA to improve their flood insurance study methods. The Urban Construction and Safety Project has taken the responsibility to work with the FIA in identifying and assessing possible NASA technologies. Prior to the past quarter of project activity, James Simpson of Technology + Economics had completed and subsequently updated a paper entitled, "Potential for the Application of Advanced Technology to Flood Elevation Studies of the Flood Insurance Administration". This paper describes the general process of conducting a flood insurance study, and identifies the major constraints to their timely, accurate, and economical completion. Based on this work, four problem statements had been generated and disseminated. The first three of them relate to the three general areas of traditional flood insurance studies, namely:

- surveying
- hydraulic analysis
- map-making and reproduction

The fourth problem statement was designed to elicit totally new approaches to flood insurance studies, such as possible use of aerial or satellite imagery.

In the past quarter, there have been two significant UCSP activities related to flood insurance problems. The first was a visit with John Leo, a new Assistant Administrator in the Federal

Insurance Administration; the second was a visit with Rex Morton, a Marshall Space Flight Center technologist.

John Leo has recently taken over his present position by transfer fron HUD's Office of Research. He is disturbed by FIA's large flood study expenditures and particularly by the costs of surveying. He wants FIA to more aggressively seek out new technology to reduce the costs of these studies. He is interested particularly in the potential of satellite surveying.

Jim Simpson brought Leo up to date concerning our flood work to date, particularly our problem statements. His office has not yet reviewed the problem statements, but will do so soon. It was agreed that we then will redo the statements and proceed to disseminate them and find solution approaches from NASA.

Our visit to Rex Morton occurred in conjunction with a July trip to Marshall Space Flight Center's TU Office. Rex spent some time with us describing his work and demonstrating his equipment and facilities. Following a large spring flood in 1973, Rex supplied data, using standard techniques, to delineate the inundated areas in three local cities. Photographs were taken using false color IR film from a plane travelling at 12,000 feet. From these pictures, flood lines were drawn on a standard topographic map using a superimposing optical device.

Rex helped us to identify several issues that will be important in effectively accessing NASA technologies for flood studies. Most notably, the following items emerged:

- The crucial distinction in flood studies is whether one is looking for floods before or after the fact. By flyovers a database can be developed and maintained, but a distinction has to be made between normal years with a normally fluctuating database, and "wild" years, where there are particularly large fluctuations and particularly damaging floods. Observing the normal years does not develop a database that is applicable to the wild years.

- A problem in any kind of predictive work is that accurate topo-lines are needed, and small differences in elevation cannot easily be detected by simply looking downwards. Possibilities that were brainstormed are stereo pairs of photographs, holographic cameras that read out the third dimension, and sideways-looking radar. The accuracy of these approaches is likely to be insufficient for definitive flood insurance work. It may be useful, though, for initial, approximate work.
- One important application is digitization, which can be used, for example, to superimpose floodlines and topo-lines at significant cost savings. Work of this type is in progress at Marshall using computerized land classifications.

The UCSP's next steps in regard to flood insurance studies will be first to take advantage of FIA's offer to better define their problems, and then to initiate interfaces between FIA and NASA technologists who have possible solution technologies and processes.

2.4 TORNADO STUDIES

In response to Congressional interest in tornado problems and tornado-related research, the Urban Construction and Safety Project looked in some detail during the past quarter at possible applications of NASA technology to this field of study. In May, Jim Simpson, USCP Senior Scientist, interviewed nineteen administrators and scientists at different universities and government agencies to define the nature of the tornado problem and to assess the scope of current research and future research needs.

The results of this inquiry was a paper ertitled, "Tornado Related Building Research in the U.S.A.--A Brief Overview". The conclusions of this paper were as follows:

- The most damaging aspects of tornadoes appear to be the high winds, either alone or in combination with flying objects. The pressure drop at the vortex is felt to be less important.
- Current tornado-related research is primarily being carried out under the auspices of the National Science Foundation (NSF) and the National Oceanic and Atmospheric Administration (NOAA). NSF has been primarily studying the engineering aspects of the problem, while NOAA has been concerned with storm mechanisms.
- There is a clear need for more research, in practically every tornado-related area.

Inquiries are needed in the following specific areas:

- Meteorology: Studies are needed of the wind forces and pressure gradients generated by tornadoes; the conditions that trigger them; their rate and path of travel; and prediction and detection. An inexpensive and reliable warning device for those in tornado paths would be worthwhile.
- Fluid Mechanics: How wind interacts with buildings, especially in connection with flying objects.
- Structures: Failure modes; "minimum life-cycle cost" design methods.
- Analytical Modelling of the dynamic characteristics of storms and buildings.

- Wind Tunnel Work: Calibration, instrumentation, data for use in modelling.
- Reconnaissance and Storm Probing, to analyze storms in progress and to quickly assess storm damage.

In July, the UCSP inquired into the status of existing tornado work at NASA. In particular, an informative visit was made to Milton Huffaker, a Marshall Space Flight Center technologist who is studying dust devils in cooperation with the National Oceanic and Atmospheric Administration.

The main conclusion of this meeting was that although there is a large and well-coordinated program under the NASA Office of Applications to study tornadoes from a meteorological point of view, there appears to be no systematic work going on related to tornado damage and tornado-safe engineering. It would seem that a clear technology transfer opportunity exists in this area: there are likely to be a variety of hardward and software developed for other purposes that would be applicable to tornado problems.

As a way of promoting applications research of this type, the USCP is seeking to facilitate a cooperative research program between the University of Arkansas (U.A.) and NASA for this winter. Several NASA and U.A. technologists have been identified who could be involved in this program. Most notably, there is Dr. Lawrence Pleimann, who is moving from NASA/JSC to take a position on the U.A. faculty. Dr. Pleimann's primary research interest will be to develop "hard core" tornado shelter design concepts for critical buildings.

2.5 CONTROLLER FOR STATIONARY DIESELS

At the request of Johnson Space Center, T+E initiated a brief study in May with Technical Marketing Associates of Concord, Massachusetts on the market potential for a new NASA solid state control system for stationary diesels. The TMA study concluded that the NASA system is fully workable but does not represent a fundamental improvement over existing designs. In July, this study was presented to the JSC technologist, Leo Monford, who initiated the design. Leo felt that the market study missed certain important features of his design, notably its potentially much lower cost and its easy replicability. T+E considers the new controller to be of possible merit, and will take the step of identifying one or two large users of stationary diesel controllers who can work with Leo in evaluating his design and better specifying the areas of needed innovation.

3.0 OPERATIONAL CONSIDERATIONS

This final part of the report focuses on two particular aspects of the Urban Construction and Safety Project's mode of operation that the team has scrutinized as part of the past quarter's activity. These two aspects are

- our tech search and access activities, and
- our interaction with other NASA TU Program elements.

These are discussed in the following sections.

3.1 TECH SEARCH AND ACCESS

The Urban Construction and Safety Project at T+E has long recognized that the main constraint in the NASA technology transfer process has been the problem of how to effectively access NASA solution technologies. When problem statements are disseminated to field centers, feedback has for the most part been minimal. The reasons have not been clear. Possible reasons have been that the problem statements have not been widely enough disseminated at the centers or have not been disseminated to the right technologists; or that the technologists have been either not motivated or not able to respond.

In an effort to get to the root of this problem, T+E made the first of a planned series of visits to field centers in July. On July 9th and 10th, T+E visited the Technology Utilization (TU) Office at Marshall Space Flight Center (MSFC), as well as several center technologists. The purpose of the trip was not only to increase our understanding of center tech access procedures and constraints, but also to improve communications with the center visited and to survey available center technologies in several areas of current interest to us.

The first part of the meeting was built around a slide presentation of the purpose, context, and operation of the UCSP. The second part of the meeting was aimed towards obtaining feedback from the MSFC attendees. Aubrey Smith, the MSFC TU Officer, was first asked what he thought would be effective ways for us to interact with center technologists. Two primary scenarios for tech access activities were identified: (1) to brainstorm intensively with a small number of technologists (4 or 5) and cover perhaps three problem areas in one day; and (2) to choose 100 technologists who might have inputs, and circulate problem statements to them. The second approach has the advantage over the first of being less expensive.

Next the problem was addressed of why technologists may not respond to problem statements for which they have input. The following points emerged about the committments and motivations of technologists:

- The natural reaction of technologists <u>is</u> to want to solve problems.
- Technologists are constrained, however, by man-hour allottments that require that they spend their time in particular ways.
- It is therefore more a question of <u>facilitating</u> than <u>motivating</u> response to urban construction and safety problems.
- Technologists' inputs would be best facilitated by having time allottments and work account numbers for acting on problem statements.
- A discretionary budget to pay for technologists' work on Urban Construction and Safety problems could be made available through the TU Office from Bill Smith. An advance set-aside is also needed for shopwork.
- Our problem statements should be disseminated via the Lab Directors, in part because the Directors can best distribute them in useful directions, and in part because their authority will legitimize working on them.
- To accomplish this arrangement, it will be necessary to work from the ground up to establish communications with the Lab Directors (most Lab Directors don't know about the UCSP). This would be most appropriately the job of the TU Officers.

Thus, it appears that our tech access activities should follow the general NASA trend towards establishment of formal linkages, procedures, and budgeting. The availability of discretionary funds at the centers appears to be an essential element of any strong tech access program.

3.2 INTERACTION WITH OTHER NASA TU PROGRAM ELEMENTS

The focus of the UCSP's examination of its relationship to other Technology Utilization (TU) Program elements was a general TU Program conference in May that was attended by UCSP team members. The conference included a series of workshops for each program element. Several insights and policy directions emerged during the Technology Application Team (TATeam) workshop that are important to the operation of the T+E UCSP. They are as follows:

1. TATeam reporting must take full account of the information needs of Headquarters. These needs include: a schedule of major events; input to the NASA TU Report; Congressional testimony (preferably one year in advance); and documentation of all major exhibits, speeches, and demonstrations.

   In addition, there is Denver Research Institute's effort to document benefits of NASA TU activities. Case studies are very important; it was suggested that all TATeams start benefits notebooks related to their activites.

2. Applications Engineering projects should be taken advantage of to provide opportunities for the Centers to make RTOP proposals to NASA TU Headquarters.

3. NASA is instituting a new Commercial Opportunity Brief Program that may provide additional support for TATeam efforts to commercialize certain products such as the baseboard wiring system which have no commercial interests at this time.

4. When the process of accessing NASA technology was discussed, the ongoing problems of Center interest and TU Officer time availability were brough up. One promising suggestion was that technology searches and problem statements be disseminated to the patent counsels at each center.

5. Public technology, Inc. is working with a group of code officials of the major cities. They have assembled a user committee and may help to gain acceptance of flat conductor cable in major building codes.

6. Suggestions were solicited in two areas: The first area is new approaches to internally marketing TU within NASA. The second area is new fields of TATeam activity.

For the UCSP team, the general result of the meeting was a substantially increased awareness of the USCP's relationship to the TU program as a whole. There are important benefits to maintaining close relationships between UCSP and the total TU context: In particular, the position of the total TU program is enhanced when its elements, such are UCSP, are effectively reporting their activities and benefits to its central dissemination and advocacy functions, most particularly Headquarters. Conversely, by understanding the rest of the program, the UCSP is able to take advantage of complementary functions such as the Public Technology, Inc. user committee.