ROBOTIC TECHNOLOGY EVOLUTION AND TRANSFER

PRESENTATION TO THE AMERICAN INSTITUTE OF AERONAUTICS AND ASTRONAUTICS - SOCIETY OF AEROSPACE TECHNOLOGY TECHNICAL COMMITTEE

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WHY TECHNOLOGY TRANSFER

PUBLIC LAW 96-480/STEVEN-WYDLER TECHNOLOGY INNOVATION ACT OF 1980

(1) TECHNOLOGY AND INDUSTRIAL INNOVATION ARE CENTRAL TO THE ECONOMIC, ENVIRONMENTAL, AND SOCIAL WELL-BEING OF CITIZENS OF THE UNITED STATES

(2) TECHNOLOGY AND INDUSTRIAL INNOVATION OFFER AN IMPROVED STANDARD OF LIVING, INCREASED PUBLIC AND PRIVATE SECTOR PRODUCTIVITY, CREATION OF NEW INDUSTRIES AND EMPLOYMENT OPPORTUNITIES, IMPROVED PUBLIC SERVICES AND ENHANCED COMPETITIVENESS OF UNITED STATES PRODUCTS IN WORLD MARKETS

(3) MANY NEW DISCOVERIES AND ADVANCES IN SCIENCE OCCUR IN UNIVERSITIES AND FEDERAL LABORATORIES, WHILE THE APPLICATION OF THIS NEW KNOWLEDGE TO COMMERCIAL AND USEFUL PUBLIC PURPOSES DEPENDS LARGELY UPON ACTIONS BY BUSINESS AND LABOR. COOPERATION AMONG ACADEMIA, FEDERAL LABORATORIES, LABOR, AND INDUSTRY, IN SUCH FORMS AS TECHNOLOGY TRANSFER, PERSONNEL EXCHANGE, JOINT RESEARCH PROJECTS, AND OTHERS, SHOULD BE RENEWED, EXPANDED, AND STRENGTHENED (U.S. CONGRESS, 1980:SEC. 2)

CONCEPTS AND DEFINITIONS

THE CONCEPT OF TECHNOLOGY TRANSFER IS NOT A SIMPLE ONE:

- TO EXPLORE THE CONCEPT OF TECH-TRANSFER, A NECESSARY STEP IS TO CONSIDER THE IDEA OF TECHNOLOGY (Gee, 1974)

- MACHINES AND PHYSICAL TOOLS ARE COMMON REFERENTS FOR TECHNOLOGY (Doctors, 1963; Tornatzky et al. 1983)

- ...ANY TOOL OR TECHNIQUE, ANY PRODUCT OR PROCESS, ANY PHYSICAL EQUIPMENT OR METHOD OF DOING OR MAKING BY WHICH HUMAN CAPABILITY IS EXTENDED (Schon, 1969)

- TECHNOLOGY IS THE MEANS OR CAPACITY TO PERFORM A PARTICULAR ACTIVITY (Gruber and Marquis, 1968)

- TECHNOLOGY HAS BEEN DEFINED SIMPLY AS THE APPLICATION OF SCIENCE (Gee, 1974)

- WHEREAS SCIENCE IS CONCERNED WITH THE INCREASE OF KNOWLEDGE AND UNDERSTANDING, TECHNOLOGY IS DIRECTED TOWARD USE...THE OUTPUT OF TECHNOLOGICAL ACTIVITY IS A PRODUCT, PROCESS, TECHNIQUE, OR MATERIAL DEVELOPED FOR SOME SPECIFIC USE. TECHNOLOGY...CAN INCORPORATE INVENTIONS...PATENTS ARE MORE COMMONLY THE OUTGROWTH OF TECHNOLOGY RATHER THAN OF SCIENCE (Gee)
CONCEPTS AND DEFINITIONS

VERTICAL TECH-TRANSFER
• "...A GENERAL PRINCIPLE IS APPLIED TO PRODUCE A NEW PRODUCT, DEVICE, OR PROCESS WITHIN A GIVEN SCIENTIFIC OR TECHNICAL DISCIPLINE, AND, GENERALLY WITHIN AN ORGANIZATIONAL ENTITY SUCH AS A SINGLE CORPORATION OR GOVERNMENT AGENCY (Doctors, 1969)."

• "...THE VERTICAL FLOW OF TECHNOLOGY IS FROM A LABORATORY TO A GIVEN APPLICATION, IN A GIVEN DISCIPLINE (Essoglu 1975)."

HORIZONTAL TECH-TRANSFER
• "...SECONDARY APPLICATIONS, WHEREIN TECHNOLOGY WHICH ORIGINATES IN ONE SECTOR (SUCH AS AEROSPACE) IS USED IN ANOTHER SECTOR (SUCH AS URBAN TRANSPORTATION OR HEALTH... ) (Linhares, 1976)."

• "...ONE TECHNOLOGY IS ADAPTED TO A DIFFERENT AREA OF APPLICATION, GENERALLY ACROSS INSTITUTIONAL LINES. AN EXAMPLE MIGHT BE SEEN IN... THE USE OF A NEW METAL ALLOY DEVELOPED FOR A ROCKET ENGINE IN A BOILER FOR A STEEL MILL (Doctors, 1969)."

CONCEPTS AND DEFINITIONS

TECHNOLOGY TRANSFER
1) MOVEMENT OF TECHNOLOGY AFTER SOME TYPE OF ADAPTATION:
• "... THE PROCESS WHEREBY TECHNICAL INFORMATION ORIGINATING IN ONE INSTITUTIONAL SETTING IS ADAPTATED FOR USE IN ANOTHER INSTITUTIONAL SETTING... MORE THAN THE MERE DISSEMINATION OF TECHNICAL INFORMATION, IT IMPLIES THE ADAPTATION OF NEW TECHNOLOGY THROUGH A CREATIVE TRANSFORMATION AND APPLICATION TO A DIFFERENT END USE" (Doctors, 1969).

• "... THE PROCESS OF EMPLOYING A TECHNOLOGY FOR A PURPOSE OTHER THAN THAT FOR WHICH IT WAS DEVELOPED... TECH TRANSFER FOCUSES ON THE UTILIZATION OF PREVIOUS RESEARCH" (Foster, 1971).

2) MOVEMENT OF TECHNOLOGY BOTH WITH AND WITHOUT ADAPTATION:
• WHEN SCIENTIFIC OR TECHNICAL INFORMATION GENERATED AND/OR USED IN ONE CONTEXT IS REEVALUATED AND/OR IMPLEMENTED IN A DIFFERENT CONTEXT, THE PROCESS IS CALLED TECHNOLOGY TRANSFER (Bar-Zakay, 1970).

• "... AN EFFORT TO BRING THE RESULTS OF RESEARCH AND DEVELOPMENT TO NEW USERS... TECHNOLOGY TRANSFER CALLS FOR THE TRANSFORMATION OF RESEARCH AND TECHNOLOGY INTO PRODUCTS, PROCESSES, OR SERVICES; OR TO THE APPLICATION OF RESEARCH DEVELOPED FOR ONE PURPOSE TO A SECONDARY PURPOSE (Myran, 1978)."
FACTORS INFLUENCING TECH-TRANSFER

TECHNO-ECONOMIC FACTORS

- The degree of general connection of the technology to the firm's existing operations will affect the degree of success of adoption.
- The specificity of the relationship between the technology and some existing and recognized problem will affect the degree of success of adoption.
- The degree of urgency of the problem to which the technology was related will affect the degree of success of adoption.
- The quality of information received from the source about the innovation will affect the degree of success of adoption.
- Maturity of the technology will affect the degree of success of adoption.
- Availability of personnel to implement the technology will affect the degree of success of adoption.
- Availability of financial resources to implement the technology will affect the degree of success of adoption.

ORGANIZATIONAL FACTORS

- The degree of top management interest in the piece of technology will affect the degree of success of adoption.
- The degree of success of adoption will be influenced by the dimensions of organizational climate of the adopting organization.
- The degree of success of adoption will be higher in organizations where the use of confrontation in joint-decision making is higher.
- The degree of success of adoption will be higher in organizations where the use of smoothing in joint-decision making is lower.
- The degree of success of adoption will be higher in organizations where the use of forcing in joint-decision making is lower.
FACTORS INFLUENCING TECH-TRANSFER

COMMUNICATION FACTORS

- THE LEVEL OF COMMUNICATION NEEDS IS DEPENDENT ON TECHNOLOGY MATURITY AND THE "GAP" BETWEEN BASIC RESEARCH AND READINESS FOR APPLIED RESEARCH OF THE TECHNOLOGY (COMMERCIALIZATION)

TECHNOLOGY MATURITY

- INCREASED MATURITY IMPLIES LESS RISK AND UNCERTAINTY FOR THE COMMERCIAL ADOPTER, AND, THEREFORE, GREATER PROBABILITY OF SUCCESSFUL TECHNOLOGY TRANSFER. THE MORE MATURE THE TECHNOLOGY, THE MORE LIKELY IS THE FIRM TO ATTEMPT TO TRANSFER AND COMMERCIALIZE IT

FACTORS AFFECTING TECH-TRANSFER

FORMAL FACTORS

- METHOD OF INFORMATION DOCUMENTATION
- THE DISTRIBUTION SYSTEM
- FORMAL ORGANIZATION OF THE USER
- SELECTION PROCESS FOR PROJECTS (USERS' CONTRIBUTION)

INFORMAL FACTORS

- CAPACITY OF THE RECEIVER
- INFORMAL LINKER IN THE RECEIVING ORGANIZATION
- CREDIBILITY AS VIEWED BY THE RECEIVER
- PERCEIVED REWARD TO THE RECEIVER
- WILLINGNESS TO BE HELPED
BARRIERS IN TECH-TRANSFER

• DIFFERENCE IN "ATTITUDES" CAN CONSTITUTE A "TRANSFER GAP"
  • THE GAP BETWEEN IDEA AND Prototype
  • THE COMMUNICATIONS GAP BETWEEN ORGANIZATIONS
  • THE DISPARITY BETWEEN THE BUYER'S CONCEPT OF WORTH OF NEW TECHNOLOGY AND THE SELLER'S OPINION OF ITS VALUE
  • THE REFUSAL OF BUYERS TO RECOGNIZE THAT OUTSIDE TECHNOLOGY CAN BE VALUABLE TO THEM
  • A BIASED INTERPRETATION OF THE RISK VERSUS RETURN AXIOM
  • A TENDENCY ON THE PART OF MANY ORGANIZATIONS TO DISCOURAGE THE SALE OF A TECHNOLOGY EVEN WHEN IT WOULD BE TO THEIR BENEFIT TO DO SO (Evans, 1976:29-30).

• TECH-TRANSFER ORGANIZATION RELATIONSHIP WITHIN THE COMPANY
  • TECH-TRANSFER FUNCTIONS SHOULD BE UNCOUPLED FROM THE MARKETING, PRODUCTION AND R&D DEPARTMENTS
    • IDEALLY, A COMPANY SHOULD BUILD A TECH-TRANSFER TEAM THAT OPERATES IN THE NEW BUSINESS DEPARTMENT, ALTHOUGH, OF COURSE, THE TEAM WILL INTERFACE WITH THE R&D, MARKETING, AND MANUFACTURING FUNCTIONS (Foster, 1971:111).
  • ORGANIZATION FOR TECHNOLOGY TRANSFER SHOULD BE BASED ON PAIRING PROBLEMS AND CUSTOMERS

TYPES OF BARRIERS IN TECH-TRANSFER

• ENVIRONMENT BETWEEN THE R&D GENERAL SYSTEM (FEDERAL LAB, UNIV OR PRIVATE LAB) AND THE COMPANY GENERAL SYSTEM (USER TO WHOM THE TECHNOLOGY IS TO BE TRANSFERRED)

• ENVIRONMENT BETWEEN THE DEPARTMENTS AND DIVISIONS WITHIN THE LABORATORY OR COMPANY WHICH REPRESENT THE SUBSYSTEMS OF BOTH GENERAL SYSTEMS
  • BETWEEN THE GENERAL SYSTEMS
    1. NO FORMAL TRANSFER POLICIES
    2. COST BARRIERS
    3. TIME HORIZON CONFLICT
    4. INFRINGEMENT PROBLEMS
  • BETWEEN SUBSYSTEMS
    1. INERTIA BARRIER
    2. LACK OF AN INCENTIVE STRUCTURE
    3. COST BARRIER
    4. COMMUNICATION
    5. TIME BARRIER
    6. GEOGRAPHIC DISTANCE
    7. NON-EXISTENT TRANSFER MANAGEMENT STRUCTURE
    8. TECHNOLOGY BARRIER

• BETWEEN ELEMENT
  1. LACK OF AN INCENTIVE STRUCTURE
  2. HIGH RISK OF BEING BLAMED FOR FAILURE
  3. INSECURITY OF RETAINING JOB IF NOT SUCCESSFUL
  4. MUTUAL DISRESPECT
  5. UNIQUE REQUIREMENTS OF EACH SUBSYSTEM
  6. UPDATING OF TECHNOLOGY NEEDS
  7. TIME BARRIER
  8. LACK OF TRANSFER ORGANIZATION MANAGERS
ENHANCING FACTORS TO TECH-TRANSFER

INTERPERSONAL RELATIONSHIP

... THE MECHANISM OF TECHNOLOGICAL TRANSFER IS ONE OF AGENTS, NOT AGENCIES; OF THE MOVEMENT OF PEOPLE AMONG ESTABLISHMENTS, RATHER THAN OF THE ROUTING OF INFORMATION THROUGH COMMUNICATION SYSTEMS (Burns, 1969:12).

THE NATIONAL REFERRAL CENTER, A SERVICE OPERATED UNDER THE LIBRARY OF CONGRESS, HEARTILY SUBSCRIBES TO THE CONVICTION THAT SCIENTIFIC AND TECHNICAL INFORMATION IS MOST EFFECTIVELY TRANSFERRED FROM PERSON TO PERSON, NOT FROM MEDIA TO PEOPLE (Timmons, 1978: 34).

![KEY TECHNOLOGY TRANSFER FACILITATORS](chart)

THE ABOVE CONDITIONS WERE PERCEIVED BY THE RESPONDENTS TO BE THE GREATEST FACILITATORS OF TECHNOLOGY TRANSFER

* LACK OF INCENTIVES WAS A KEY BARRIER
ENHANCING ROLES IN TECH-TRANSFER

• TECHNOLOGICAL GATEKEEPER "EXPERT SCIENTIST TO THE WORLD OF SCIENCE"
  • IS ONE WHO CONTROLS A STRATEGIC PORTION OF THE TECHNICAL LEVEL OF THE
    COMMUNICATION CHANNEL (Brown, 1979) AND THE DIFFUSION OF INFORMATION
    WHICH IS A MULTI-STEP PATTERN

  • TECHNOLOGICAL GATEKEEPERS CREATE AWARENESS OF NEW PRODUCTS AND
    PROCESSES BY THEIR ABILITY TO ABSORB INFORMATION AND TRANSLATE IT INTO
    MORE UNDERSTANDABLE FORM NOT ONLY FOR THEIR COLLEAGUES BUT ALSO
    FOR TOP MANAGEMENT (Tornatzky et al 1983)

• TECHNOLOGICAL LINKERS "R&D MANAGERS"
  • OPERATES WITHIN THE ORGANIZATION WHICH RECEIVES THE
    KNOWLEDGE (Creighton, 1972)

MAJOR BARRIERS AND HINDRANCES TO TECH-TRANSFER

1. A TENDENCY TO ASSUME WITHOUT PROOF THAT THERE IS A RECEIVER FOR
   THE TECHNOLOGY, THAT IS, THAT SOMEBODY ACTUALLY WANTS IT AND
   WILL ACCEPT IT

2. LACK OF INTEREST AND SUPPORT BY TOP MANAGEMENT, THAT IS, THOSE
   WHO MAKE POLICY AND CONTROL THE NECESSARY RESOURCES

3. LACK OF INTEREST OR EFFORT BY MANAGERS AT THE LEVEL WHERE
   TECHNOLOGY TRANSFER WILL ACTUALLY BE IMPLEMENTED

4. FAILURE TO FIX RESPONSIBILITY AND ACCOUNTABILITY FOR GETTING THE
   JOB DONE

5. LACK OF AWARENESS OF THE VALUE OF TECHNOLOGY TRANSFER

6. LACK OF FUNDING FOR THE TRANSFER EFFORT

7. LACK OF PERSONNEL ASSIGNED TO THE TASK OR LACK OF SUFFICIENT
   TIME AVAILABLE TO THOSE WHO ARE ASSIGNED TO THE TASK

8. LACK OF NECESSARY KNOWLEDGE AND TRAINING FOR THOSE ASSIGNED
   THE TASK

9. RESTRICTIONS ON MOBILITY OF PERSONNEL

10. INDIFFERENCE TO TECHNOLOGY TRANSFER
MAJOR BARRIERS AND HINDRANCES TO TECH-TRANSFER (Cont'd)

11. POWER GAMES INTENDED TO MAINTAIN OR PROMOTE PERSONAL AMBITIONS, SUCH AS JOB PROTECTION, COMMERCIAL INTEREST, POLITICAL AMBITIONS, STATUS, OR CONTROL OF THE WORK SITUATION. USUALLY TAKES THE FORM OF SECRECY. (Hawthorne 1978)

12. POOR INTERPERSONAL RELATIONS – THE PARTIES REACT NEGATIVELY TO EACH OTHER

13. EXPECTATIONS OF ONE PARTY ARE NOT SHARED BY THE OTHER PARTIES

14. LACK OF CONTINUED ORGANIZATIONAL COMMITMENT TO THE EFFORT

15. PROMISING MORE THAN CAN BE DELIVERED

16. SOMEONE TAKING OFFENSE, WHERE NONE WAS INTENDED, AT A SUGGESTION THAT SOME ACTIVITY THEY ARE RESPONSIBLE FOR COULD BE IMPROVED

17. CULTURAL DIFFERENCES: ETHNIC, REGIONAL, NATIONAL, OR ORGANIZATIONAL

18. EMPLOYMENT SENIORITY SYSTEMS OR FEATHERBEDDING

19. DOCUMENTS TOO TECHNICAL FOR THE POTENTIAL USER TO UNDERSTAND

20. EXCESSIVE GOVERNMENT REQUIREMENTS FOR PRODUCT TESTING AND APPROVAL

KEY TECHNOLOGY TRANSFER BARRIERS

THE ABOVE CONDITIONS WERE PERCEIVED BY THE RESPONDENTS TO BE THE GREATEST BARRIERS TO TECHNOLOGY TRANSFER
### BAR-ZAKAY TECH TRANSFER EVOLUTION MODEL (1970) (Cont'd)

<table>
<thead>
<tr>
<th>STAGE</th>
<th>DONOR</th>
<th>BOTH</th>
<th>RECIPIENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>(ADAPTATION)</td>
<td></td>
<td></td>
<td>DECISION: GO/NO GO</td>
</tr>
<tr>
<td>IMPLEMENTATION</td>
<td>CONSIDER CAPITAL AND HARDWARE</td>
<td>RECRUIT RESOURCES</td>
<td>CONSIDER PEOPLE AND EMOTIONS</td>
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<td></td>
<td>OVERCOME PREJUDICE</td>
<td></td>
<td>BUILD Cohesive Organization</td>
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<td></td>
<td>PROVIDE TRAINING</td>
<td></td>
<td>PROVIDE Supporting Elements</td>
</tr>
<tr>
<td></td>
<td>OVERCOME RESISTANCE TO CHANGE</td>
<td></td>
<td>ENSURE BUREAUCRATIC SUPPORT</td>
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<tr>
<td>MAINTENANCE</td>
<td>DELEGATE AUTHORITY</td>
<td>RUN PILOT OPERATION</td>
<td>DECISION: GO/NO GO</td>
</tr>
<tr>
<td></td>
<td>ASSIST IN TROUBLE-SHOOTING</td>
<td></td>
<td>ENSURE COMPATIBILITY WITH SUPPORTING ELEMENTS</td>
</tr>
<tr>
<td></td>
<td>IDENTIFY DIVERSIFICATION POSSIBILITIES</td>
<td></td>
<td>EVALUATE SIDE EFFECTS</td>
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<tr>
<td></td>
<td>EVALUATE NET BENEFITS</td>
<td></td>
<td>PERFORM CONCURRENT R&amp;D</td>
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<td></td>
<td></td>
<td></td>
<td>EVALUATE NET BENEFITS</td>
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</tbody>
</table>

### BARRIERS THAT RESULTS IN PROJECT ATTRITION OR NO TRANSFER

**GAUNTLET OPEN SWITCH MODEL**

(OPEN SWITCHES)

- PERCEPTION OF NEED
- DESCRIPTION OF PROBLEM
- SEARCH FOR SOLUTIONS
- AWARENESS OF IDEAS
- EVALUATION OF ALTERNATIVES
- SELECTION
- MOTIVATION TO IMPLEMENT
- MOBILIZATION OF SUPPORT
- COMMITMENT - DECISION
- DEVELOPMENT
- ADAPTATION
- STEADY USE
TECHNOLOGY DEVELOPMENT STAGES

1. BASIC PRINCIPLES OBSERVED AND REPORTED
2. CONCEPTUAL DESIGN FORMULATED
3. CONCEPTUAL DESIGN TESTED ANALYTICALLY OR EXPERIMENTALLY
4. CRITICAL FUNCTION/CHARACTERISTIC DEMONSTRATED
5. COMPONENT/BRASSBOARD TESTED IN RELEVANT ENVIRONMENT
6. PROTOTYPE/ENGINEERING MODEL TESTED IN RELEVANT ENVIRONMENT
7. ENGINEERING MODEL SPACE QUALIFIED

TECHNOLOGY TRANSFER SYSTEM

THE PUBLIC

STATE/LOCAL AGENCIES

PRIVATE INDUSTRY

TECHNOLOGY TRANSFER

FEDERAL RESEARCH AND DEVELOPMENT
STRATEGIES FOR PROMOTING TECH-TRANSFER TO PRIVATE SECTOR

<table>
<thead>
<tr>
<th>TECHNOLOGY TRANSFER STRATEGY</th>
<th>PURPOSE</th>
<th>TRANSFER MECHANISMS</th>
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</thead>
<tbody>
<tr>
<td>PASSIVE</td>
<td>TO MAKE INFORMATION ACCESSIBLE TO THOSE INDIVIDUALS AND ORGANIZATIONS SEARCHING FOR SOLUTIONS TO CUSTOMER/SOCIETY PROBLEMS</td>
<td>TECHNICAL DATABASES NTIS</td>
</tr>
<tr>
<td>ROLE-DIRECTED</td>
<td>TO ACTIVELY PROMOTE AWARENESS OF NEW TECHNOLOGY TO INDIVIDUALS OCCUPying BOUNDARY-SPANNING ROLES IN ORGANIZATIONS</td>
<td>PROFESSIONAL JOURNALS AND SEMINAR PRESENTATIONS TARGETED TO CERTAIN DISCIPLINES</td>
</tr>
<tr>
<td>ORGANIZATION DIRECTED</td>
<td>TO ACTIVELY PROMOTE THE ADOPTION OF NEW PRODUCT OR PROCESS CONCEPTS TO INNOVATOR FIRMS IN AN INDUSTRY</td>
<td>TECHNOLOGY FAIRS INDUSTRY TEAMS</td>
</tr>
</tbody>
</table>

EVOLUTION PROCESS TO TECH-TRANSFER

GRUBBER 1976

1. INVENTORY OF TECHNOLOGY
2. RECOGNITION OF TECHNICAL FEASIBILITY
3. DESIGN CONCEPT FORMULATION
4. TECHNICAL EVALUATION ACTIVITIES
5. IDEA GENERATION
6. DEVELOPMENT FUNDING DECISION
7. R&D ACTIVITIES LEADING TO PROTOTYPE
8. PROBLEM SOLVING
9. COMMERCIALIZATION FUNDING DECISION
10. FINAL PRODUCT AND PROCESS DEVELOPMENT
11. MANUFACTURING AND SALES
12. CONSUMER ADOPTION AND USE

INVENTORY OF SOCIAL ECONOMIC HUMAN & ENVIRONMENTAL NEEDS AND PROBLEMS

RECOGNITION OF POTENTIAL DEMAND

MARKET RESEARCH AND EVALUATION ACTIVITIES

DEVELOPMENT ACTIVITIES

MARKET DEVELOPMENT ACTIVITIES

FINAL MARKET DEVELOPMENT ACTIVITIES
Japanese Space Related Organizations

NASDA: National Space Development Agency of Japan
ISAS: Institute of Space and Astronautical Science
ETL: Electro-Technical Laboratory
MEL: Mechanical Engineering Laboratory
JSUP: Japan Space Utilization Promotion Center
USEF: Institute of Unmanned Space Experiment Flyer
CRL: Communication Research Laboratory
SCR: Space Communication Research Institute
NTT: Nippon Telephone and Telegraph
NHK: Nippon Hoso Kyokai (Japan Broadcasting Company)
JCSAT: Japan Communication Satellite
SCC: Space Communication Company

NASDA: National Space Development Agency of Japan
ISAS: Institute of Space and Astronautical Science
ETL: Electro-Technical Laboratory
MEL: Mechanical Engineering Laboratory
JSUP: Japan Space Utilization Promotion Center
USEF: Institute of Unmanned Space Experiment Flyer
CRL: Communication Research Laboratory
SCR: Space Communication Research Institute
NTT: Nippon Telephone and Telegraph
NHK: Nippon Hoso Kyokai (Japan Broadcasting Company)
JCSAT: Japan Communication Satellite
SCC: Space Communication Company

R & D of Space Technologies

Launch/Operation
NASDA, ISAS

Development
NASDA, ISAS

Feasibility Research
NASDA, ISAS

Basic Research
National Labs
Universities

Qualification Level

Space Environment
Simulated Space Env.
Ground Environment
Lab. Environment

X-10 X-5 X-0
Rough Year
NASDA's Space Robotics and AI

R&D Plan

( Operation )

( Development )

National Space Development Agency of Japan

Development of JEM

Phase-1 Research (FY87-91)
Prototype Algorithm

Phase-0 Research (FY87-92)
Pre-Research Study

Development of ETS-VII

Phase-2 Research (FY91-94)
Onboard Algorithm

Phase-1 Research (FY93-)
AI System Application Study

ETS-VII On-orbit Experiments

Development of ETS-VII

Phase-3 Research (FY95-)
Third Generation

Development of OSV

• Lunar/Planetary Exploration
• Autonomous Satellite

Generation of Space Robots

Ground Segment

Second Generation: Teleoperation

Ground Controller

Operator

Data Relay Satellite

Sensing & Perception

Onboard Controller

Manipulator

Astronauts

Third Generation: Autonomous

First Generation: Proximity Operation

Space Segment

Operator

Teleoperator

Ground Controller

Data Relay Satellite

Onboard Controller

Manipulator

Astronauts

T3-14
ENVIRONMENTAL CONDITIONING FOR TECH-TRANSFER

- Organization Identity
- Urgency of the Problem
- Specificity of the Relationship Between the Technology and Some Existing Problem
- Use of Smoothing in Joint Decision Making
- Org Risk Taking
- Connection of the Technology with Current Operations
- Availability of Funds
- Availability of Person
- Maturity of the Technology
- Quality of Information About the Technology
- Success of Adoption