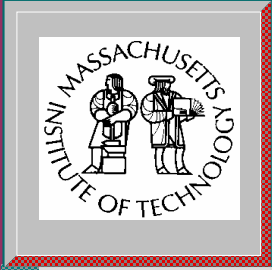


Massachusetts Institute of Technology Sloan School of Management

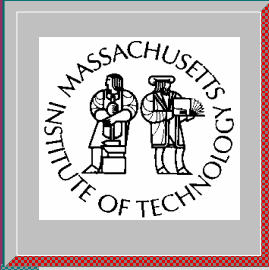
Executive Programs

Prof. Tom Allen, MIT



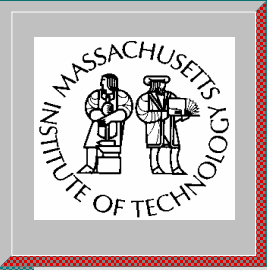
Knowledge Management

- **Gaining Knowledge**
 - Technology Transfer
 - Between Organizations
 - Within Organizations
 - Gatekeepers
- **Disseminating Knowledge**
 - Technical Communication
 - Organization Structure
 - Physical Structure of Facilities

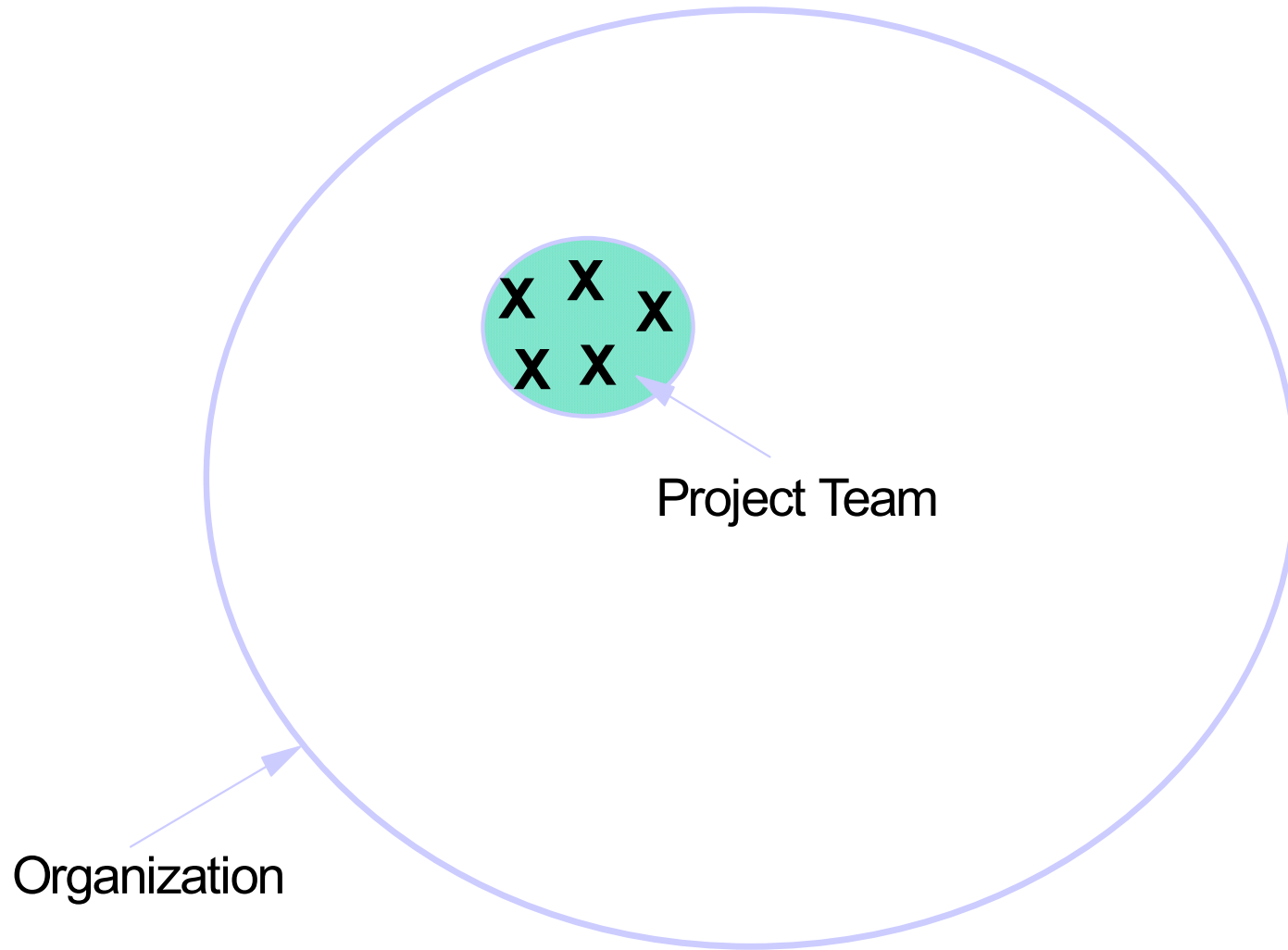


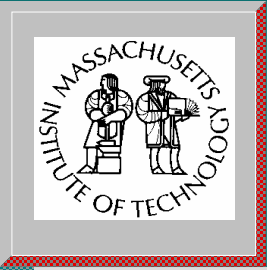
What do we know about technology transfer?

- It is a 'people process'.
- Transferring documentation is, at best, an auxiliary process.
- People must be in direct contact and understand each other to transfer knowledge.
- The best 'package' for knowledge is the human mind.
- Moving people is the most effective way to move knowledge
- This can imply either organizational or geographical movement.
- Organizational boundaries impose a serious barrier to the transfer of technology
- This is due to the development of different organizational cultures.

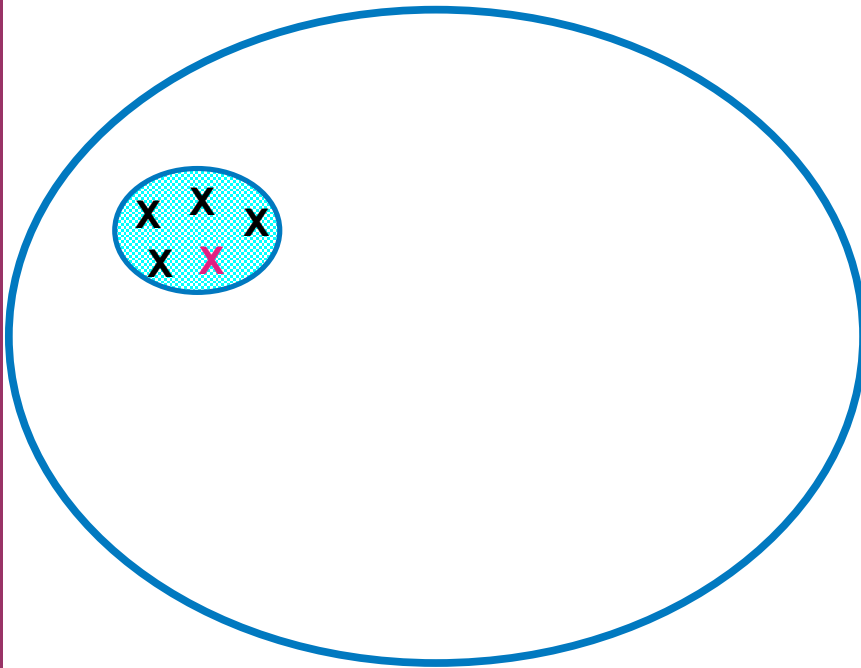


The Context of the Study

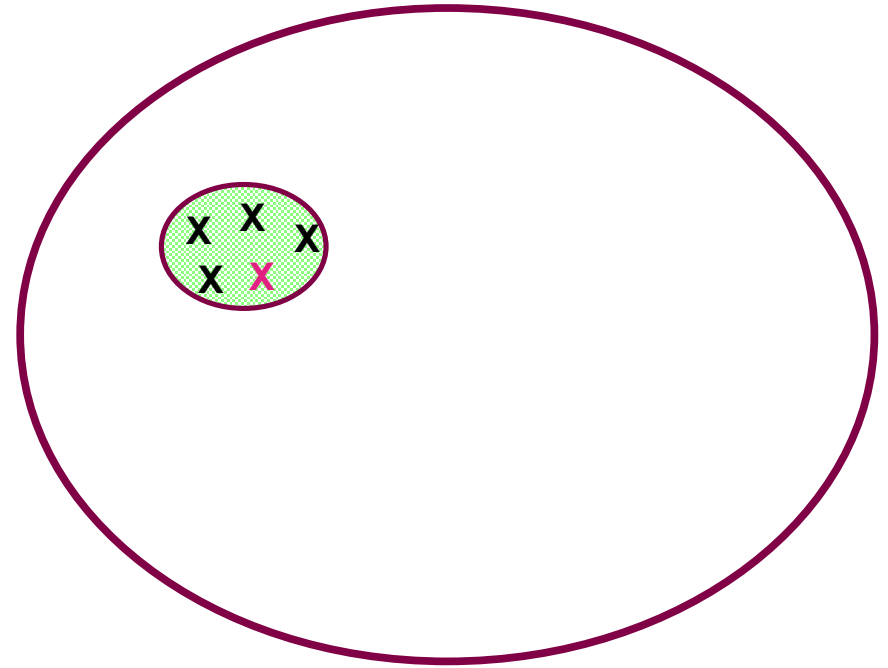




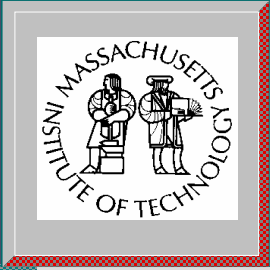
'Twin' Projects



Company 'A'

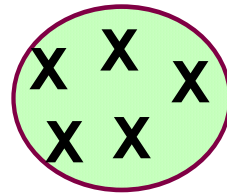


Company 'B'



Sources of Technology

Outside
Experts

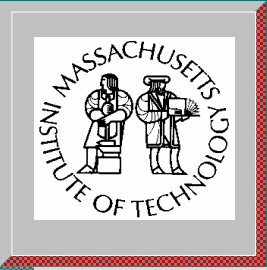


Internal
Staff



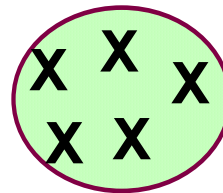
Literature





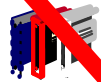
Literature & Documentation

Outside
Experts



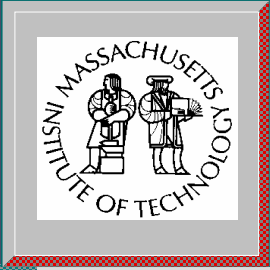
Internal
Staff

~~Literature~~



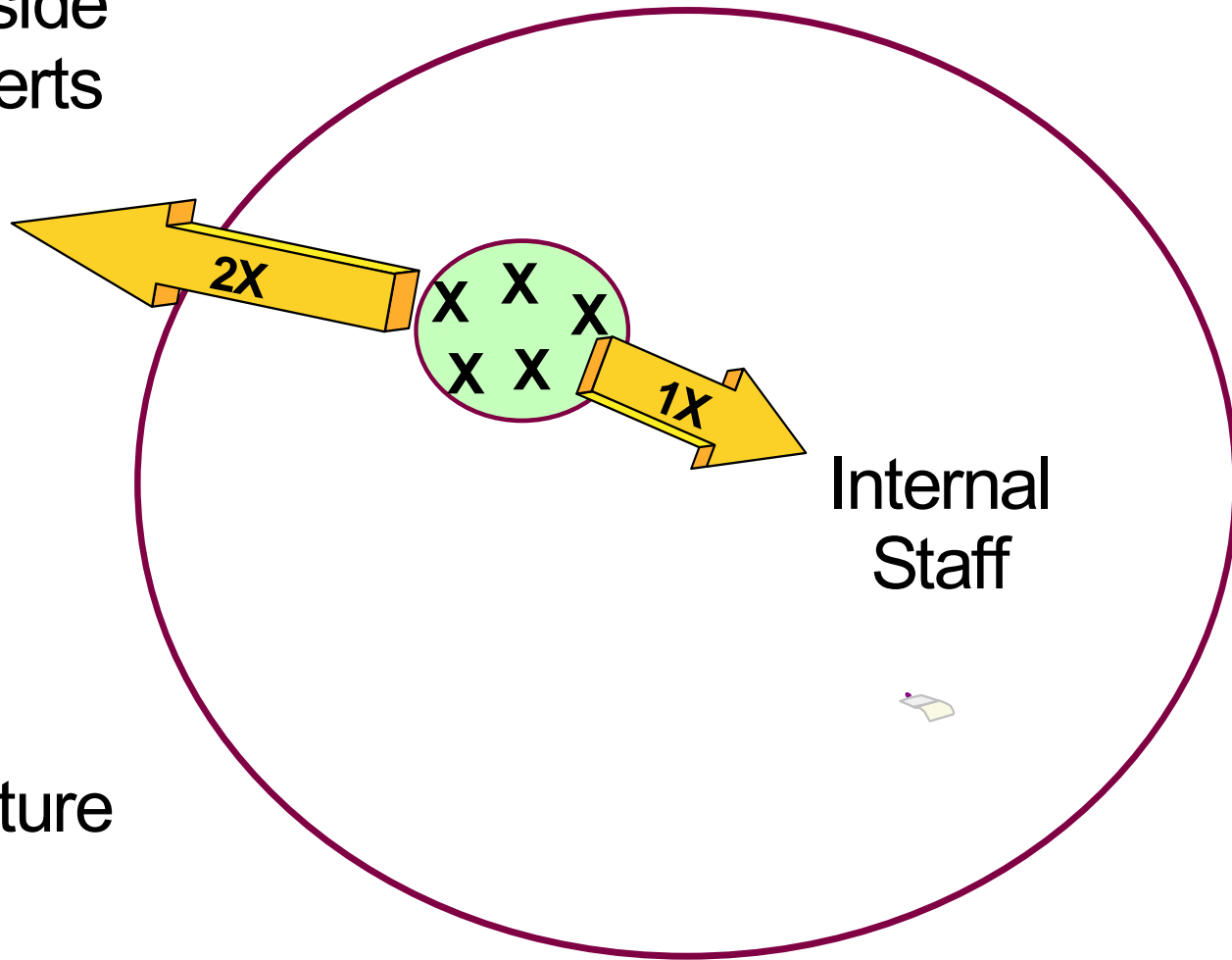
18%

4%



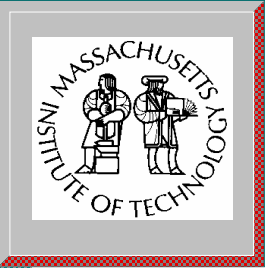
People as Sources of Technology

Outside Experts

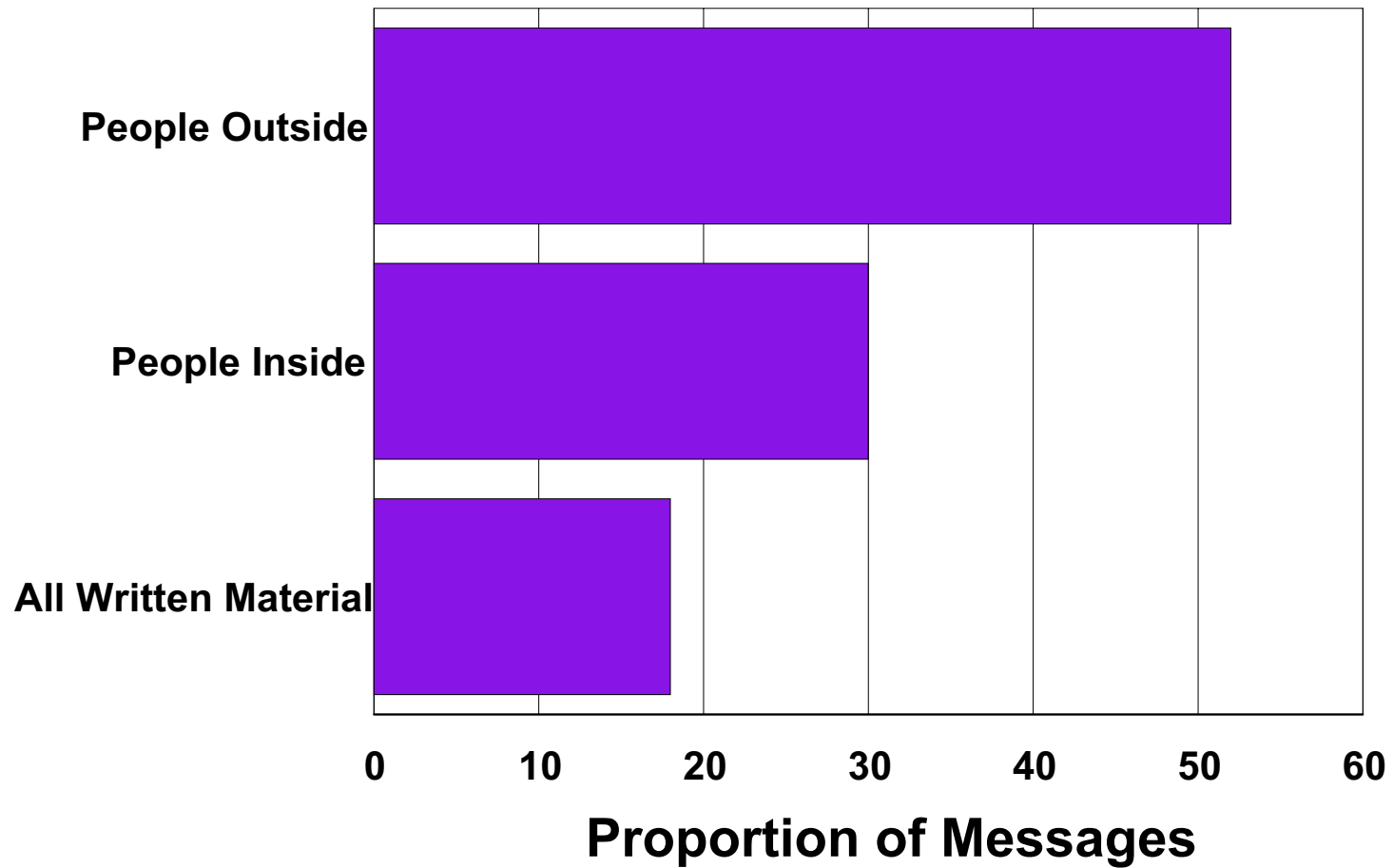


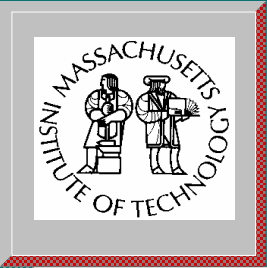
Literature





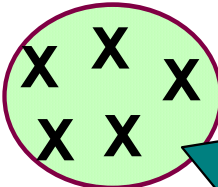
Technology Sources for Product Development Projects





People as Sources of Technology

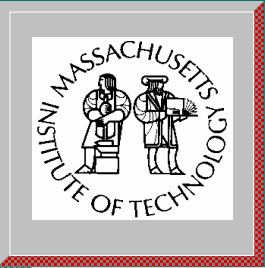
Outside Experts



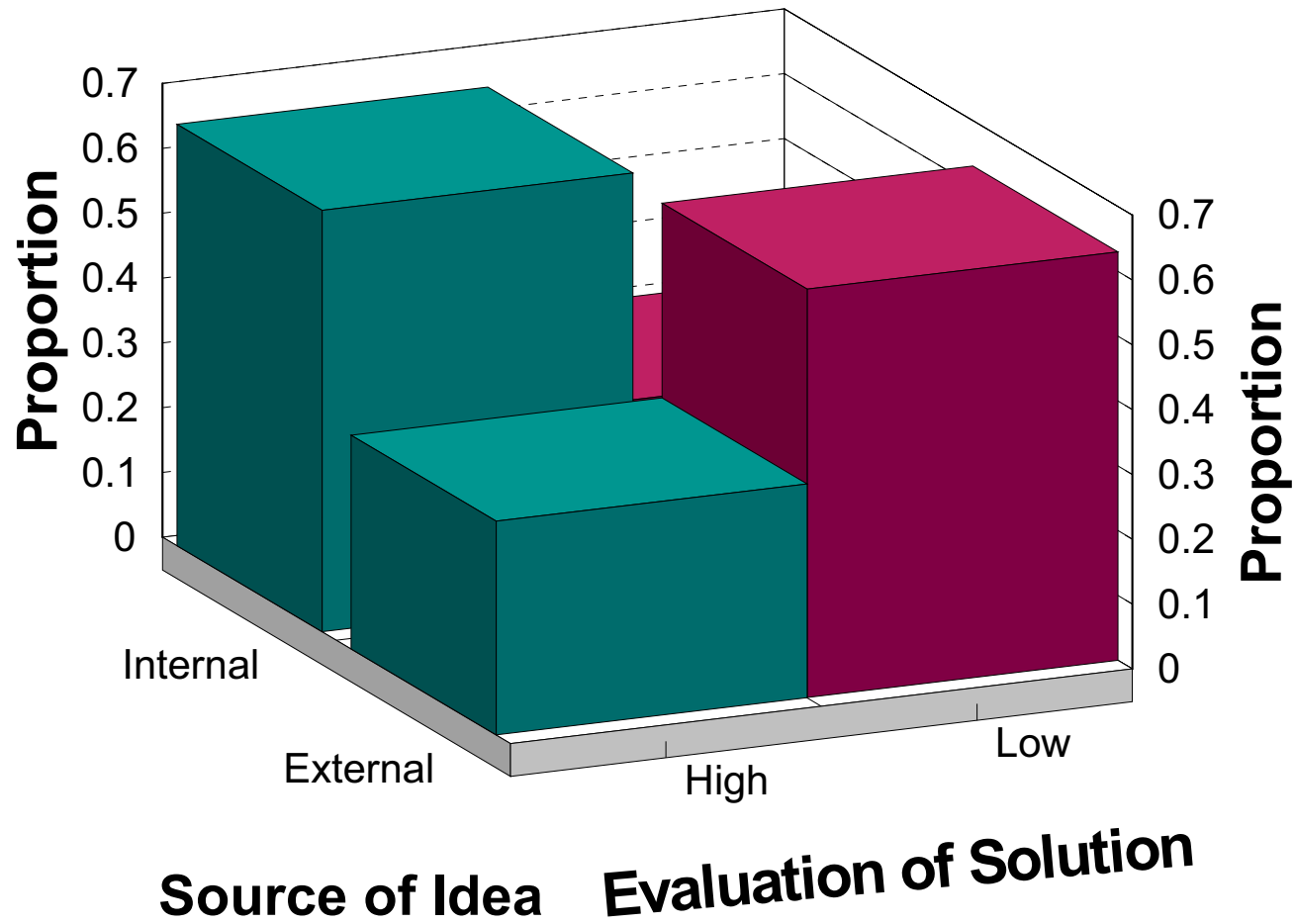
Internal Staff

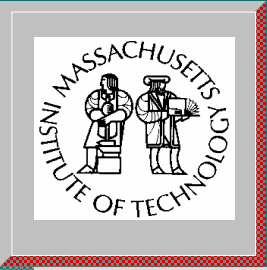
Literature





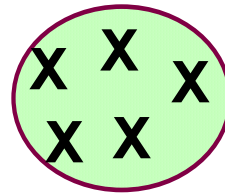
Customer Evaluation of Solutions as a Function of Idea Source





'Boundary Impedance' of the Organization

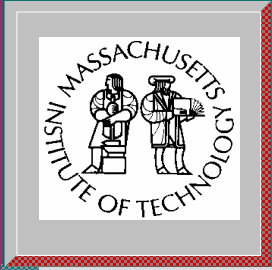
Outside Experts



Internal Staff

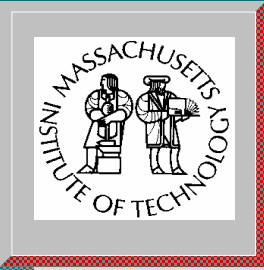
Literature





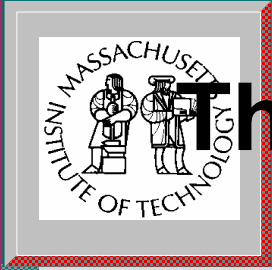
Science and Technology

- Science is Universal.
- Technology is *Local*.



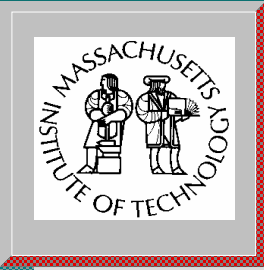
Technology

- Technology is defined in terms of:
- The Business Goals
- The Marketing Strategy
- and most importantly,
- The Culture
- of the organization in which it is developed.
- Technical problems are thus defined in terms of that culture and its system of values.

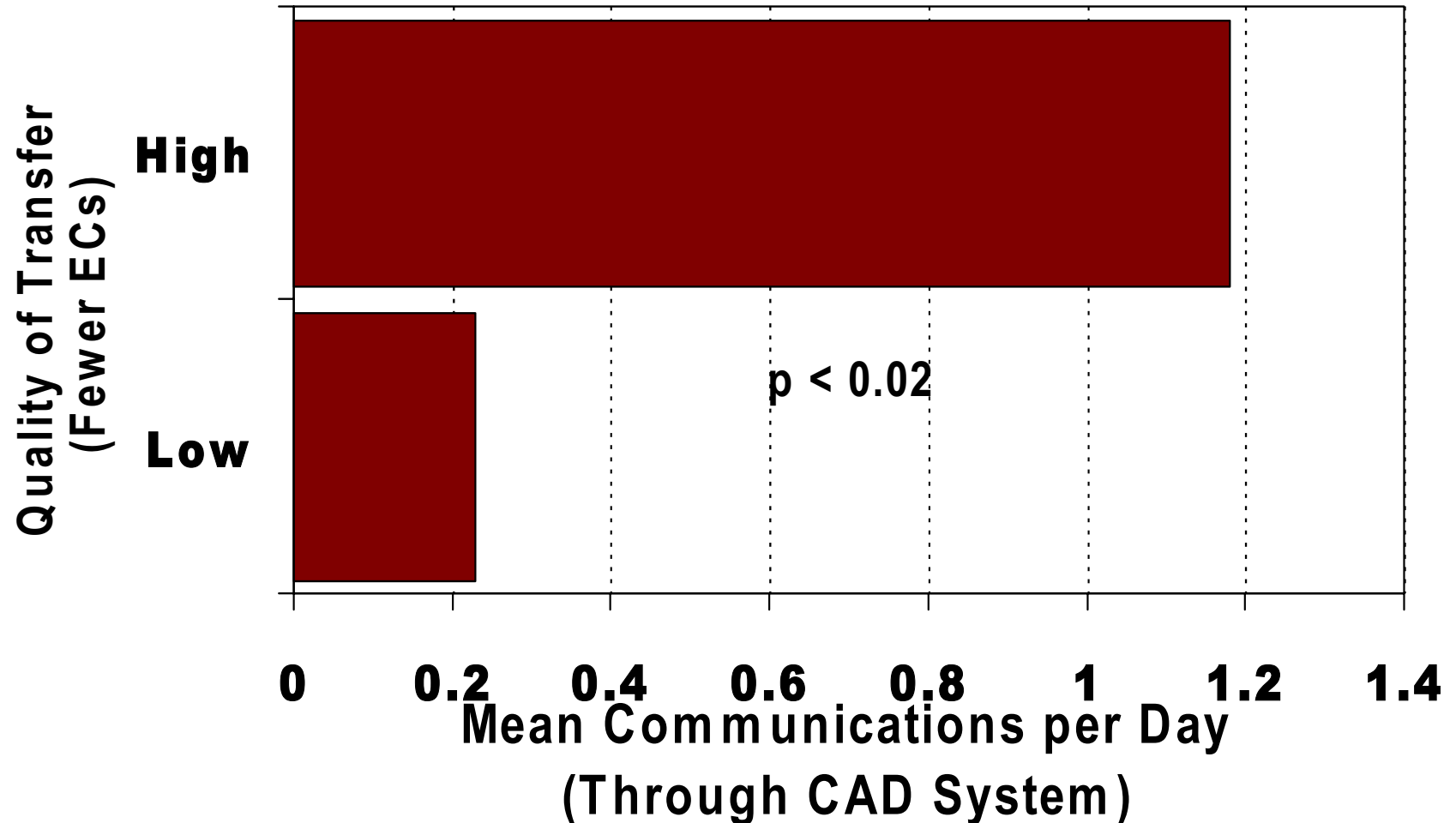


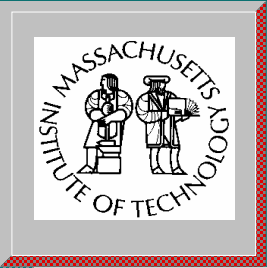
The Local Nature of Technology

- This implies that:
- Anyone outside of the organization cannot fully understand the way that those within the organization define technical problems without understanding the organization's culture.
- This difficulty in understanding the problem is the principal barrier to technology transfer.
- Barriers of this sort arise any time that we try to transfer knowledge across organizational boundaries.
- It thus holds true for internal communication as well as communication with other organizations.
- It is one of the causes of poor interfunctional relations in organizations.

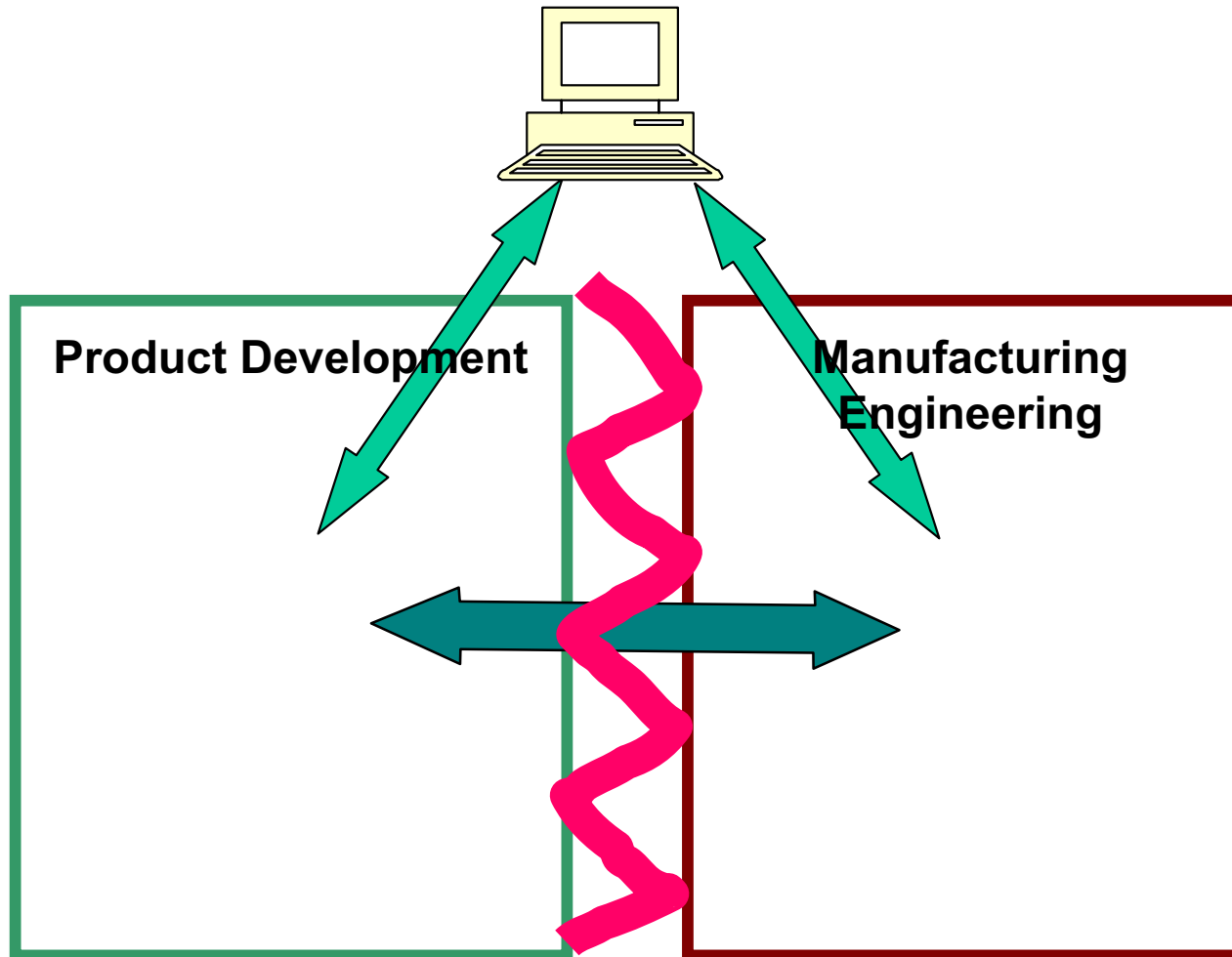


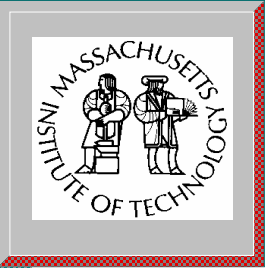
Performance in Transferring Designs to Manufacturing as a Function of CAD System Use for Communication



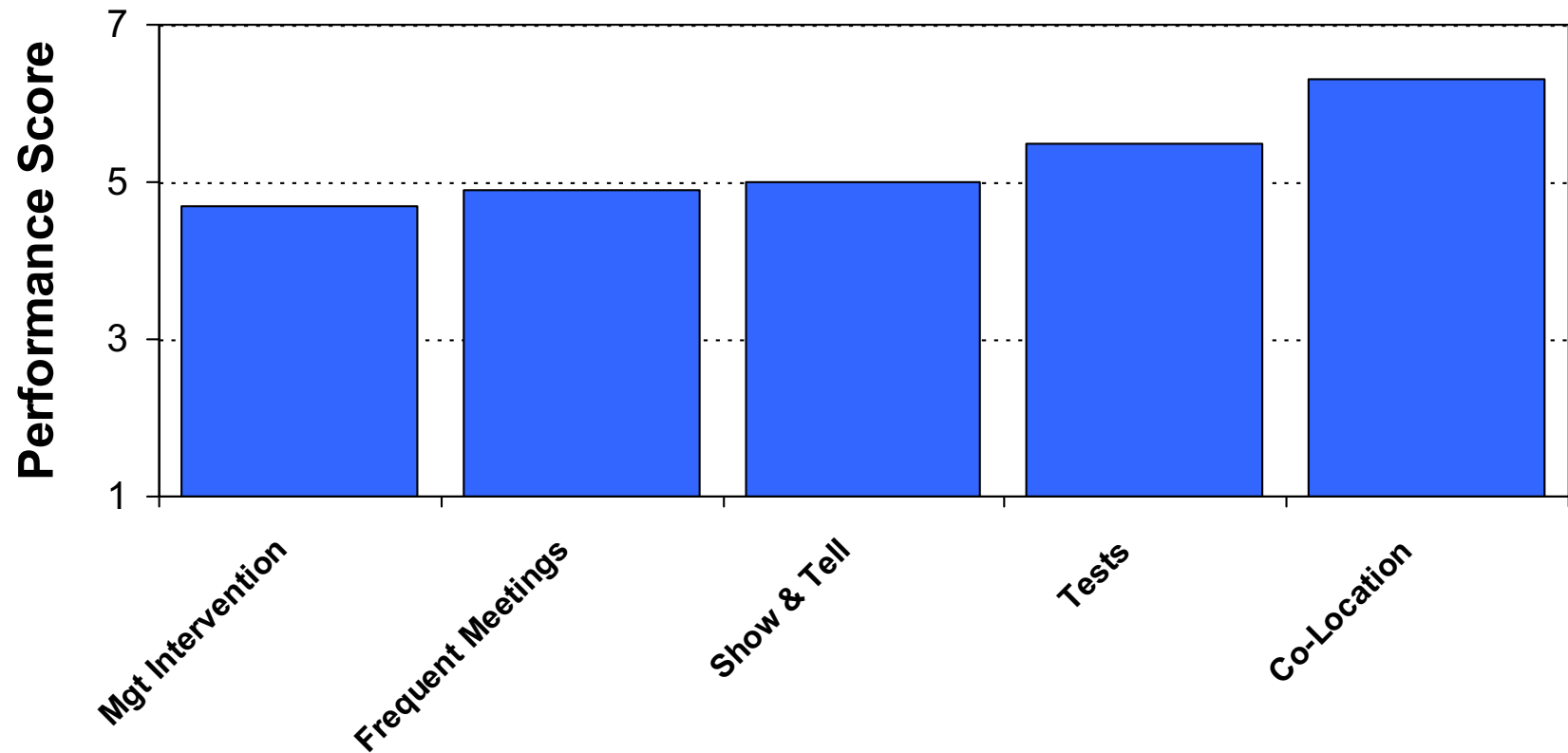


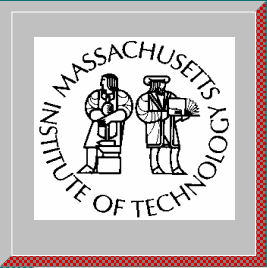
Using a Common Reference to Reduce Ambiguity in Communication



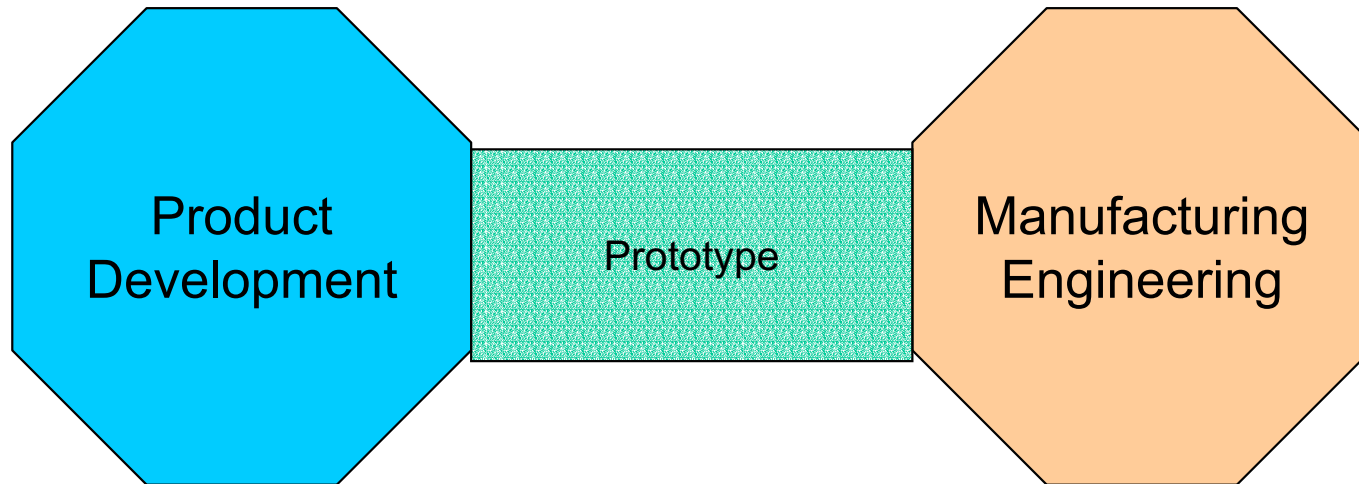


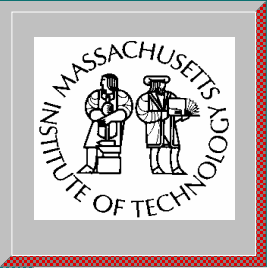
Effectiveness of Strategies for Reaching Common Understanding of Problems by Product Development and Manufacturing Engineering





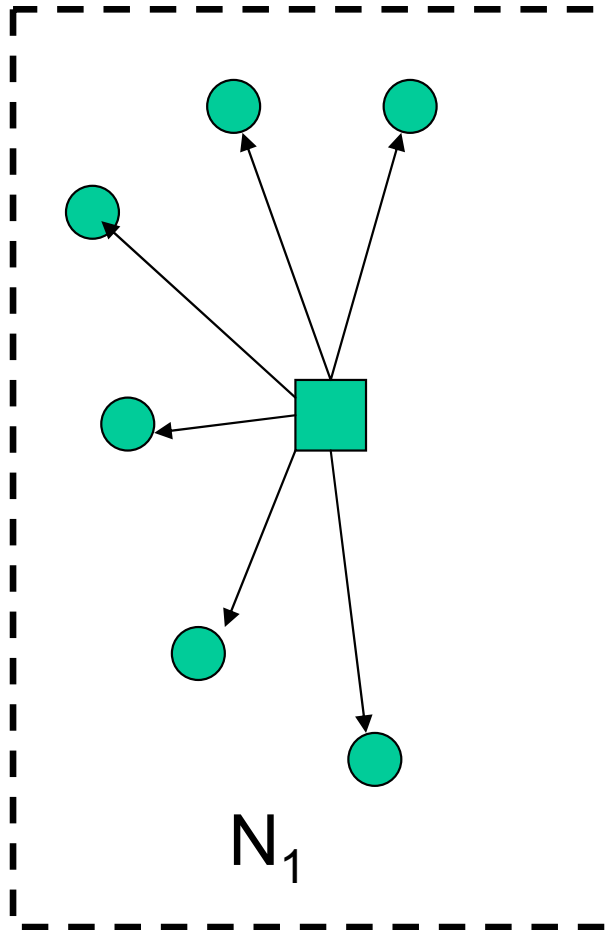
Partial Layout of the BMW Forschung und Ingenieurung Zentrum



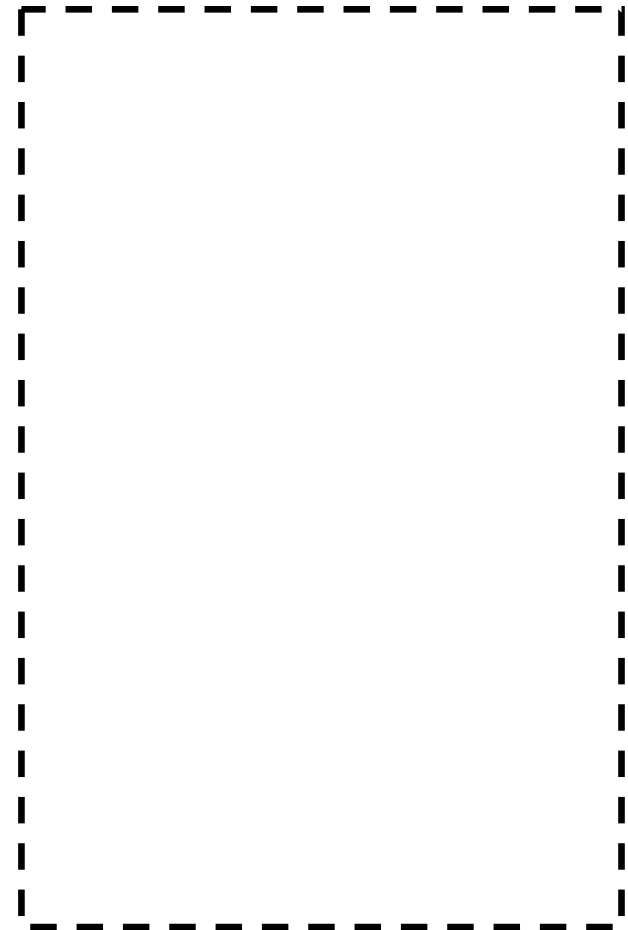


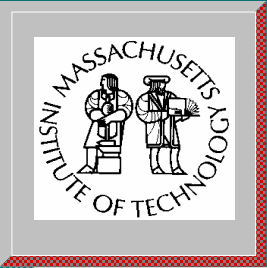
The Effect of Transfers

A

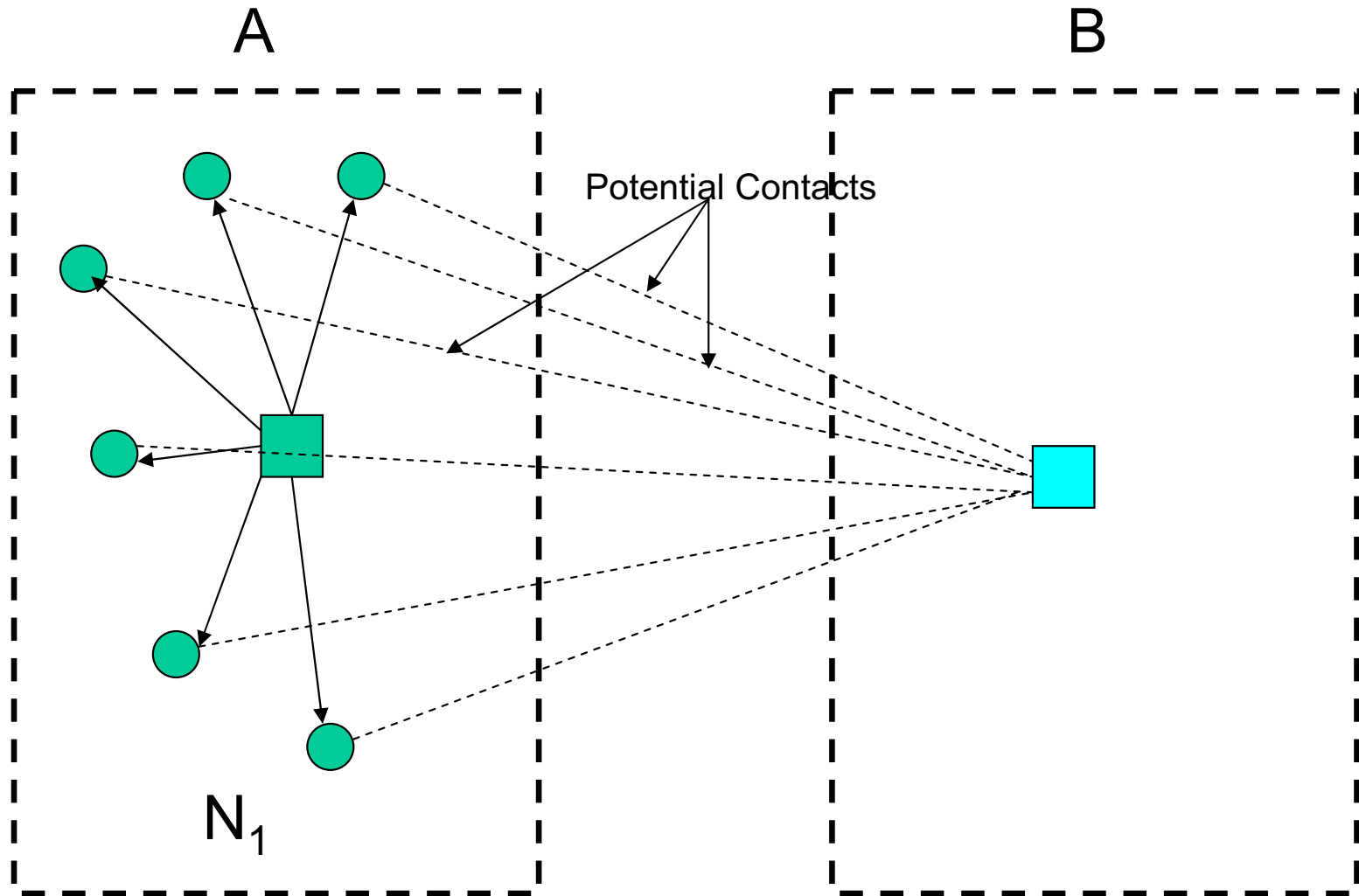


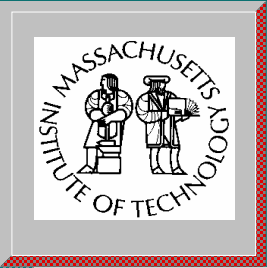
B



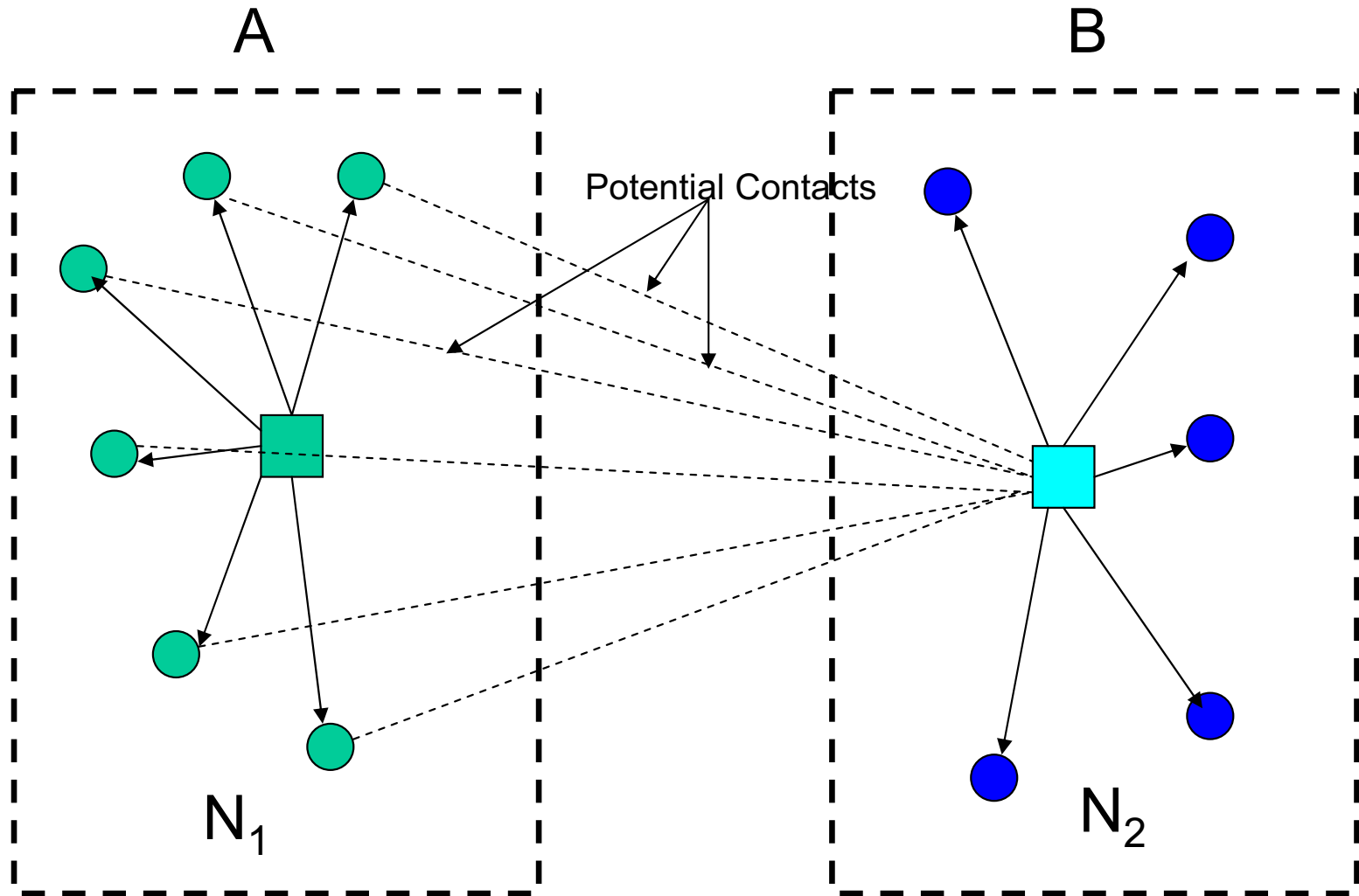


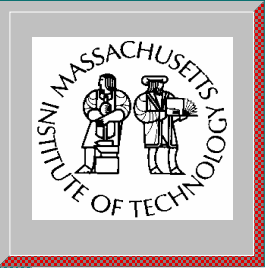
Continuing Relations



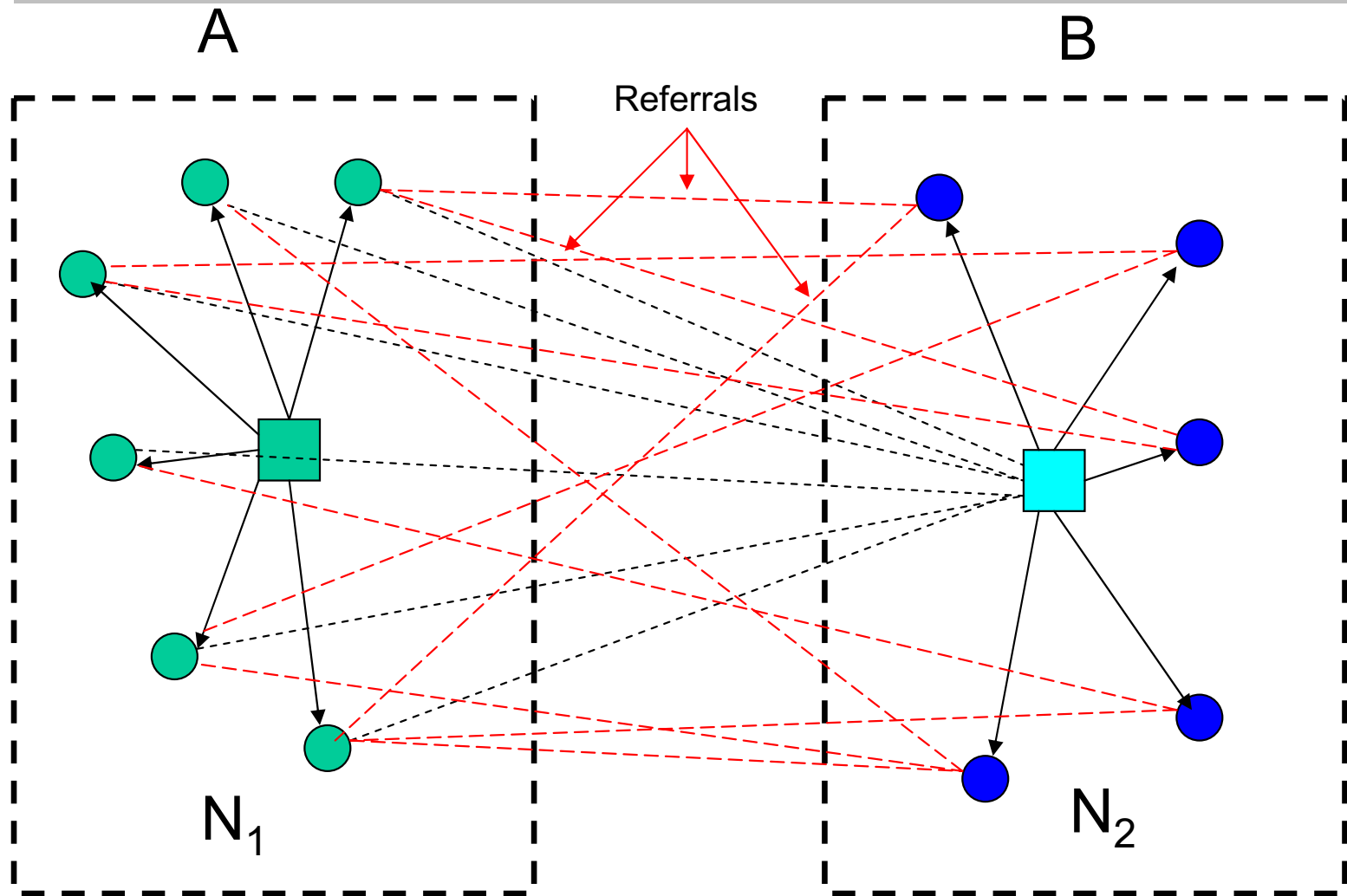


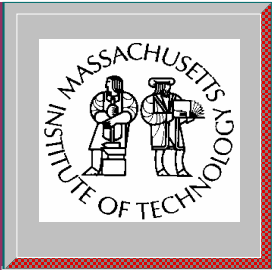
More Continuing Relations



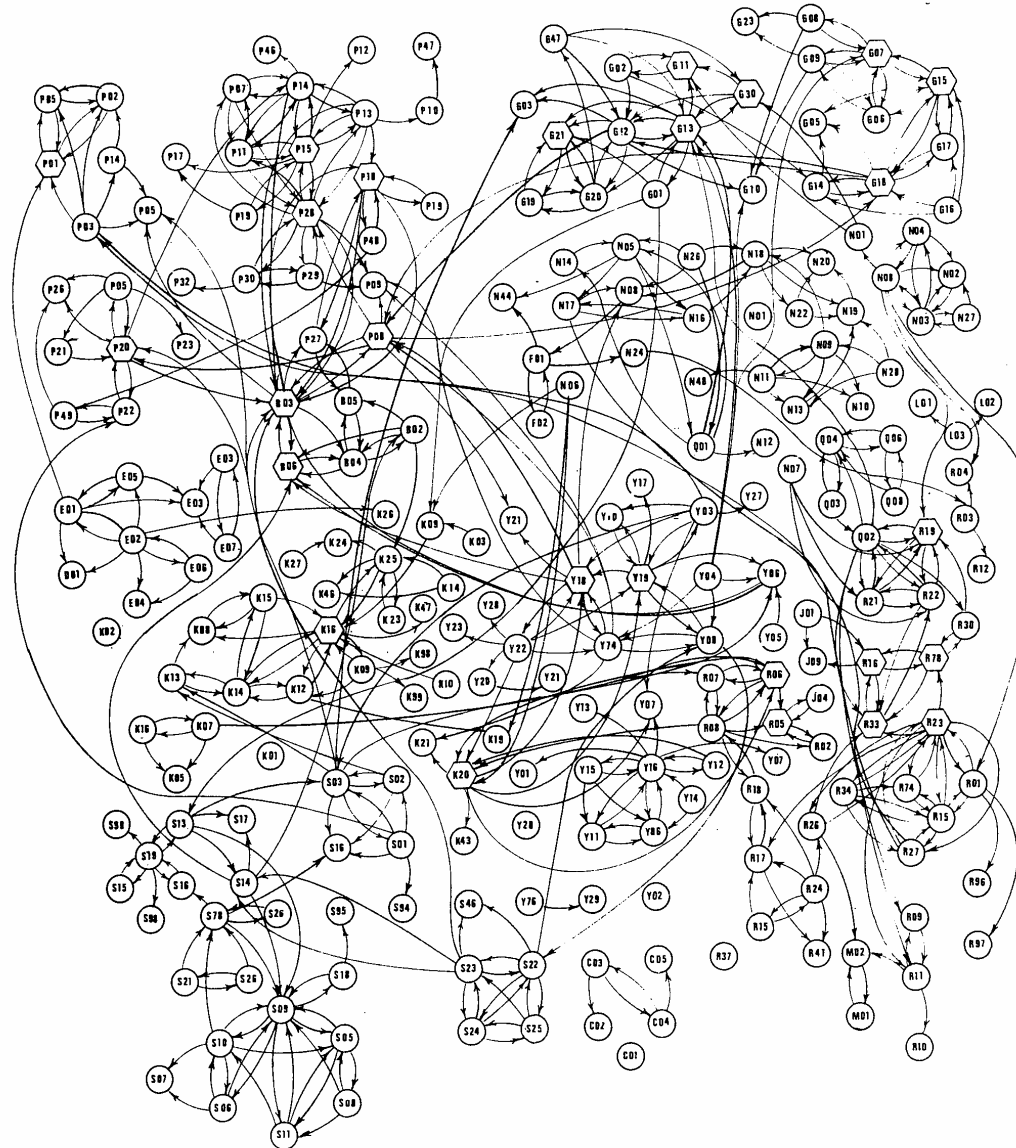


Referrals



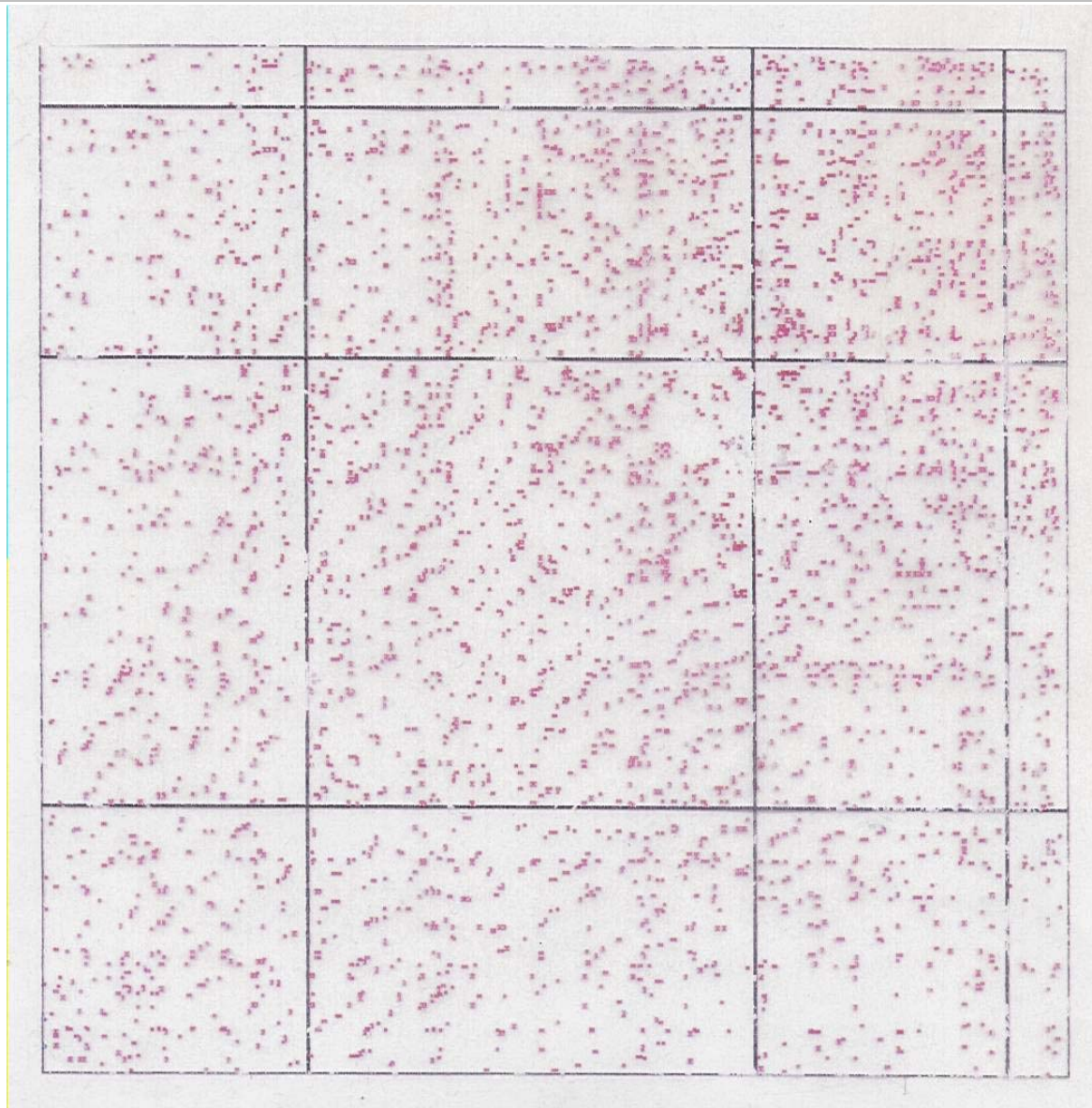


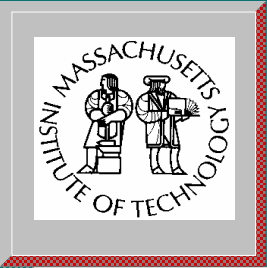
A Typical Technical Communication Network





Netgraph of Communication Among Software Developers ($N > 600$)



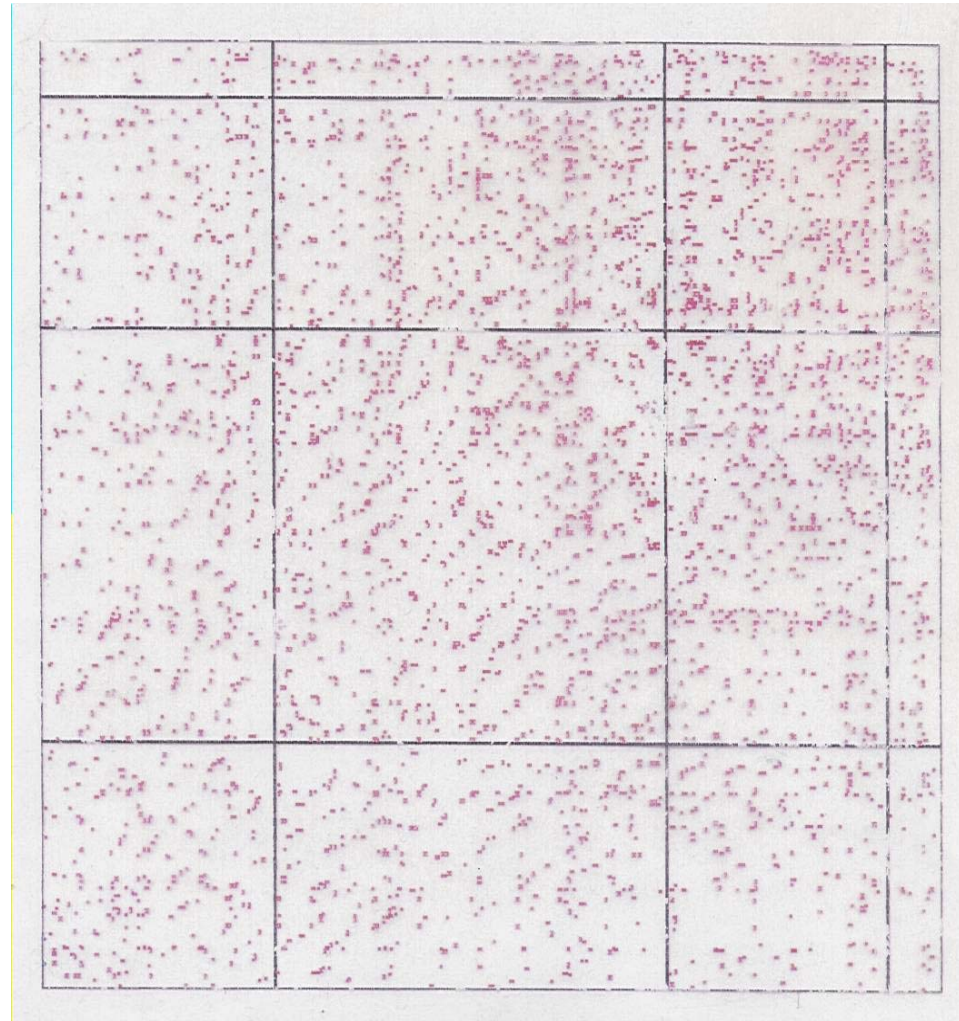


Netgraph of Communication Related to Age

50
Year
Olds
40
Year
Olds

30
Year
Olds

20
Year
Olds

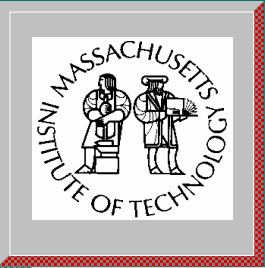


20
Year
Olds

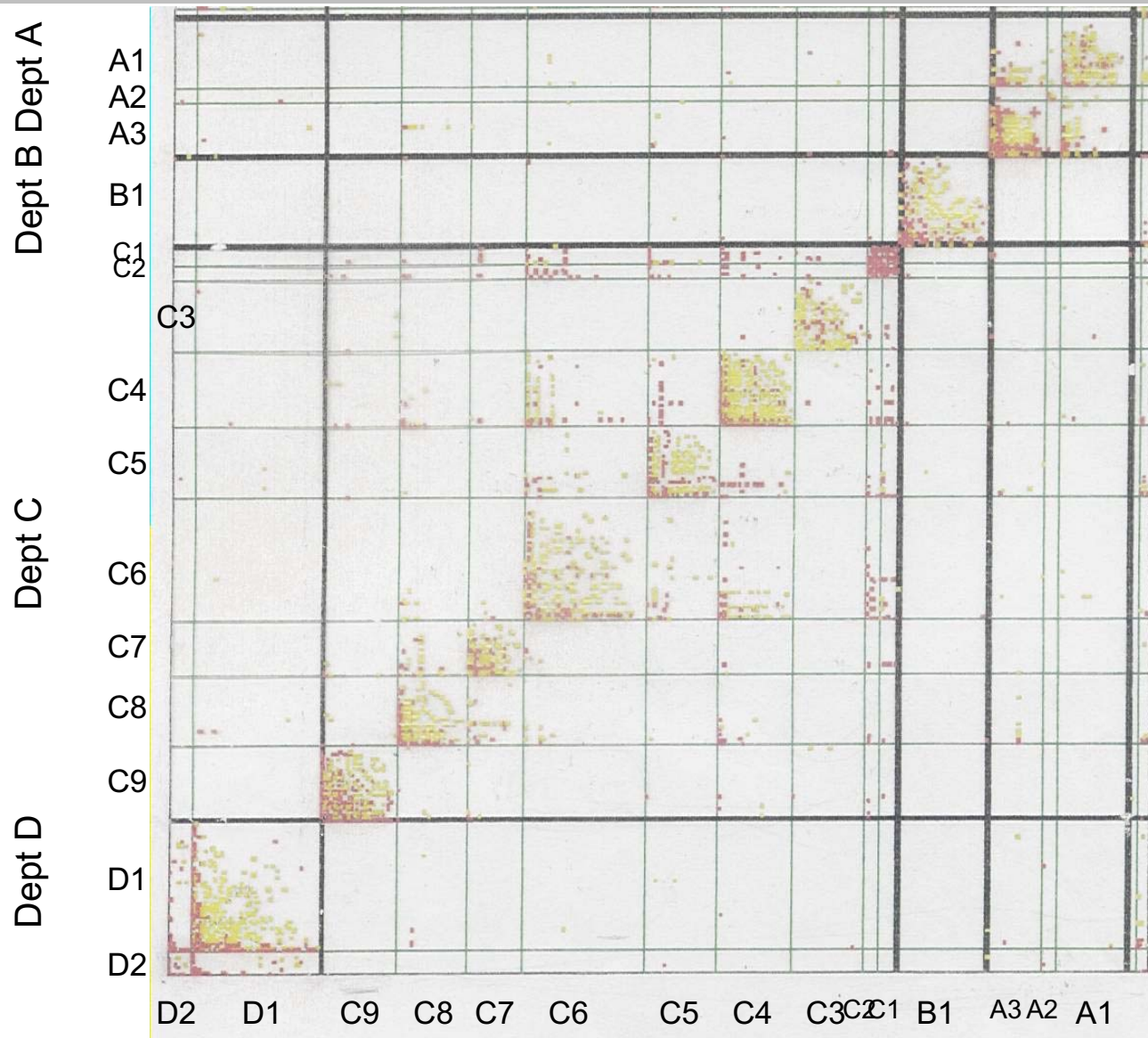
30
Year
Olds

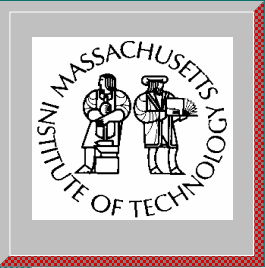
40
Year
Olds

50
Year
Olds

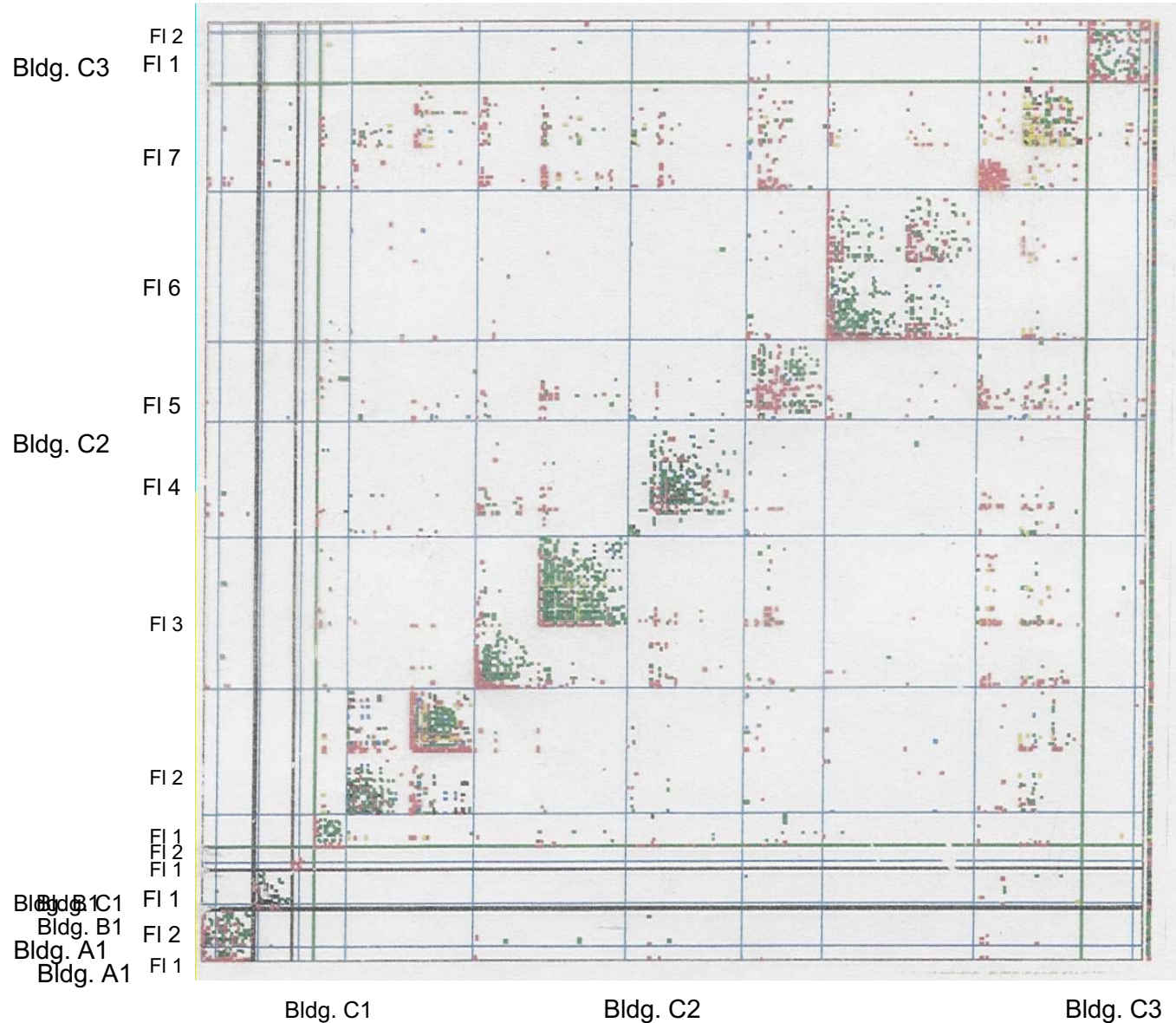


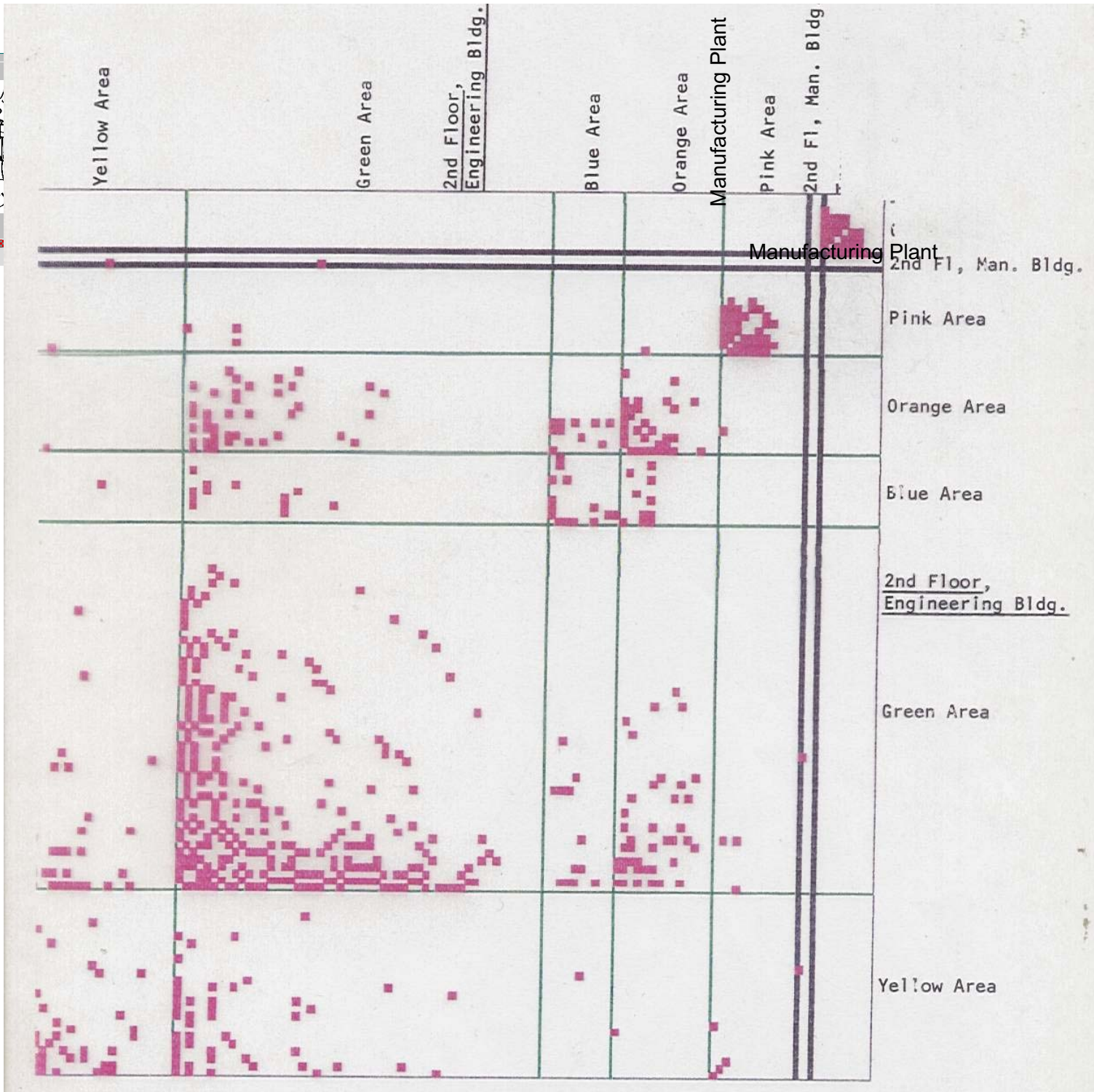
Netgraph of Communication Related to Organizational Structure

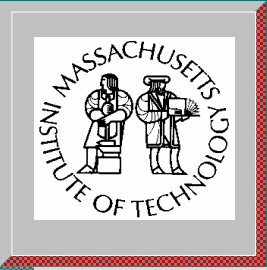




Netgraph of Communication Related to Physical Location

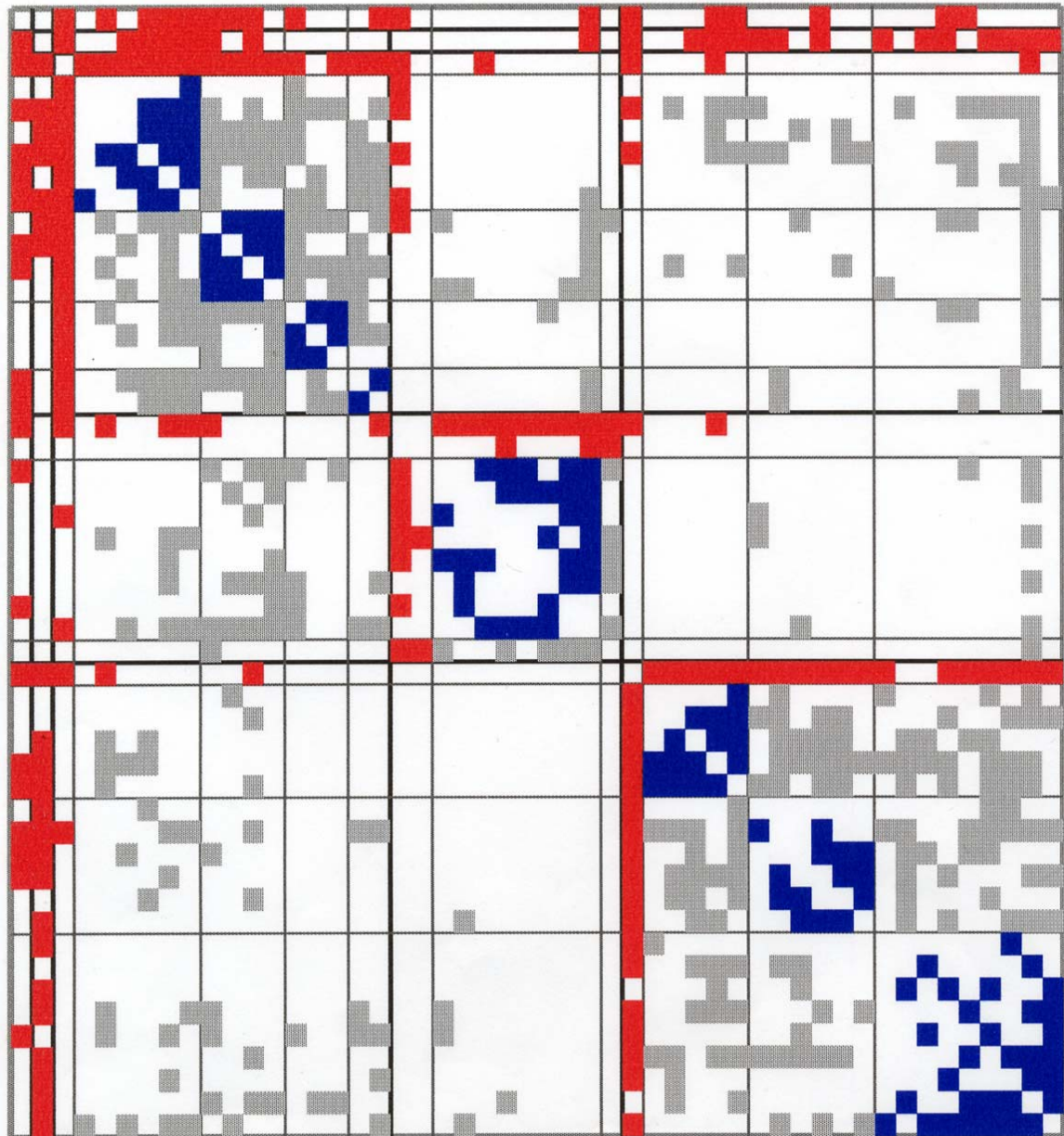


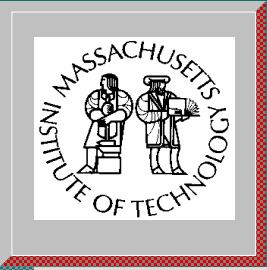




Communication Mapping

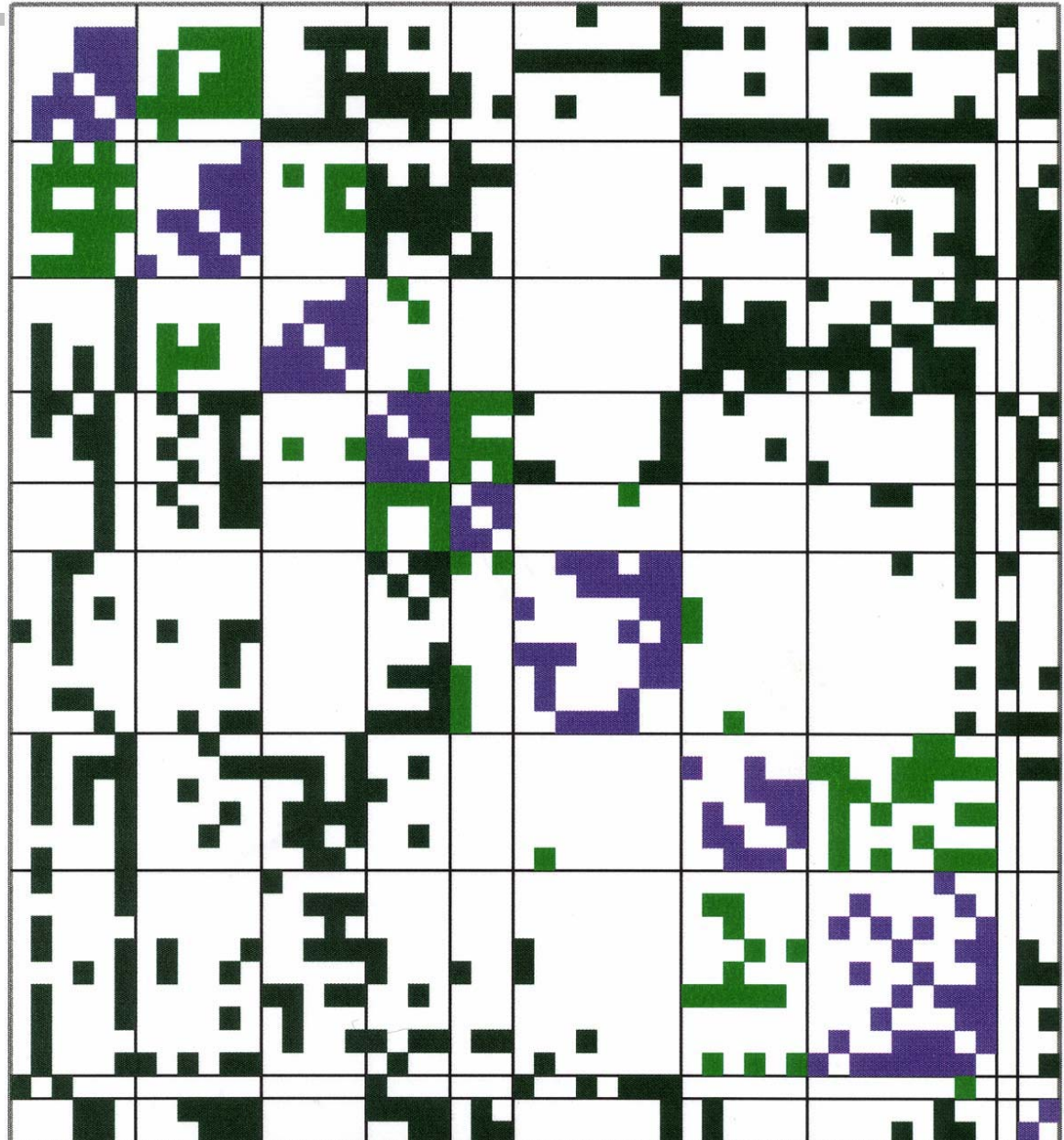
- Order by location

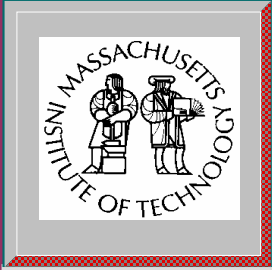




Communication Mapping

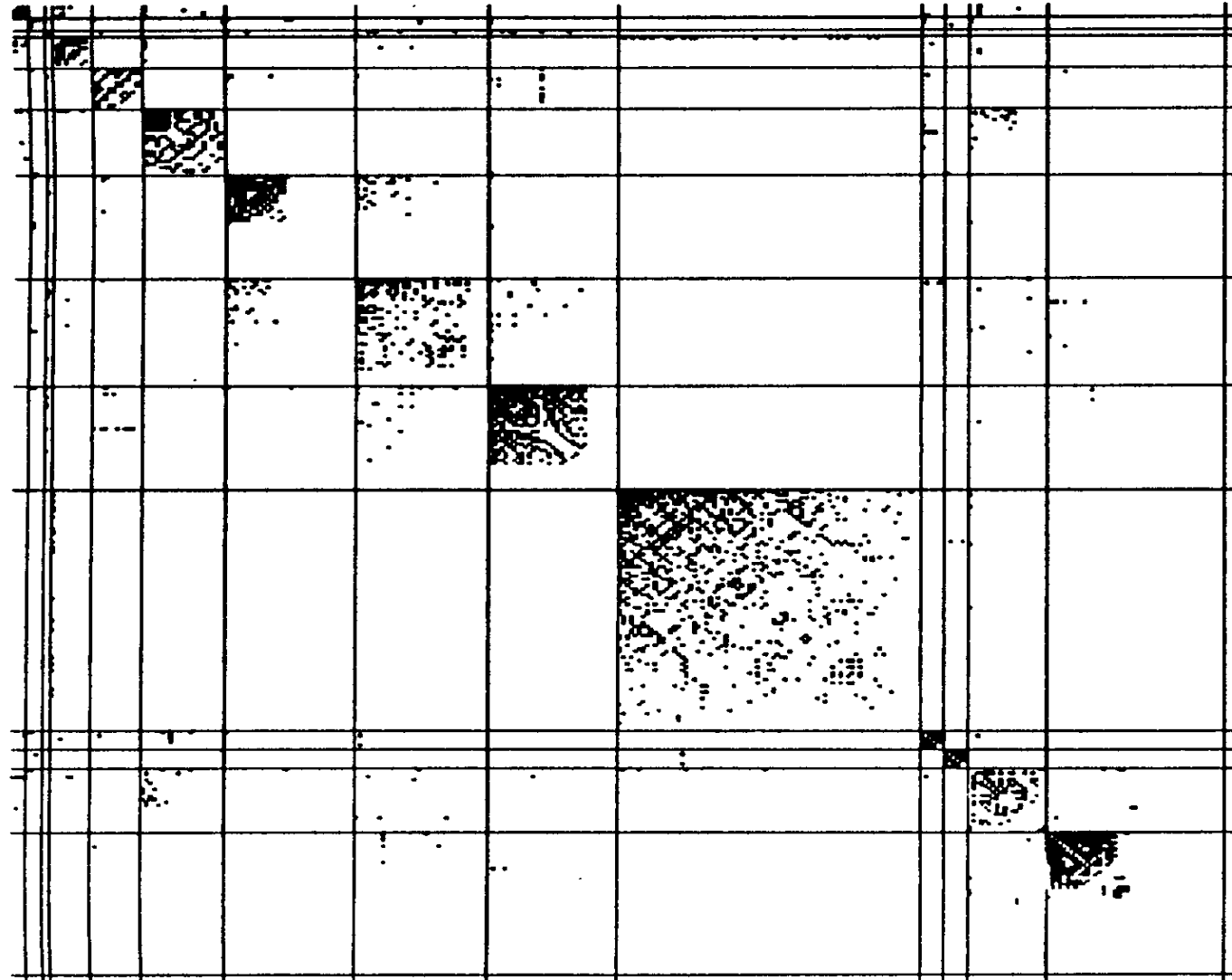
- Order by
Project
Development
Process



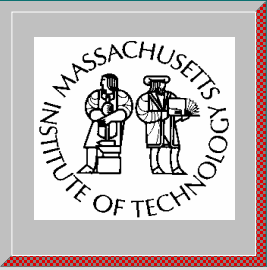


Netgraph Showing the Low Level of Communication Among Groups in Laboratory 'K'.

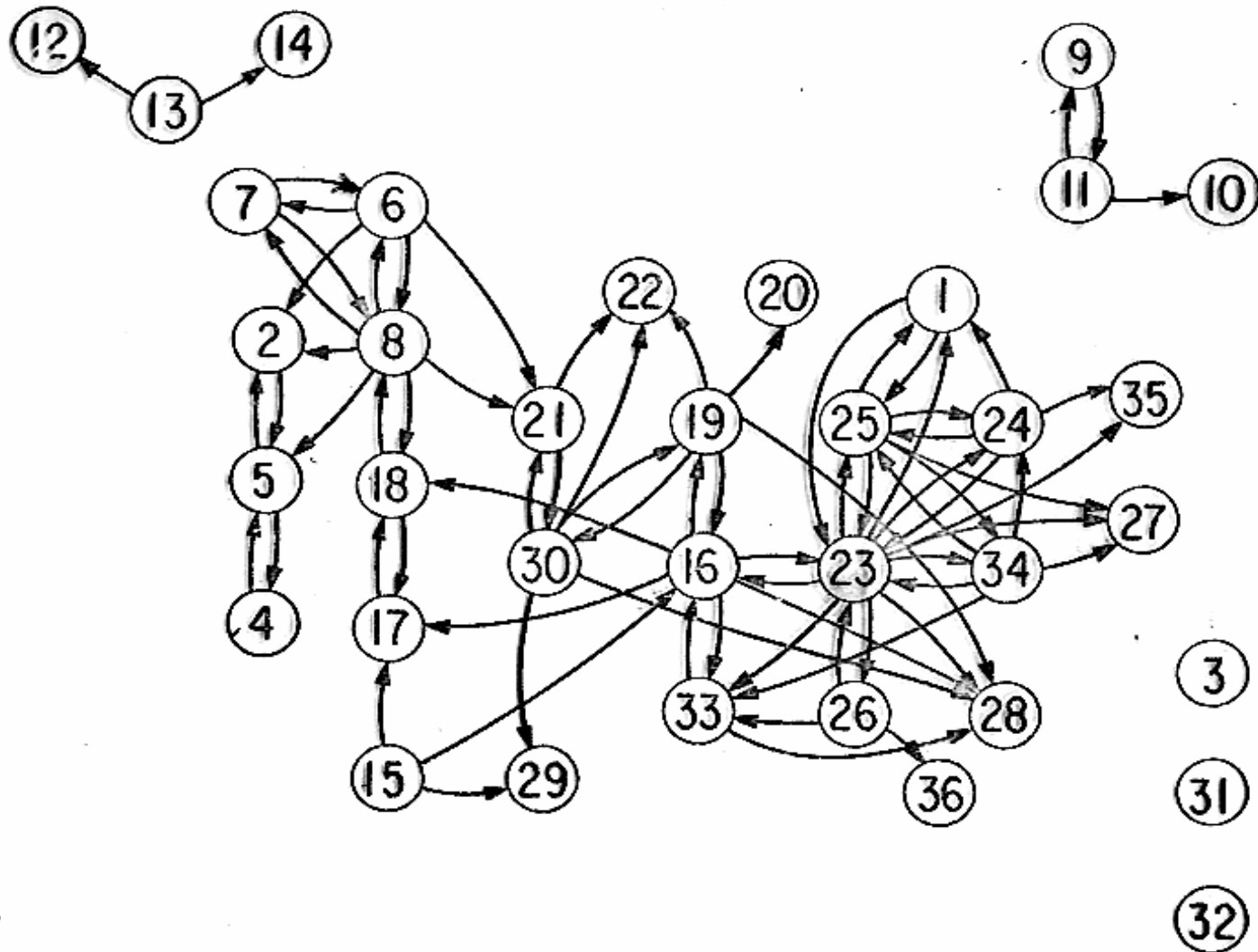
Groups

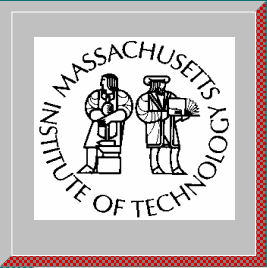


Groups

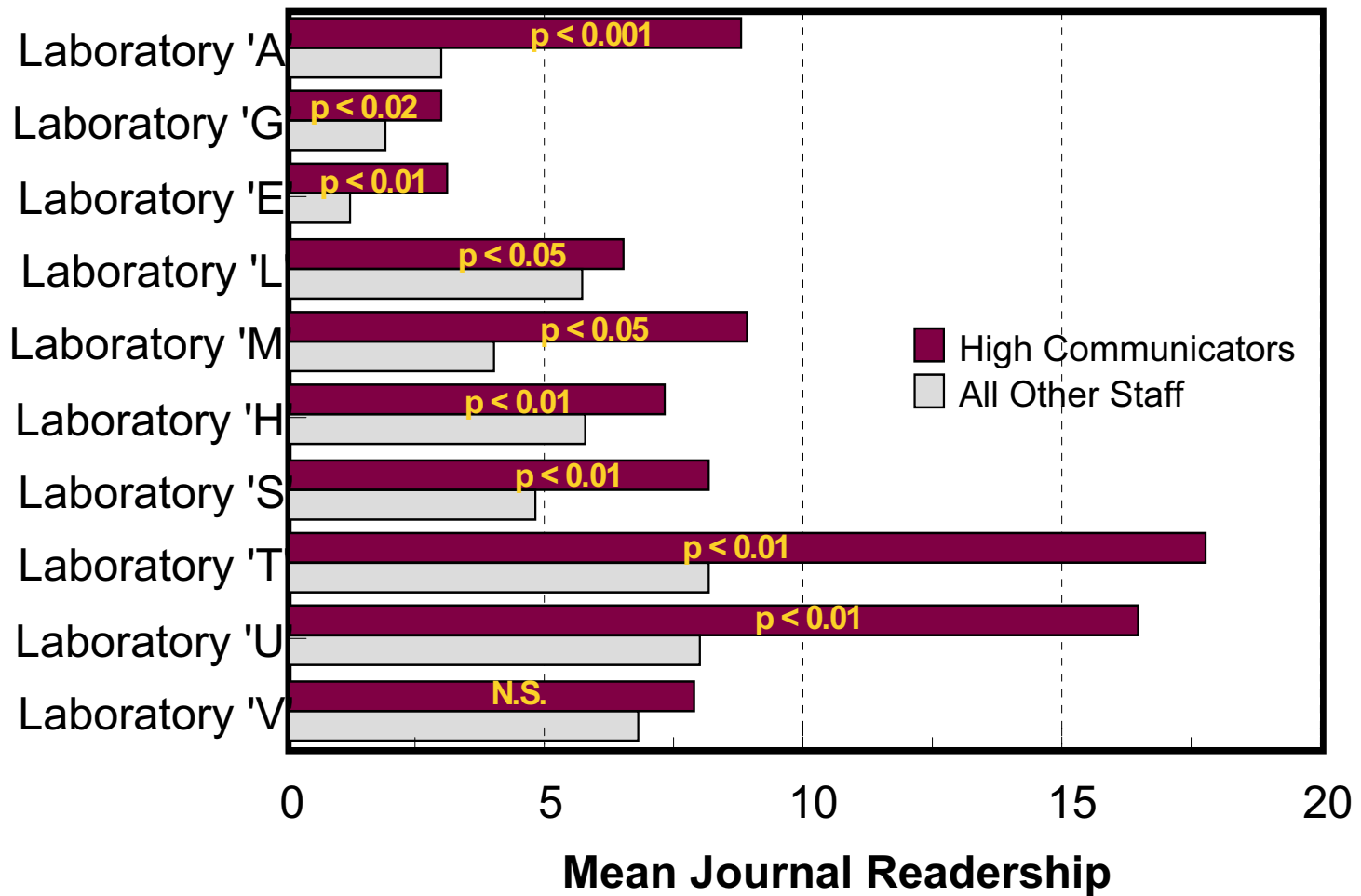


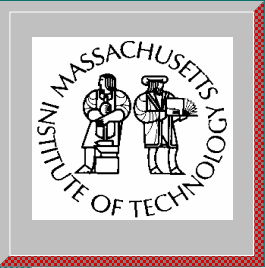
Communication Network in a Small Laboratory



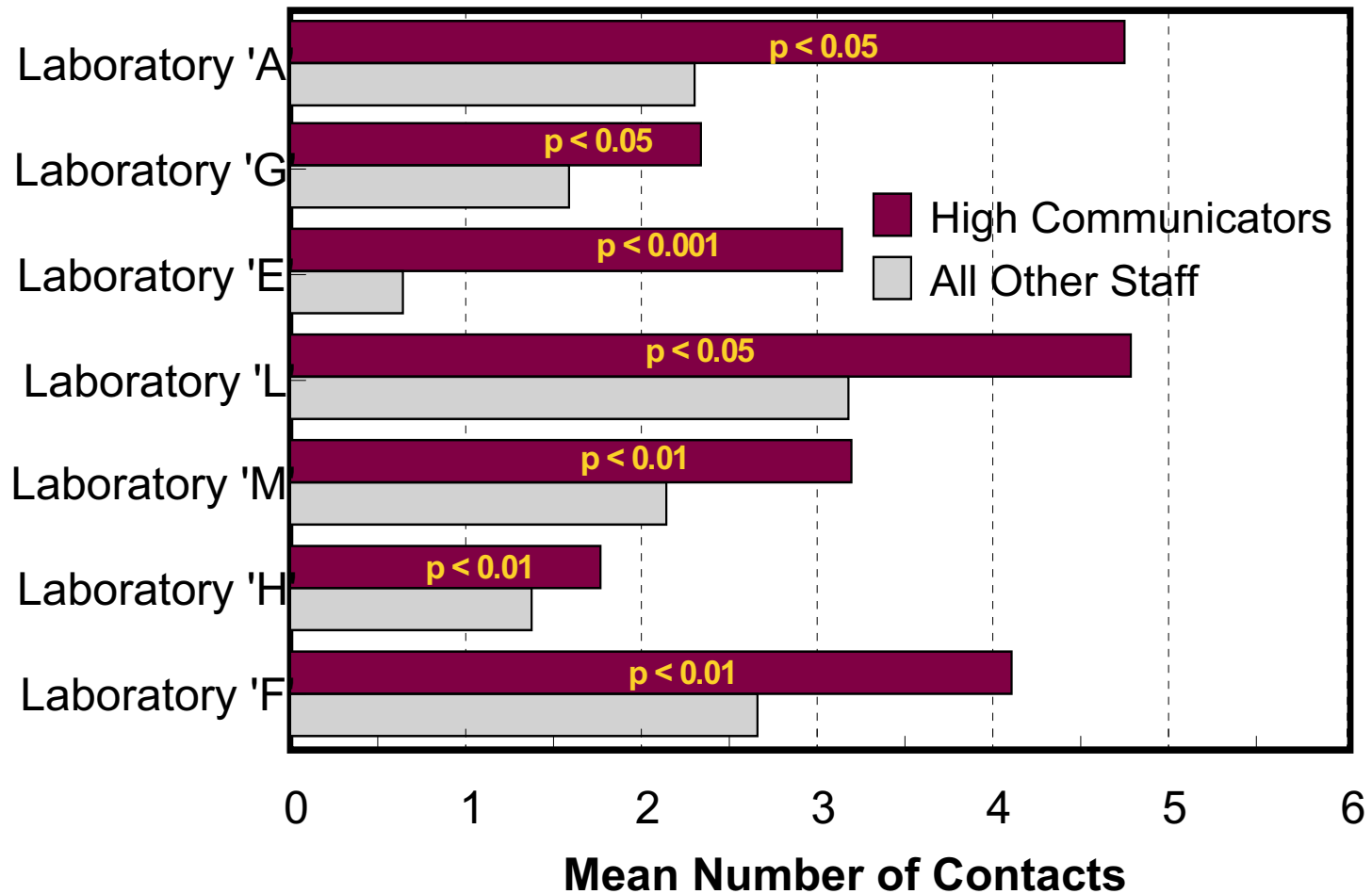


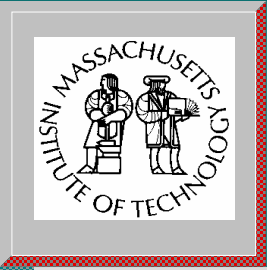
High Communicators Compared with Colleagues in Readership of Refereed Journals



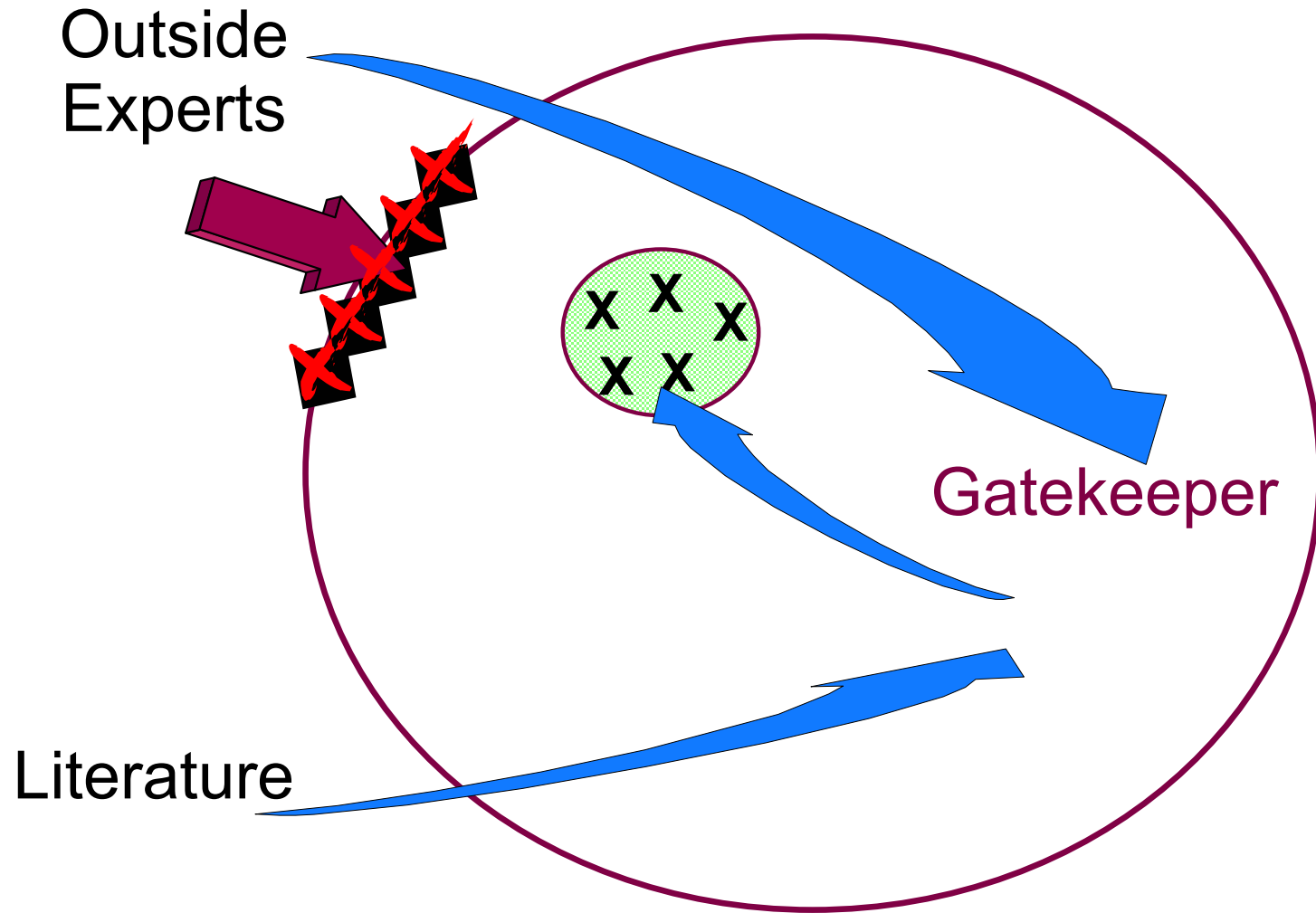


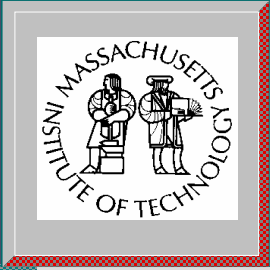
High Communicators Compared with Colleagues in Terms of Regular Informal Contact Outside of the Organization





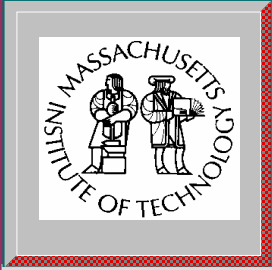
The Gatekeeper as a Link to Outside Technology





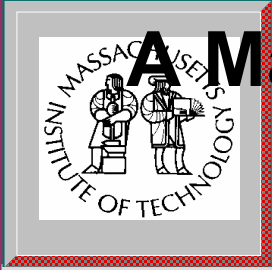
Gatekeeper Characteristics

- **High Technical Performance**
- Not 'just communicators'
- Highest technical performers in the organization.
- Cannot be created by management.
- **Low in the Organizational Hierarchy**
- Concentrated at first level of technical supervision or below.
- Seldom found at higher levels of management.
- Seldom found on the technical ladder.
- **Visibility**
- They are easy to identify.
- Everyone knows who they are.
- **Approachability**
- Must be at least receptive to people.

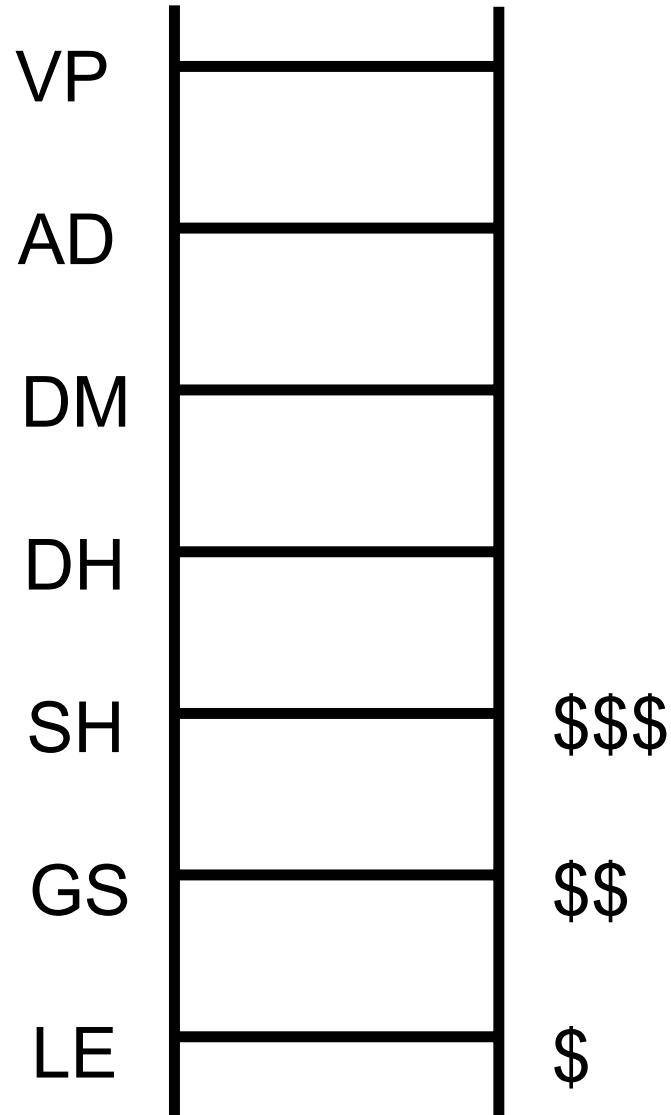


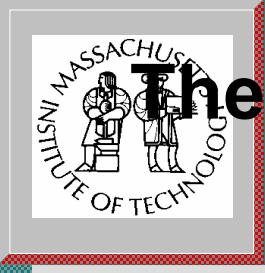
International Gatekeepers

- ✎ International Gatekeepers tend to be Engineers or Scientists, who have worked in other countries and returned home.
- ✎ Engineers and Scientists visiting from other countries had very high foreign contact, but insufficient domestic contact to be International Gatekeepers.



A Managerial Career

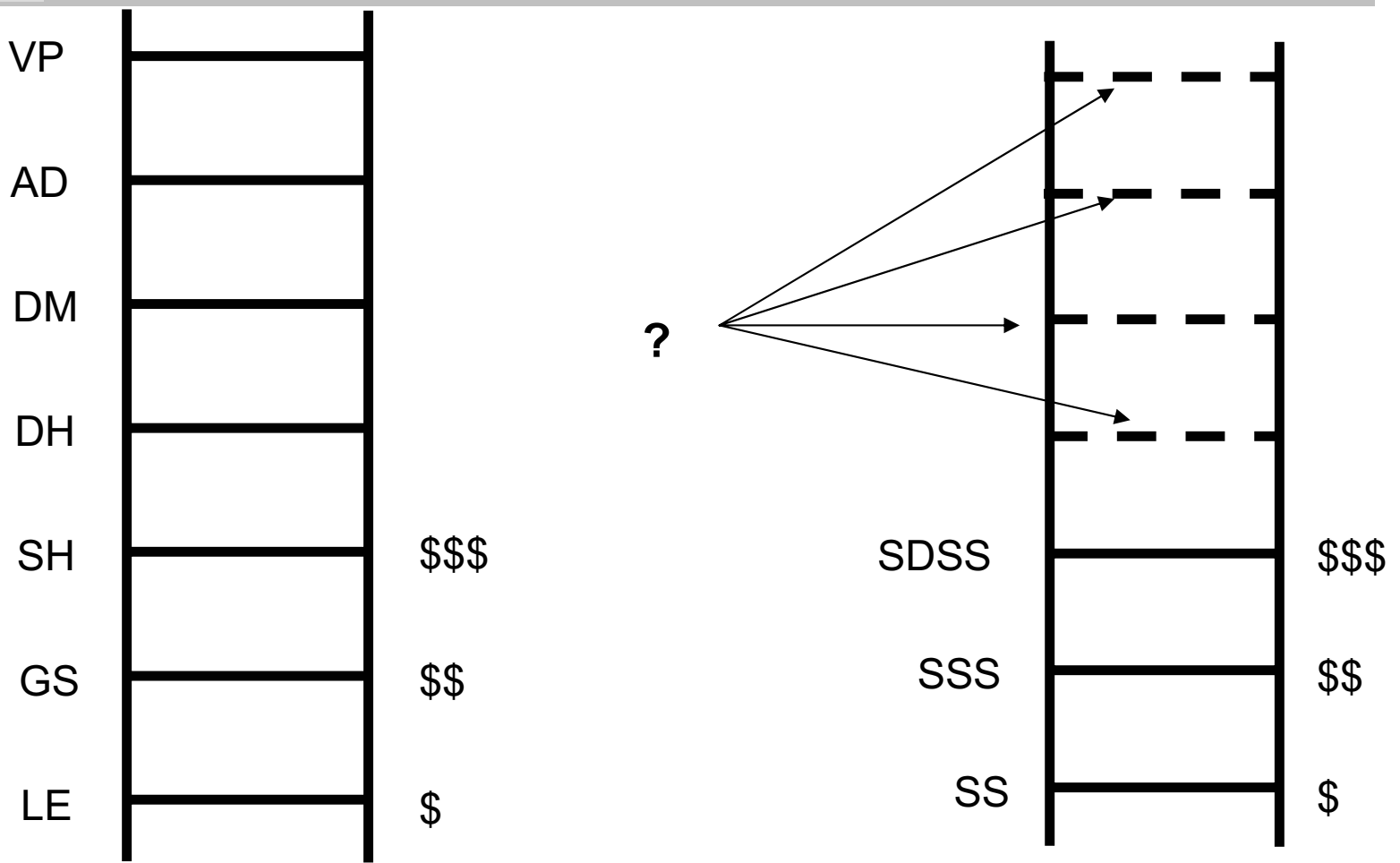




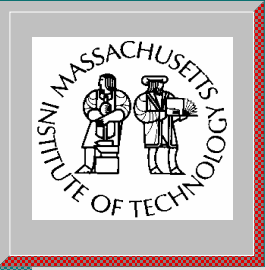
The Dual Ladder

Managerial

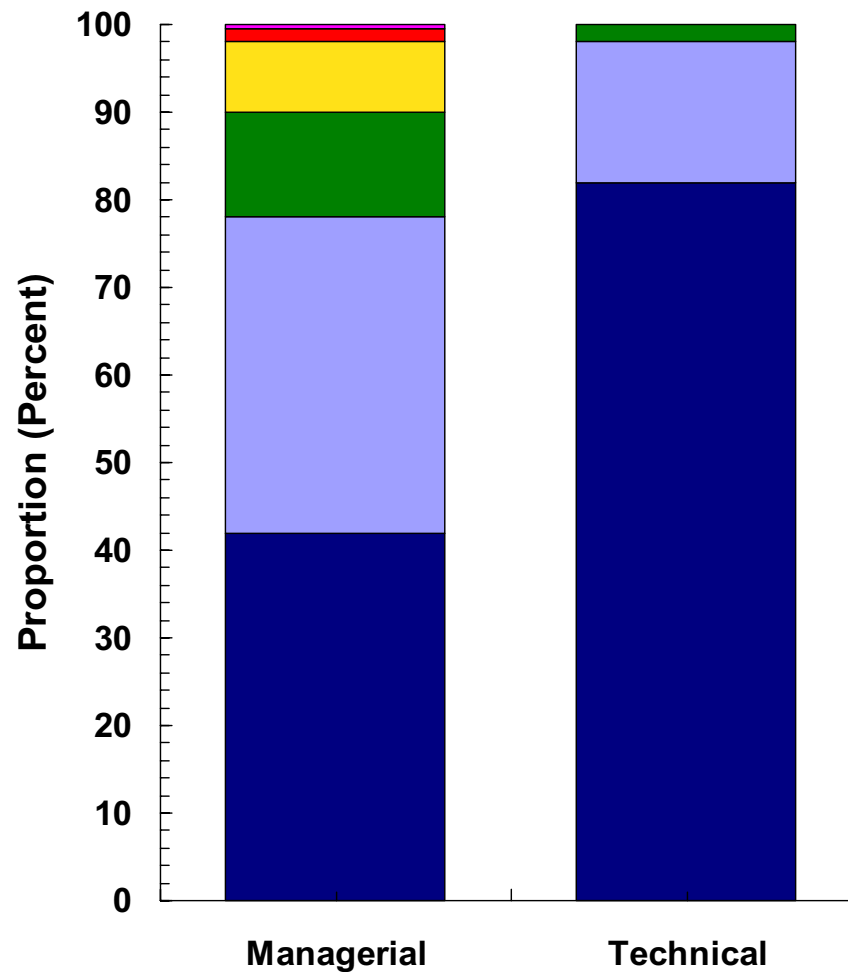
Technical

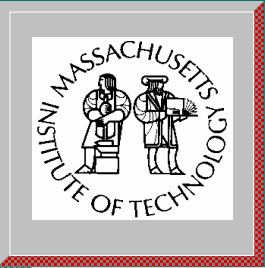


Engineer A
Engineer B
Engineer C



Distribution of Positions in One Firm's Dual Ladder

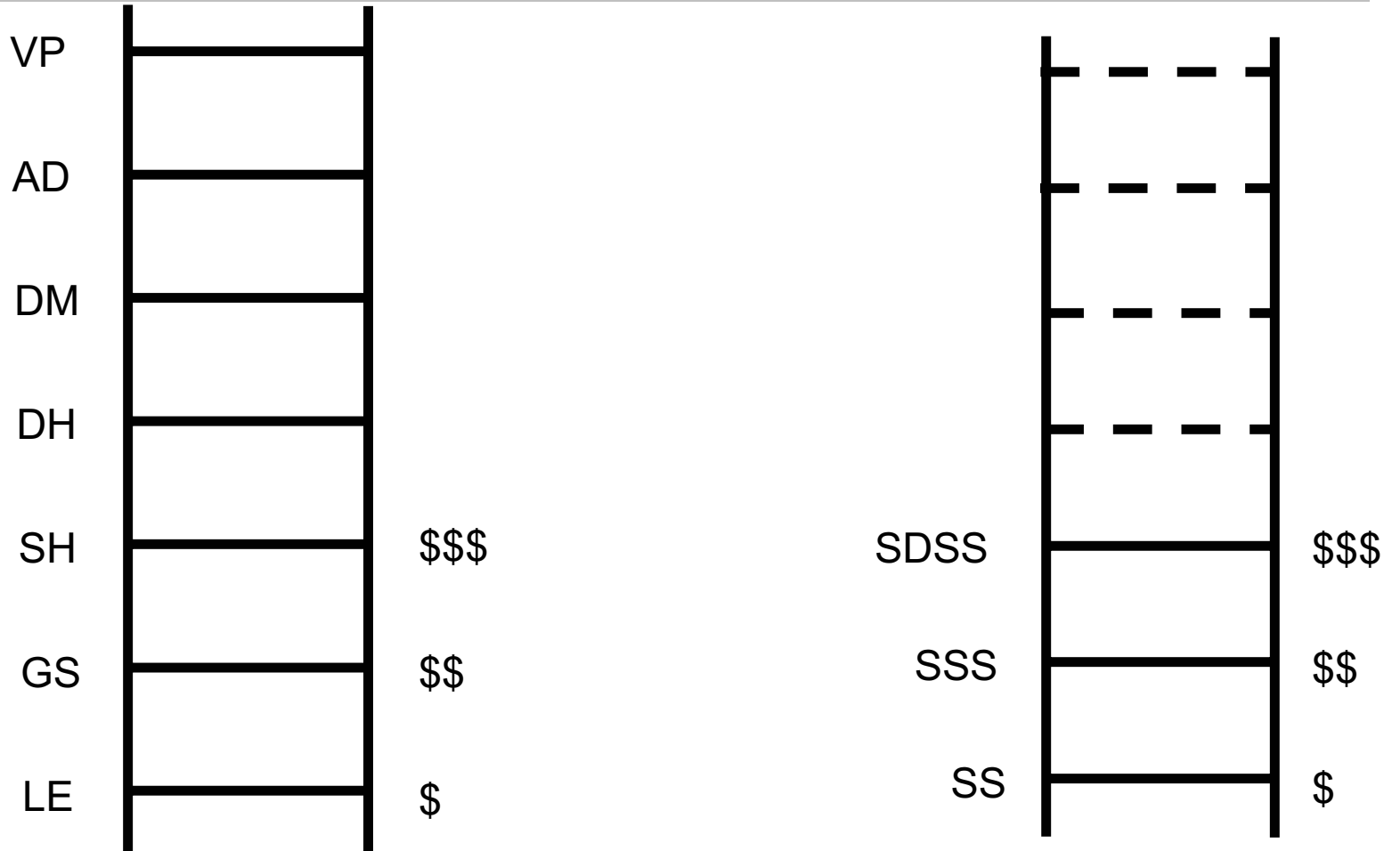




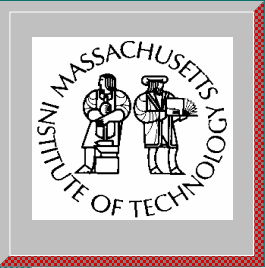
The Dual Ladder

Managerial

Technical



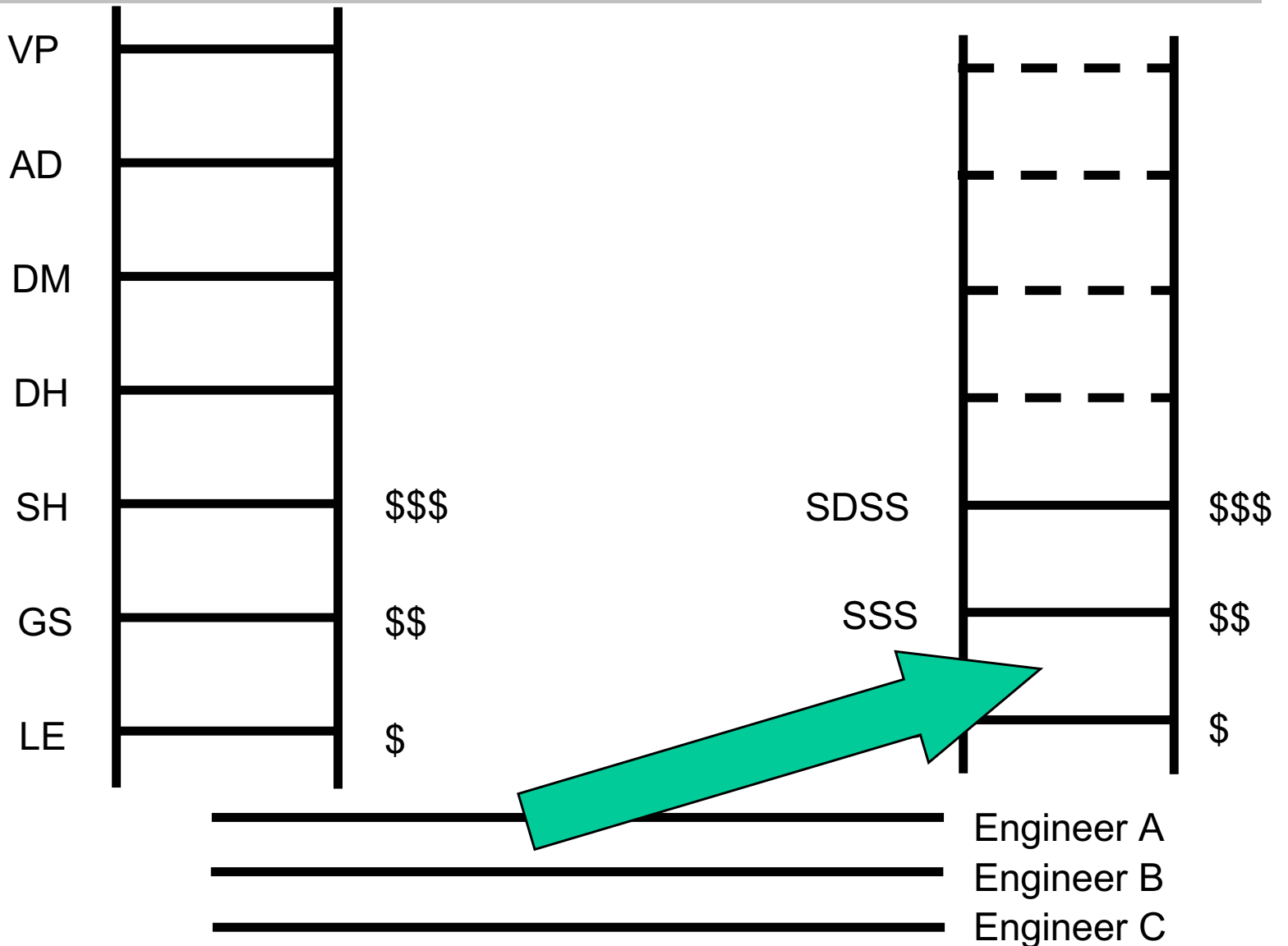
Engineer A
Engineer B
Engineer C

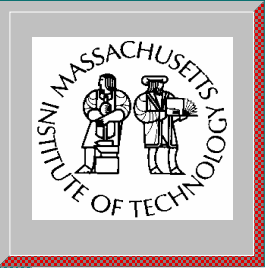


Criteria for Technical Ladder Promotion

Managerial

Technical

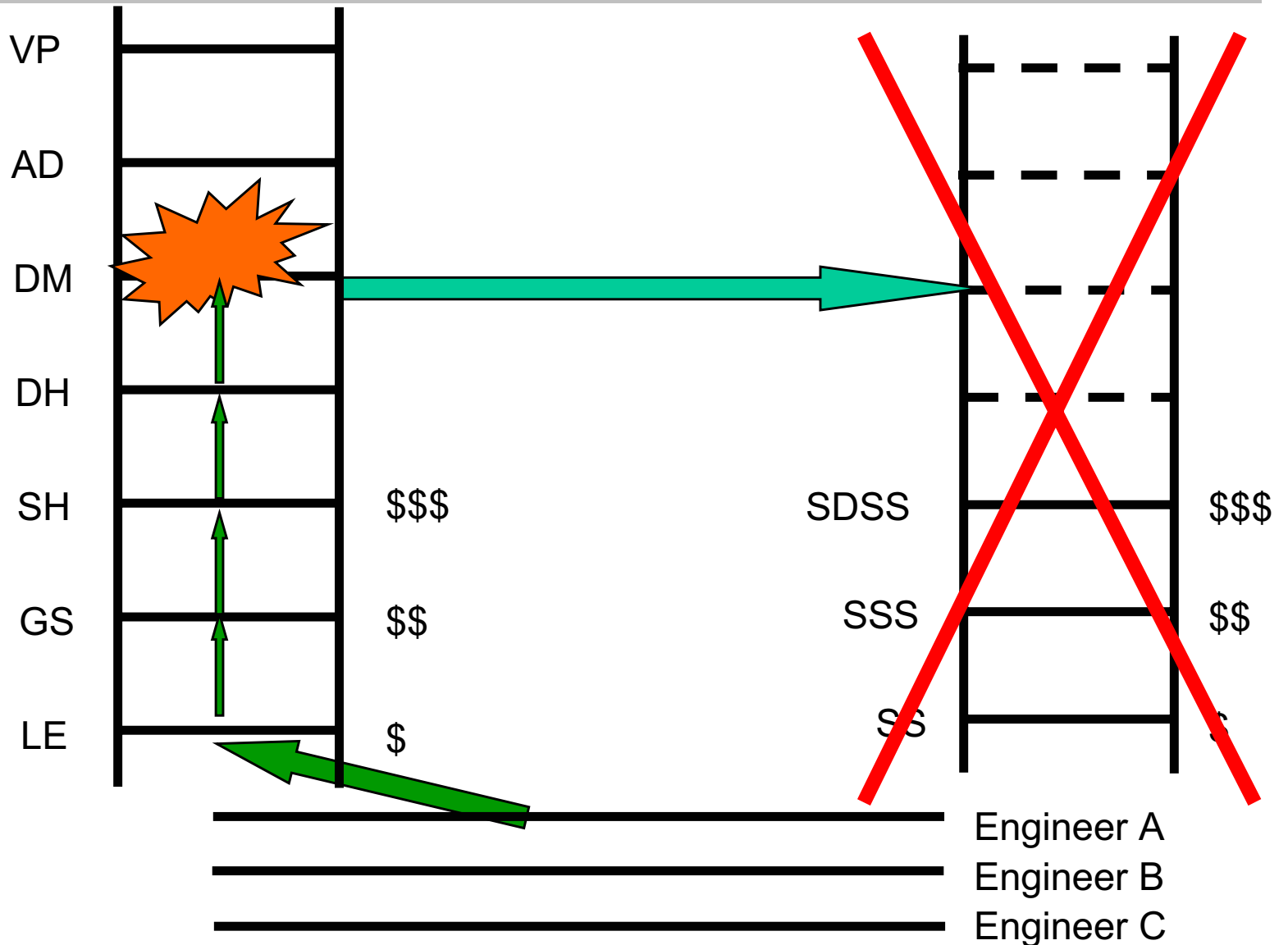


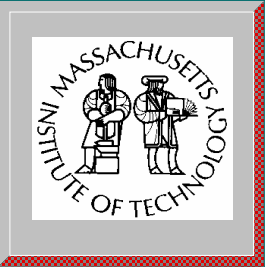


The Biggest Problem with the Dual Ladder

Managerial

Technical

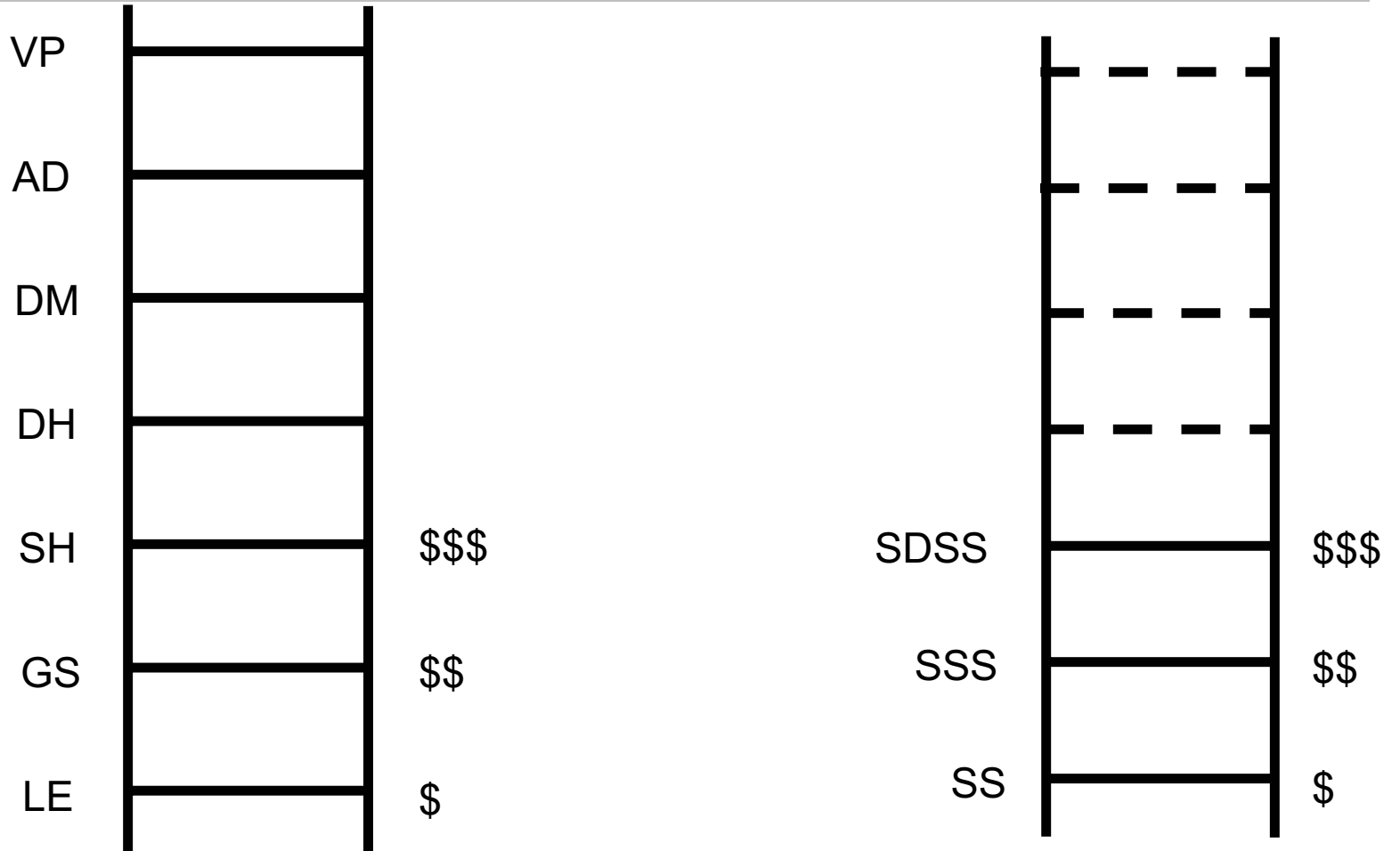




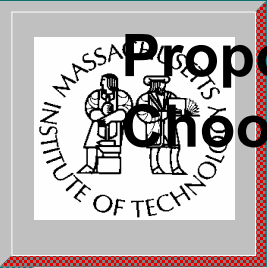
The Dual Ladder

Managerial

Technical

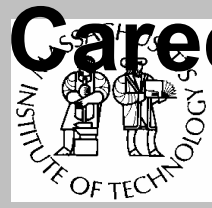


Engineer A
Engineer B
Engineer C

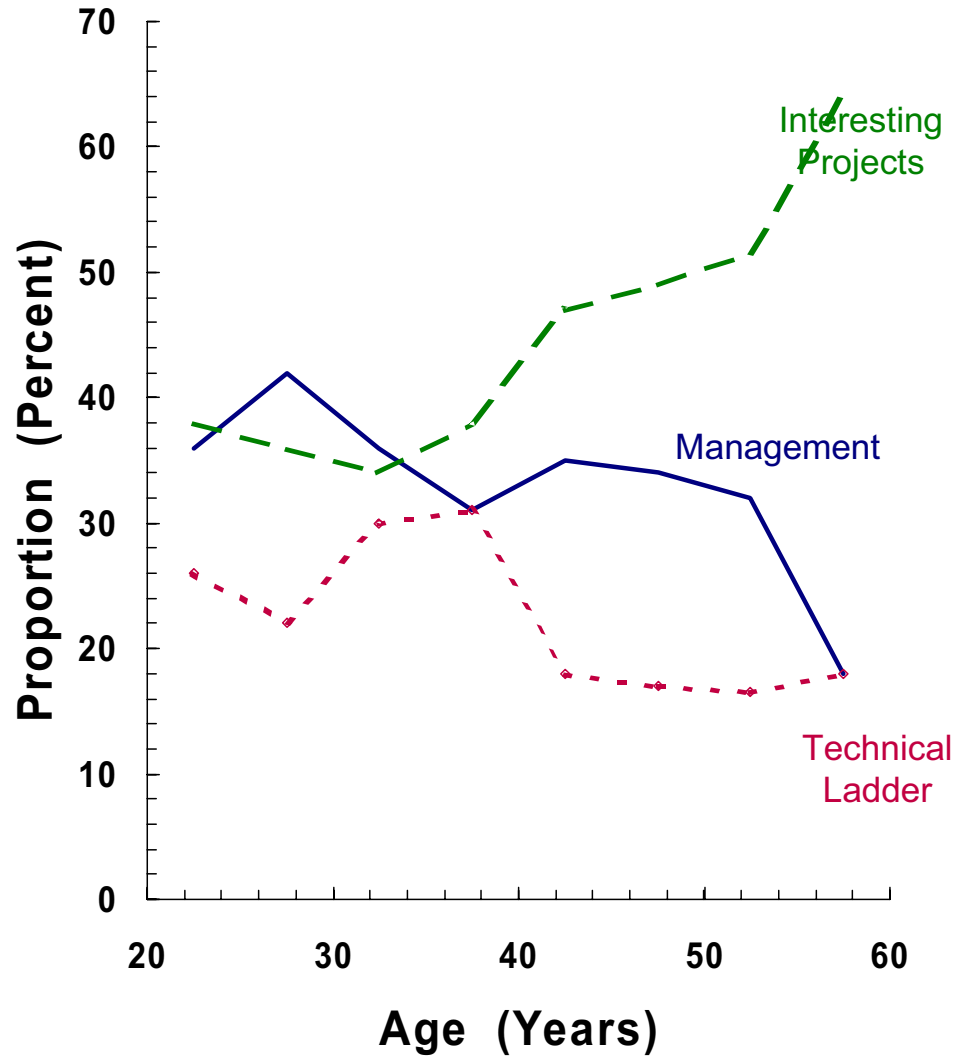


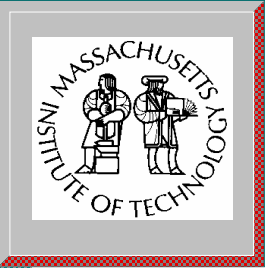
Proportion of Engineers & Scientists in Ten Organizations Choosing Each of Three Possible Career Paths

- MANAGEMENT 32%
- TECHNICAL LADDER 20%
- PROJECT ASSIGNMENT 48%

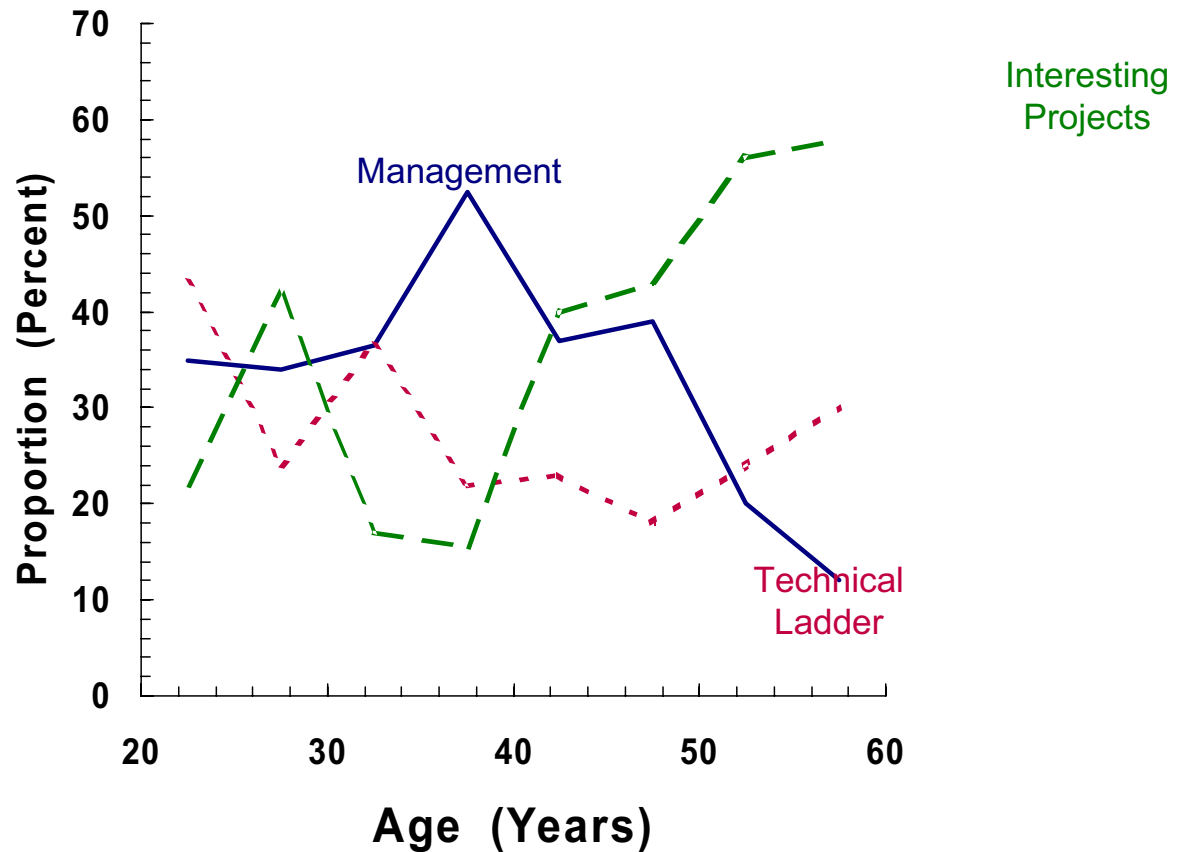


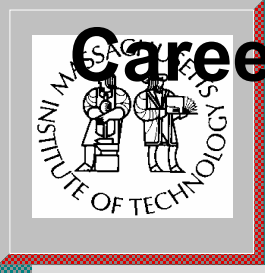
Career Preference as a Function of Age (N = 1,402)



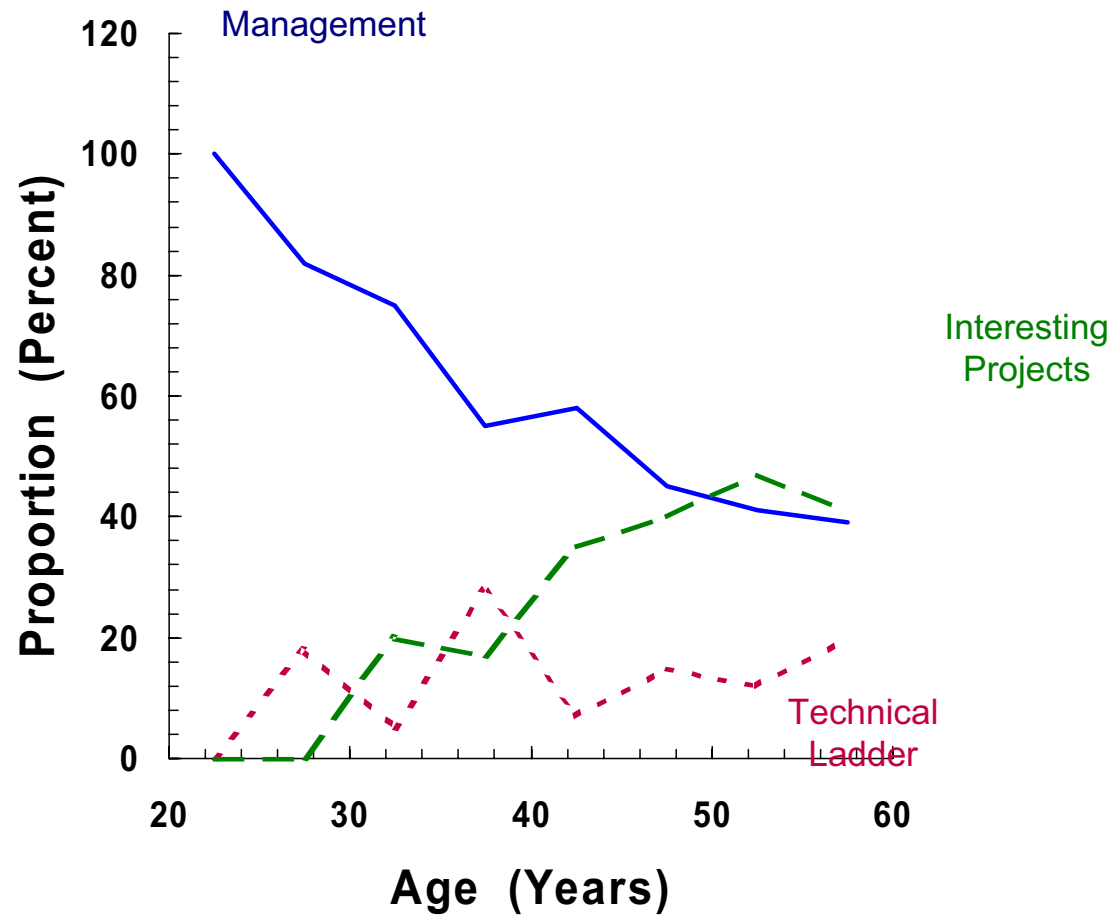


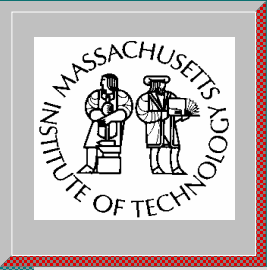
Preferences of Technical Ladder Staff as a Function of Age (N = 351)



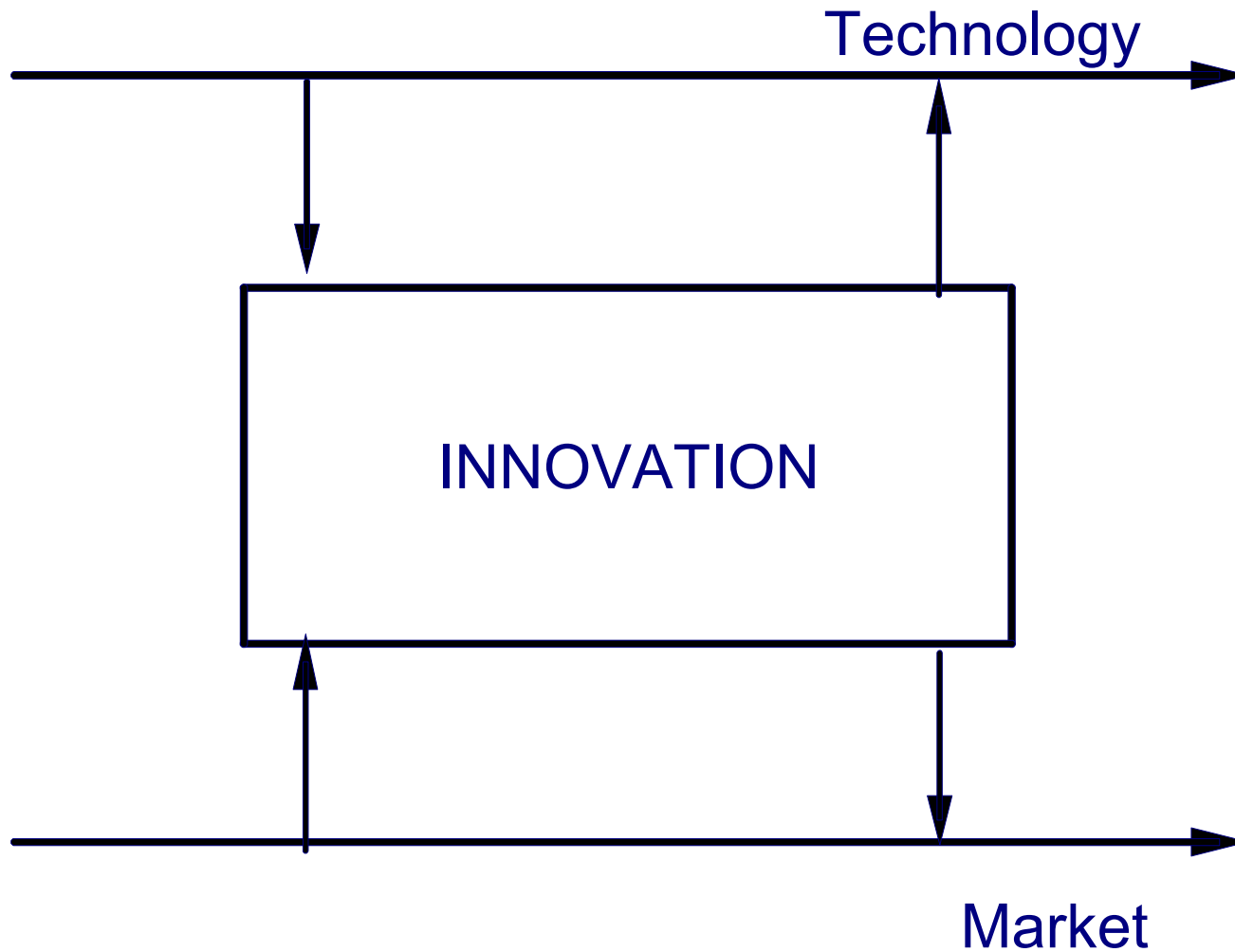


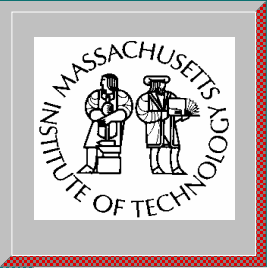
Career Preferences of Managers as a Function of Age (N = 374)



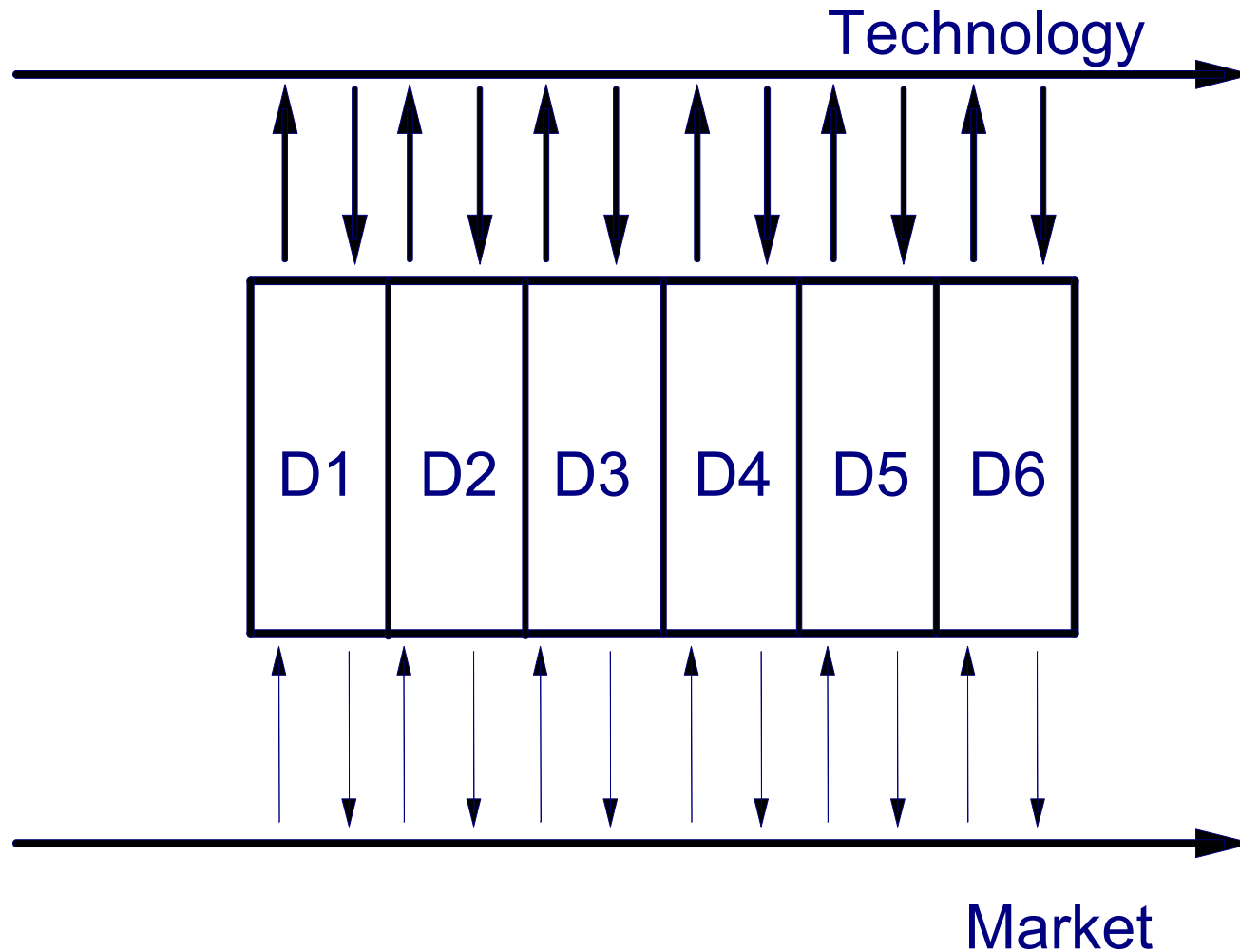


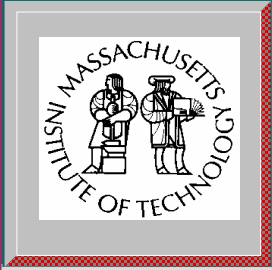
The Process of Innovation



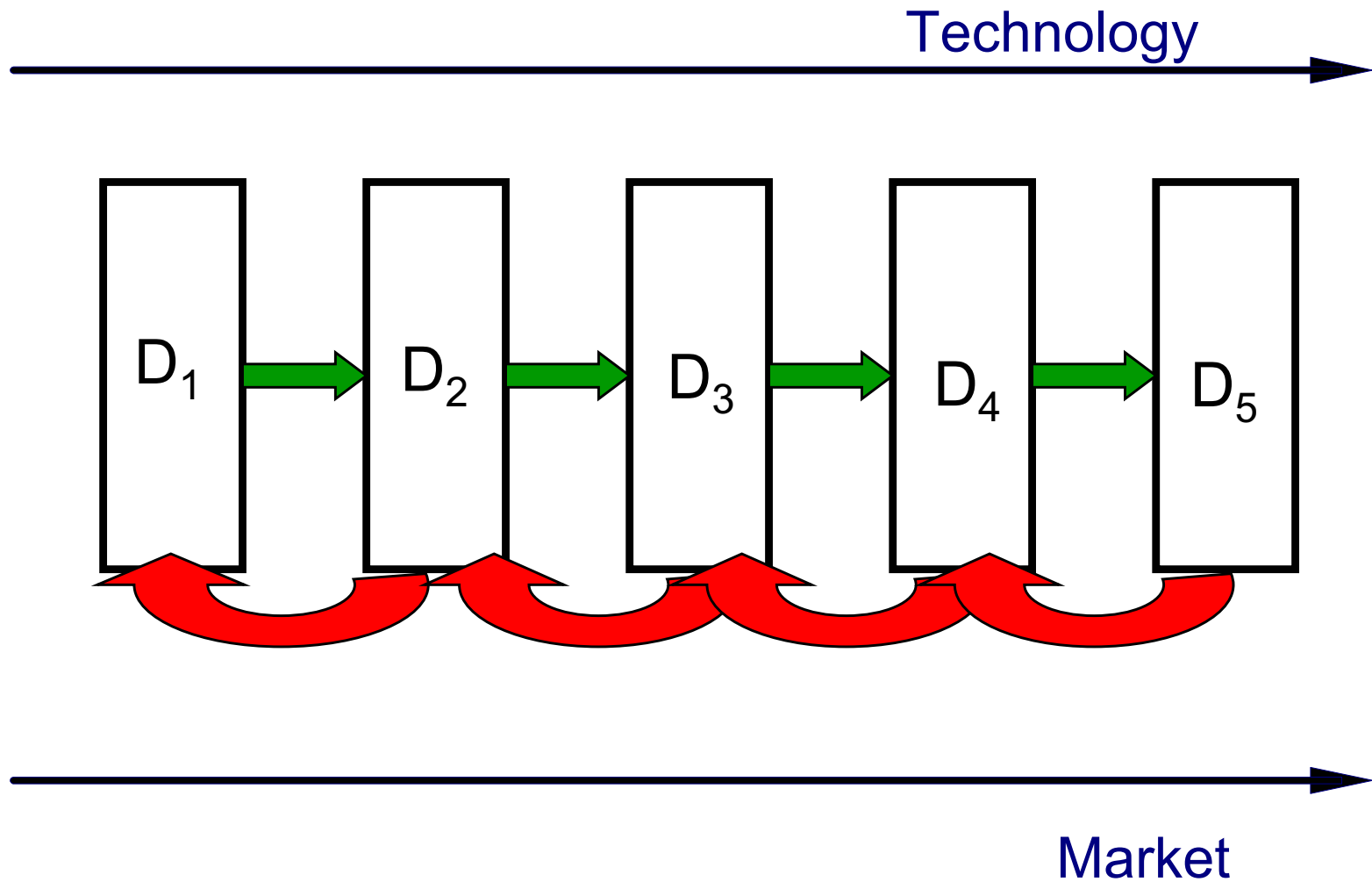


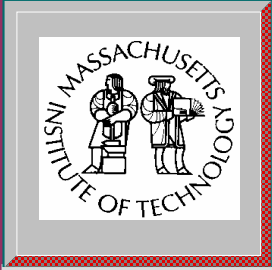
Departmental Organization





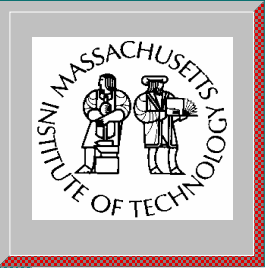
Departmental Organization



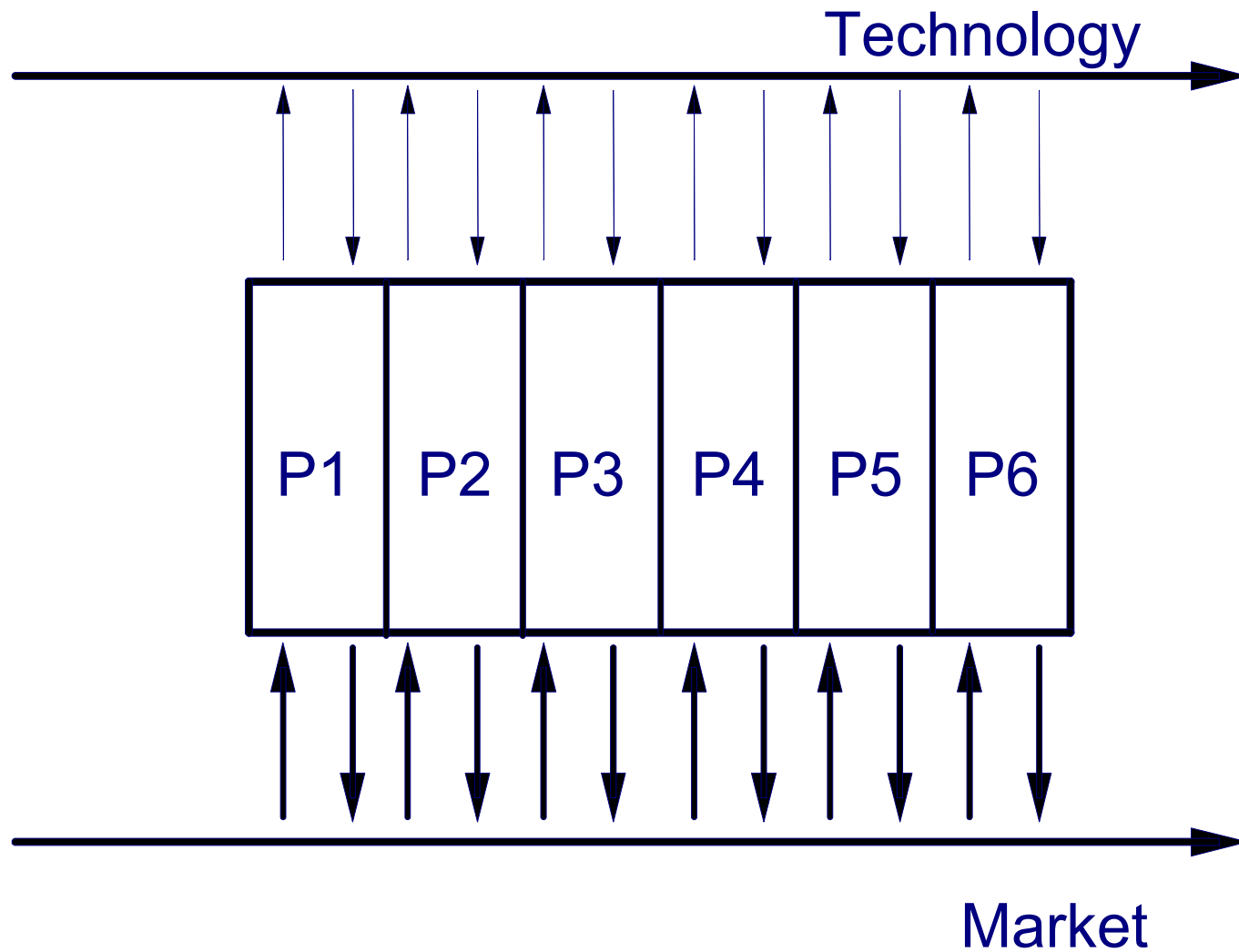


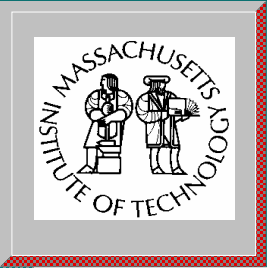
Time & Coordination

- Time can always be substituted for coordination!
- and the converse...
- Better coordination can reduce development time.

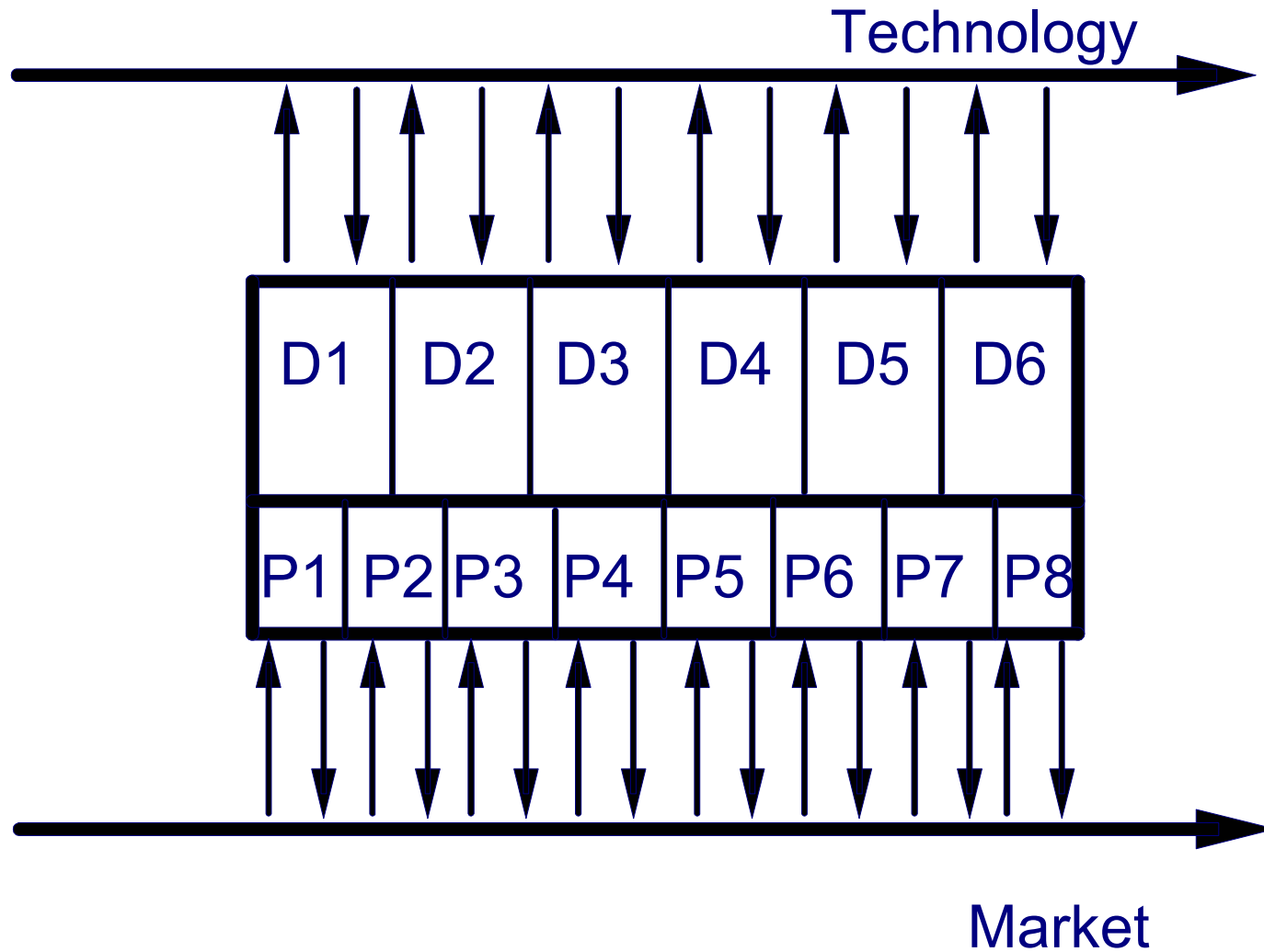


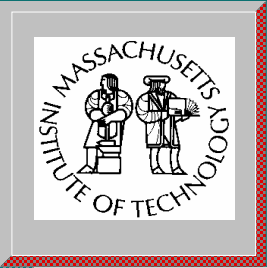
Project Team Organization



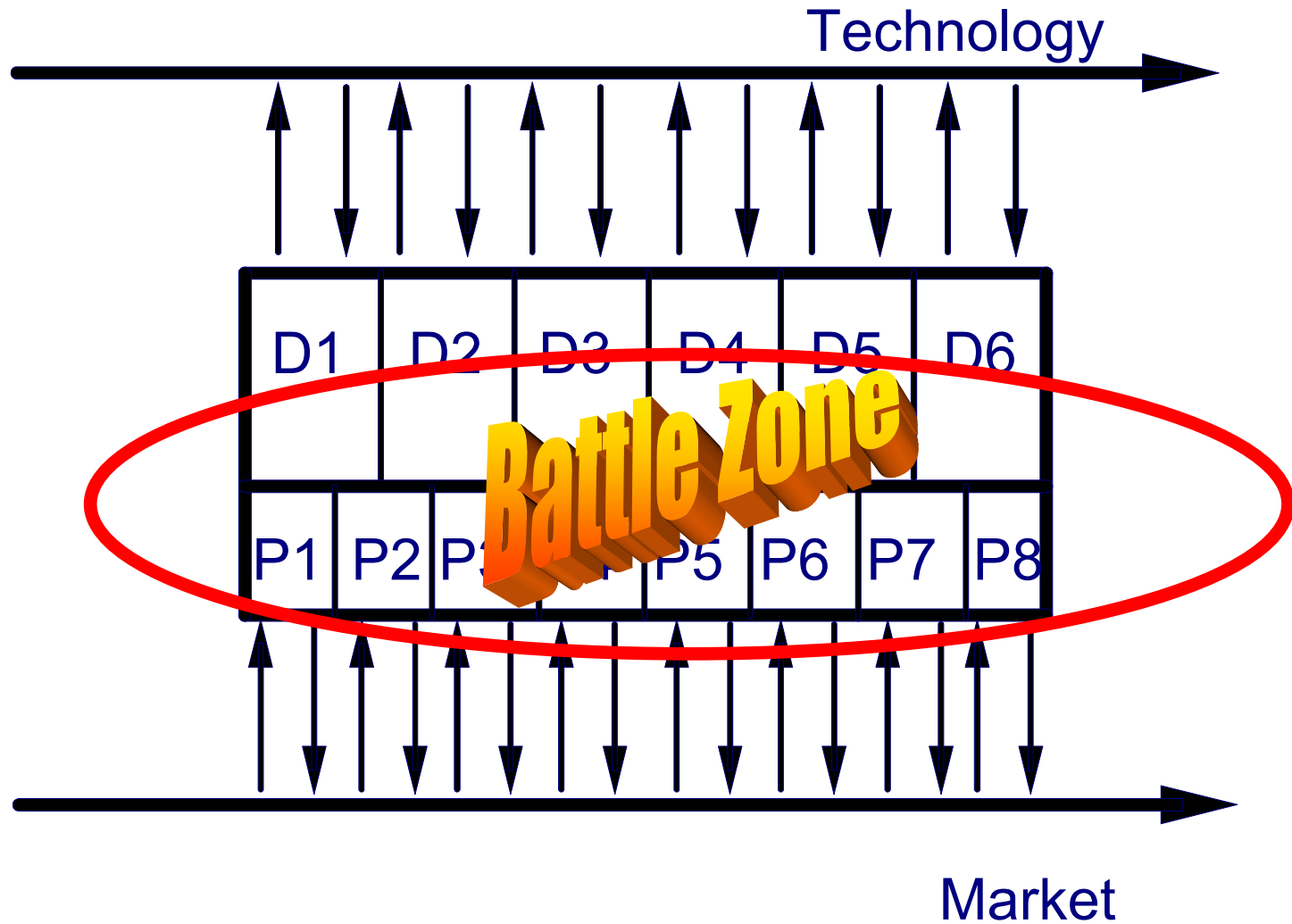


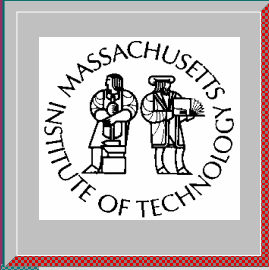
Matrix Organization





Matrix Organization





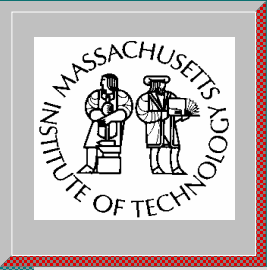
The Basic Tradeoff and Dilemma in Product Development Organization

- **Departmental Organization**

- Departmental structure is more closely mapped to the structure of the supporting technologies
- It thereby provides a better connection to those technologies and better ongoing technical support to the project effort.
- This is, however, accomplished at the cost of much greater difficulty in coordination of the project tasks and less responsiveness to market change.

- **Project Team Organization**

- Project Team structure groups people from different disciplines together in a single team all reporting to a common manager.
- It thereby provides better coordination of the project tasks and increased sensitivity to market dynamics.
- This is, however, accomplished at the cost of a separation from the disciplinary knowledge underlying the project effort. When this is carried to an extreme, it will gradually erode the technology base of the organization.



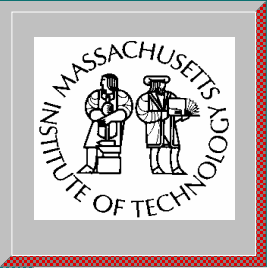
Organizational Structure Space I

I_{ss}

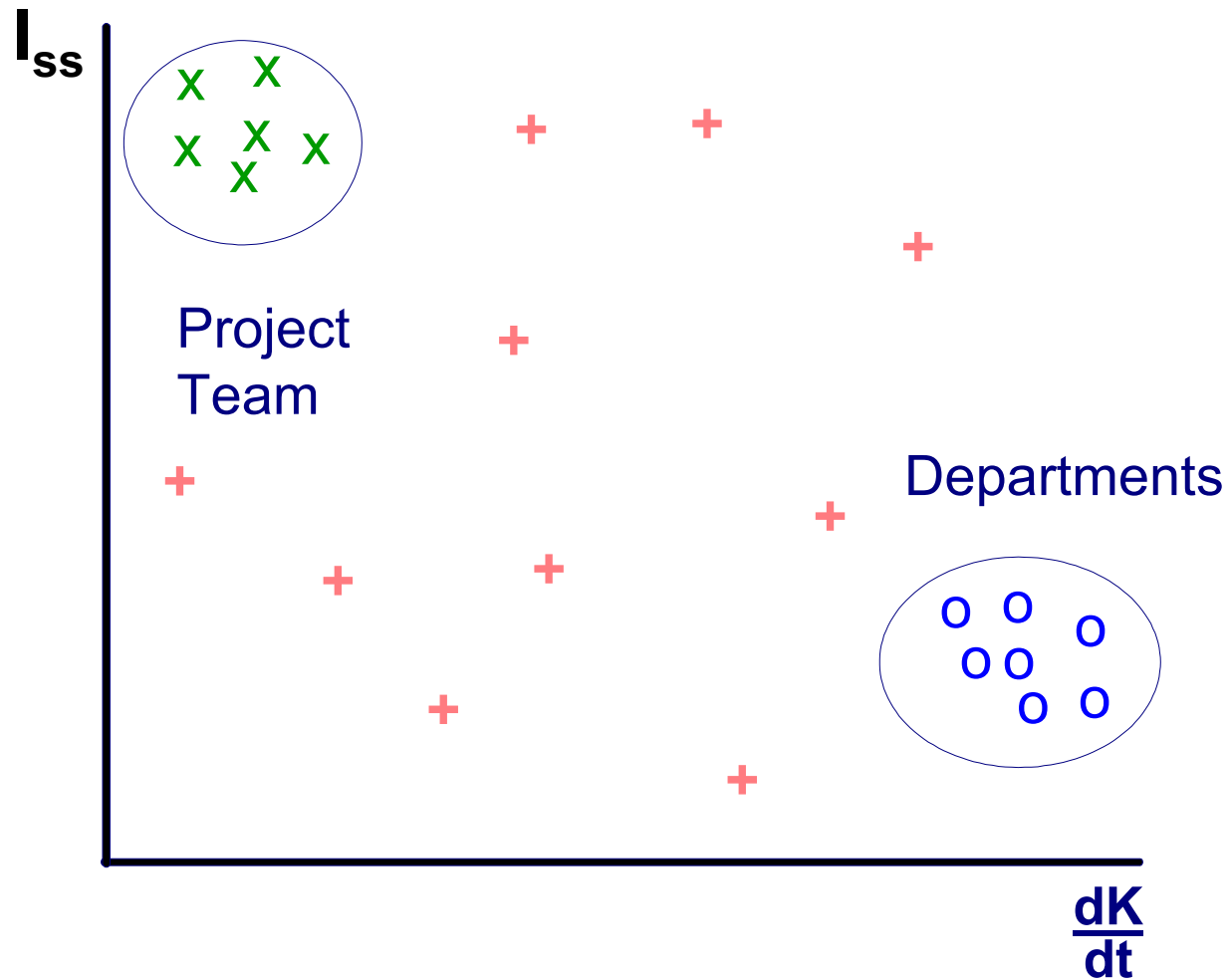
$\frac{dK}{dt}$ = rate of change of
knowledge

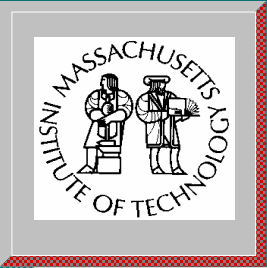
I_{ss} = subsystem
interdependence

$\frac{dK}{dt}$

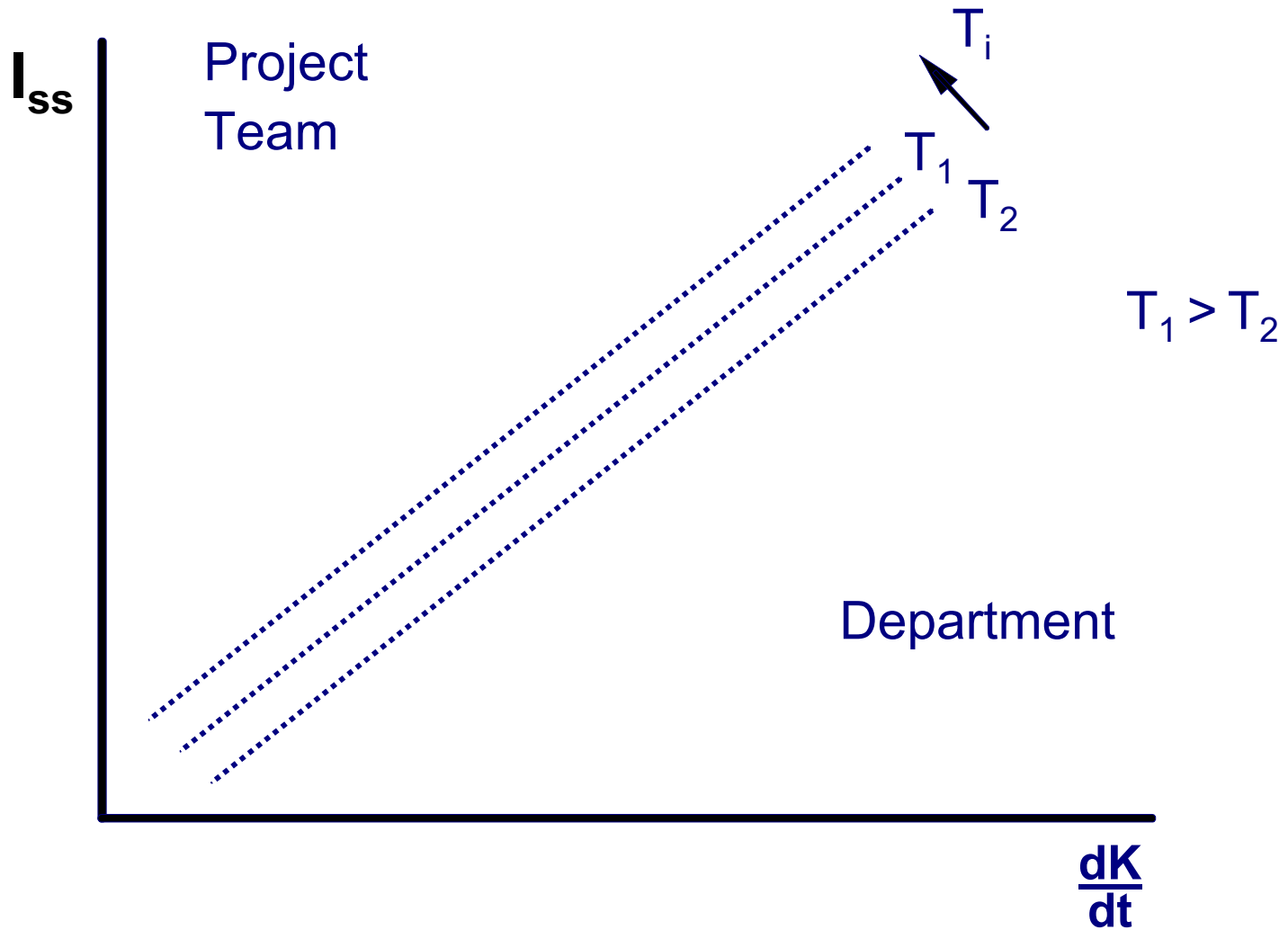


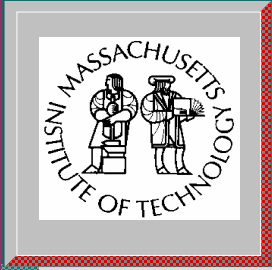
Organizational Structure Space II





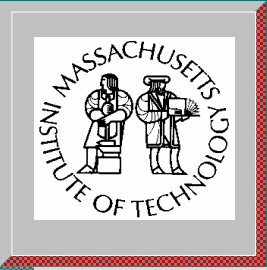
Organizational Structure Space III



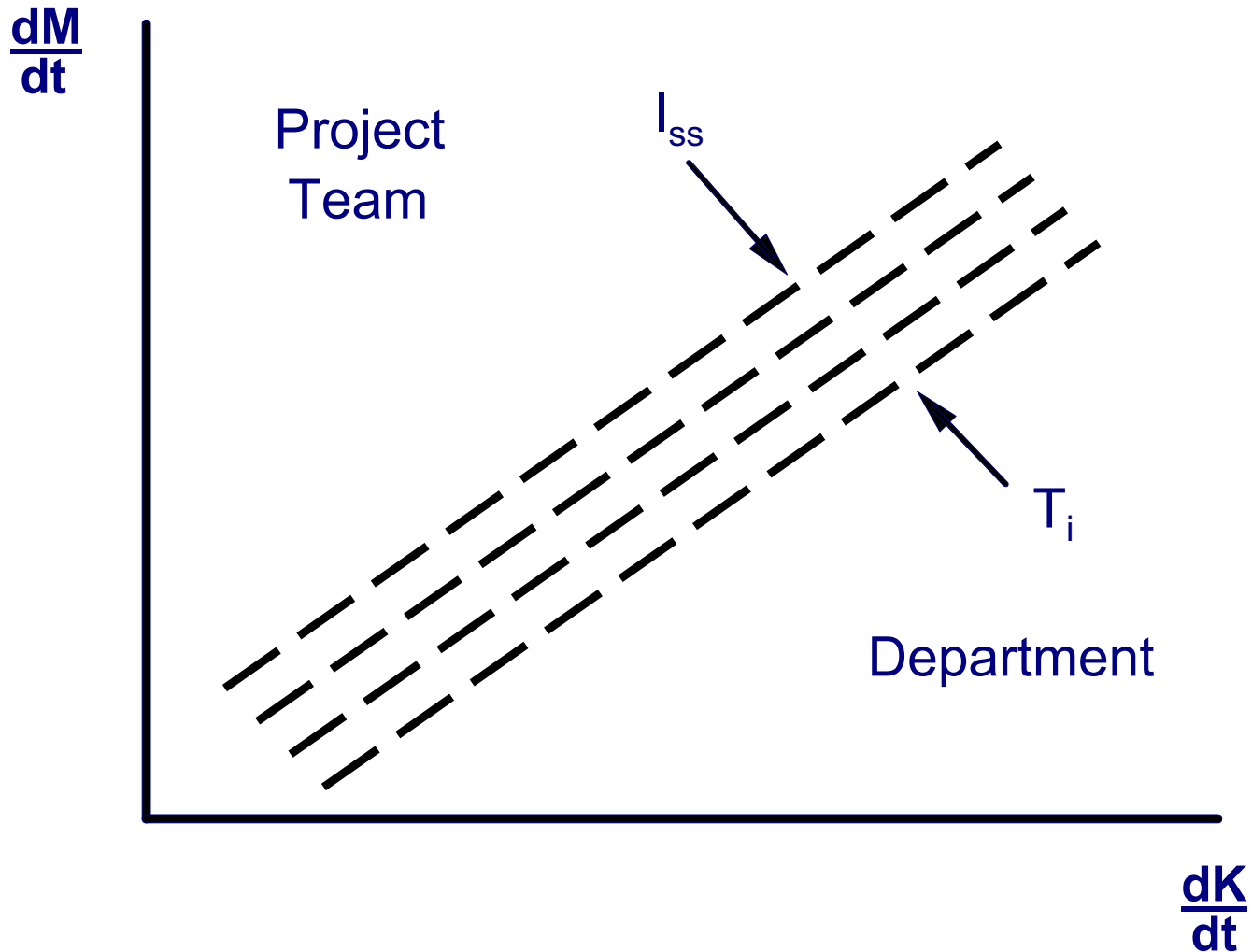


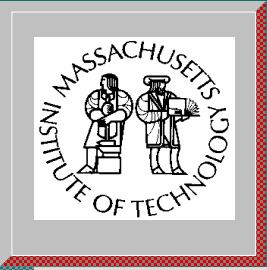
Structuring the Organization

- **Standard Industrial Practice**
 - Ignores the rate at which technologies are developing (despite the fact that this can often be measured).
 - Usually ignores the interdependencies in project work (seasoned project managers are an exception).
 - Focuses on project duration (and usually makes the wrong decision on this parameter).

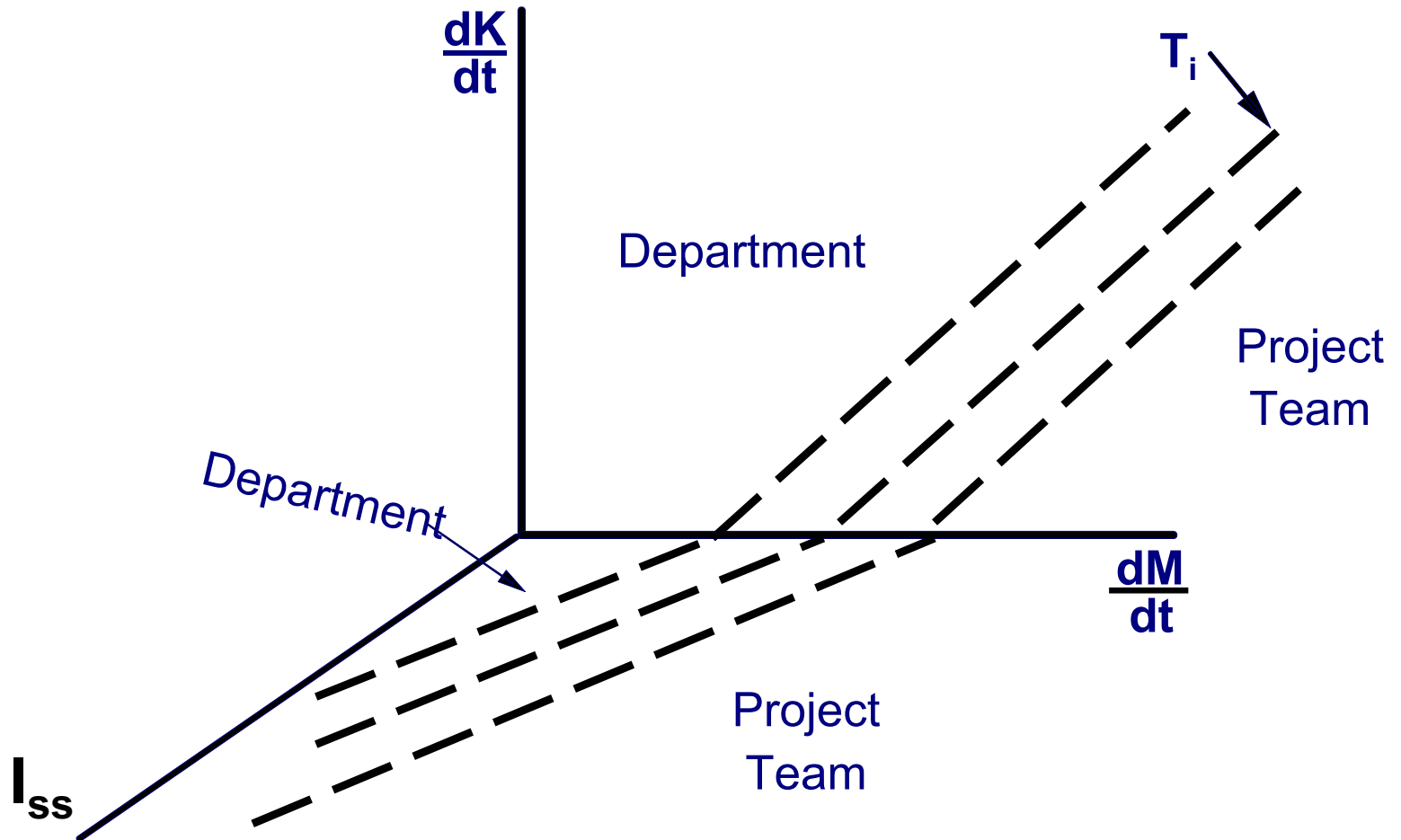


Organizational Structure Space IV

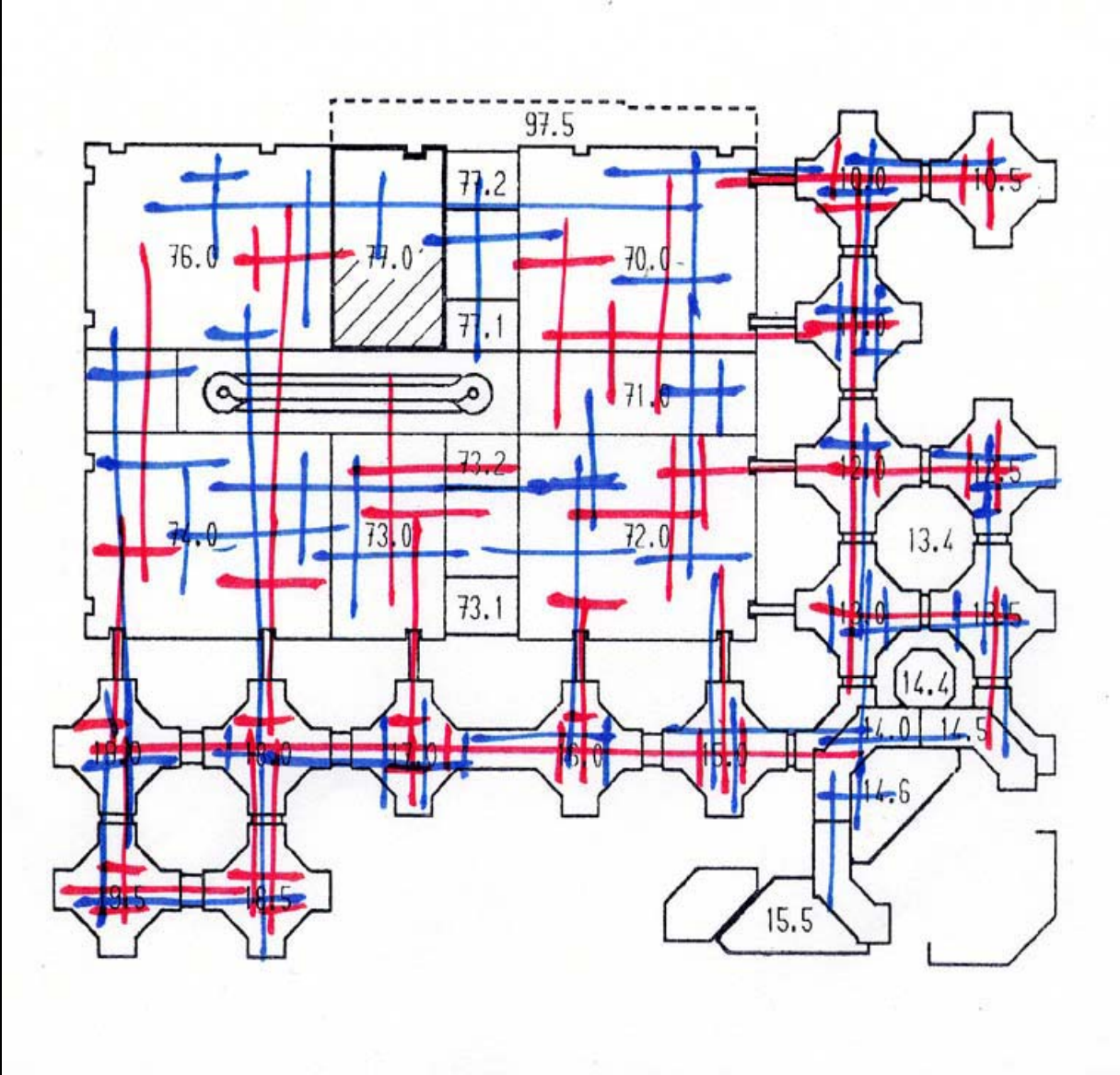
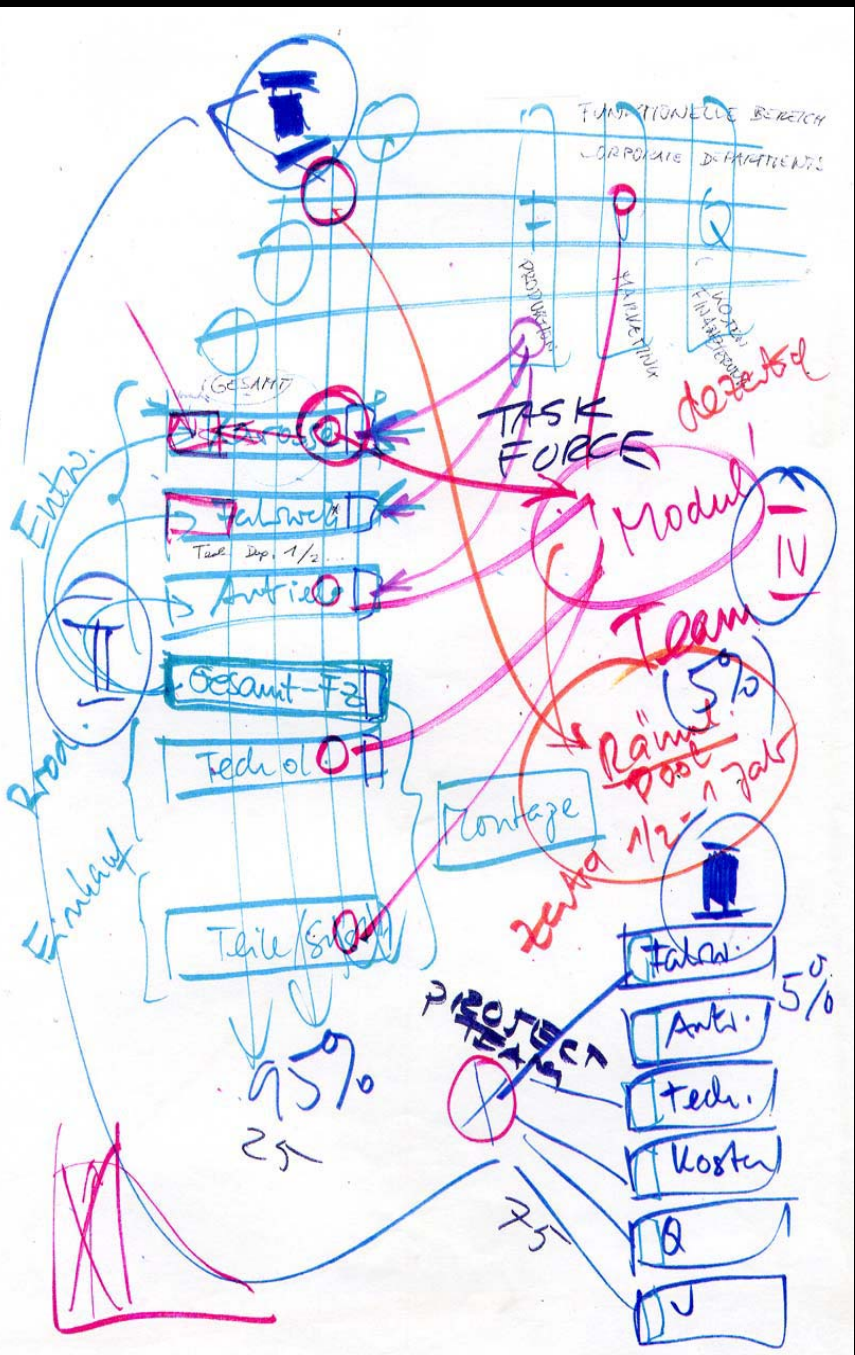


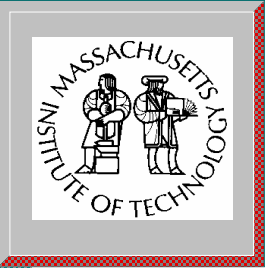


Organizational Structure Space V

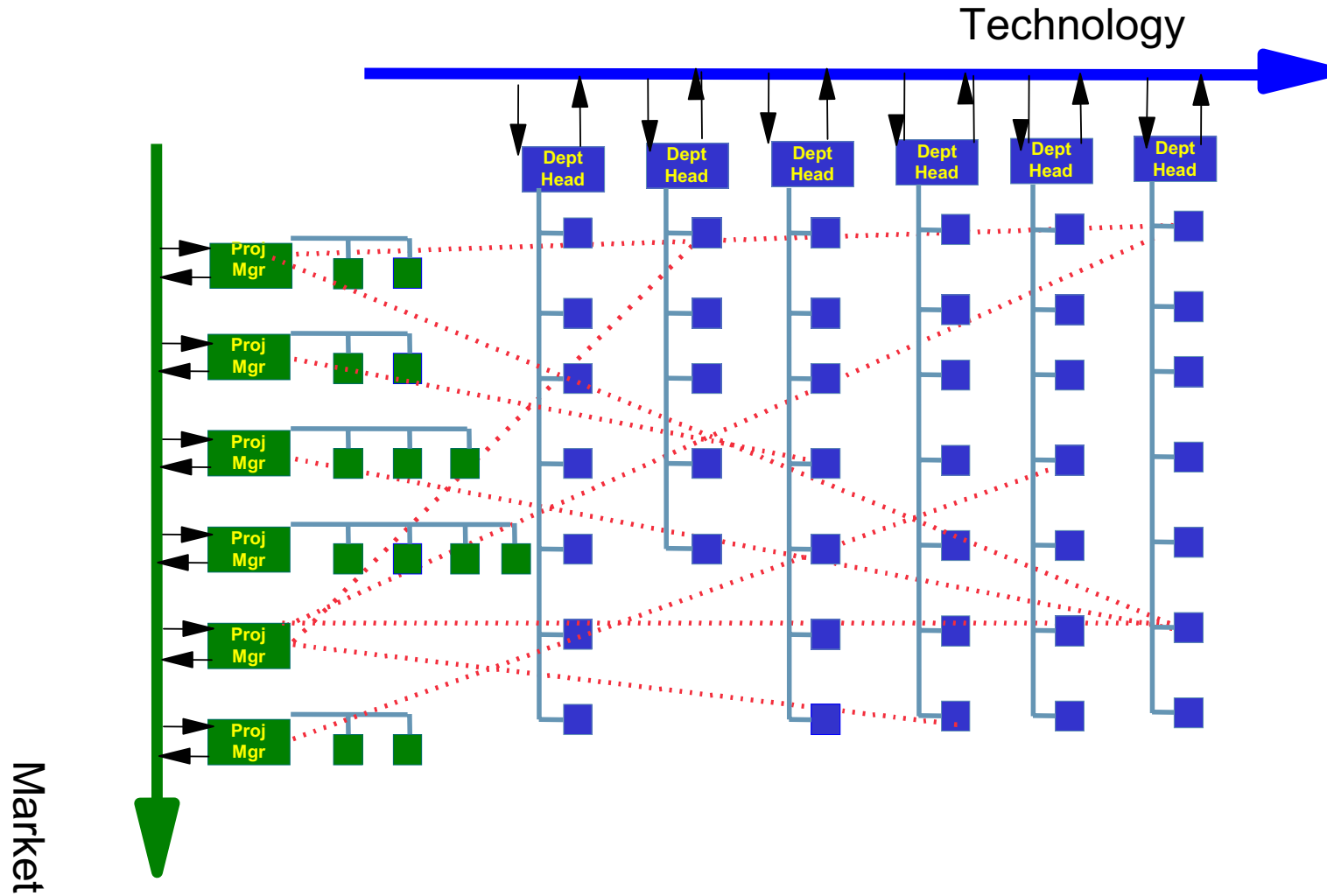


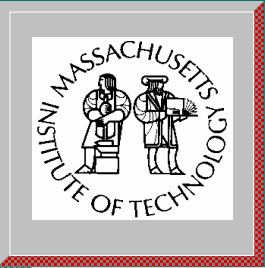
Concurrent Engineering



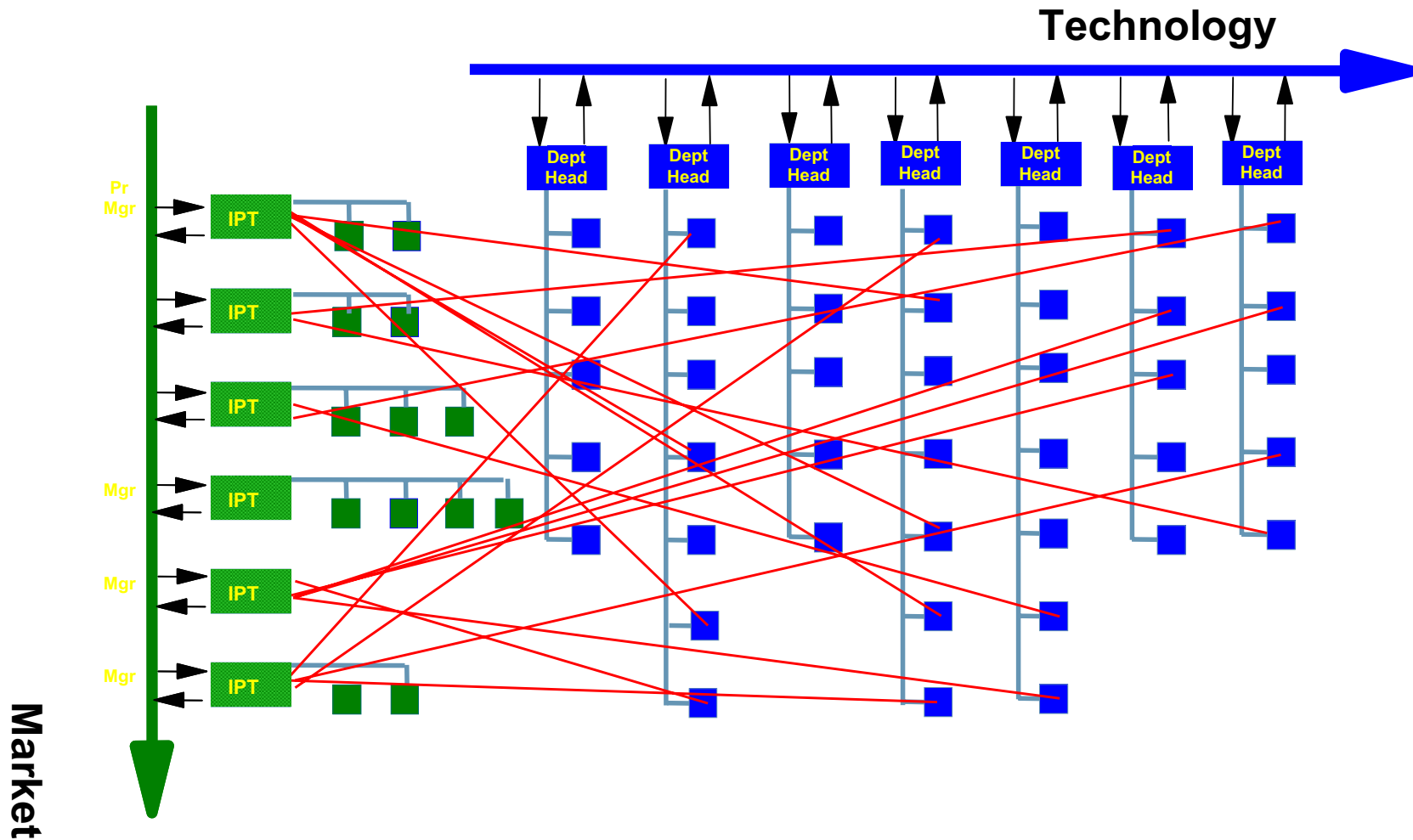


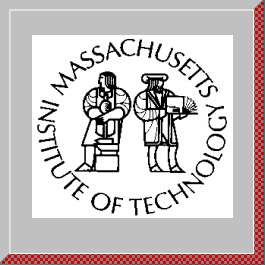
Matrix Connections to Market and Technology



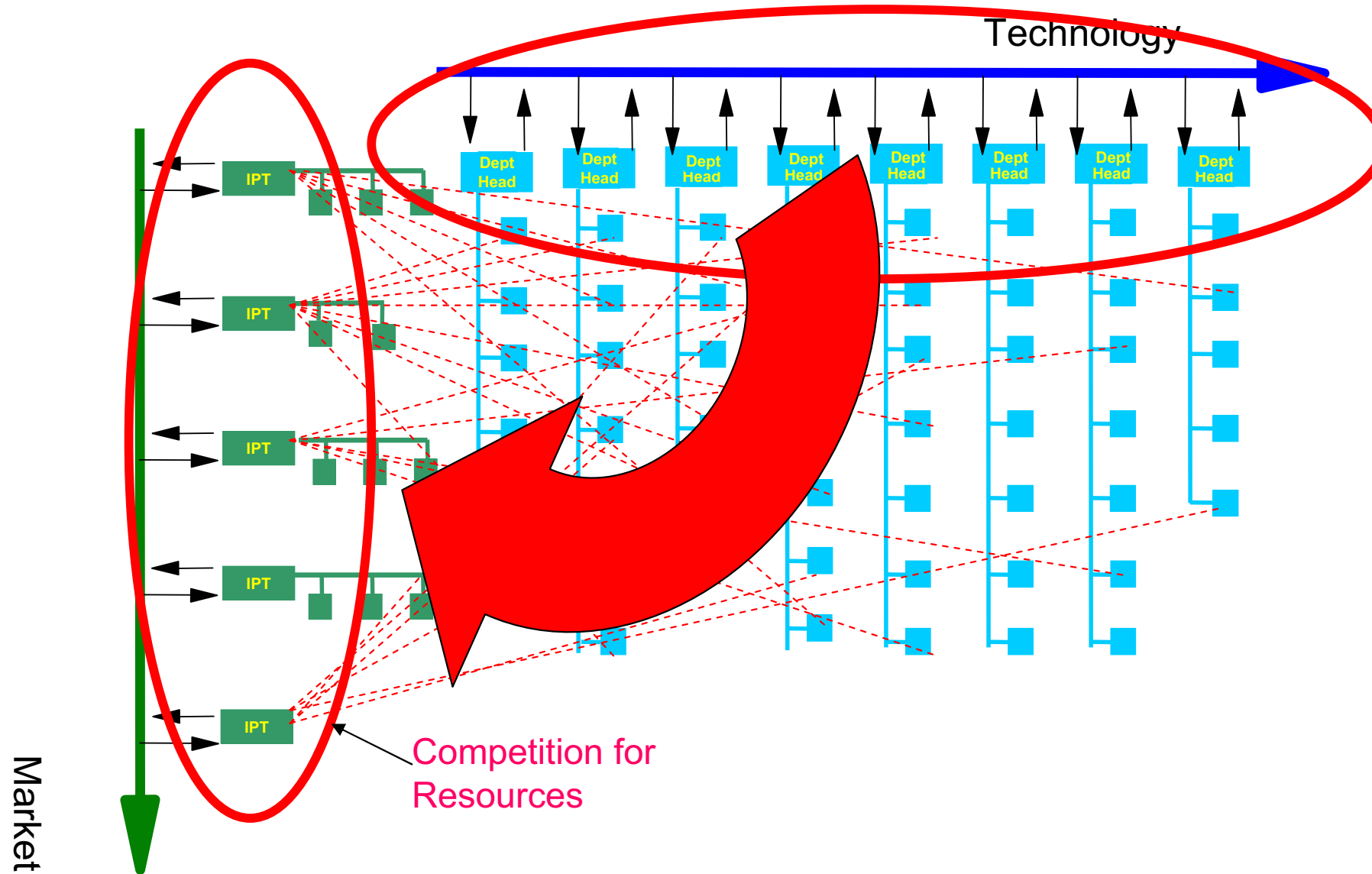


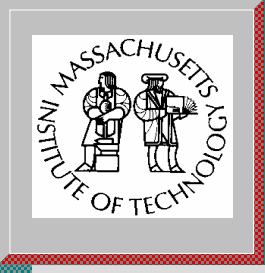
Matrix Connections to Market and Technology



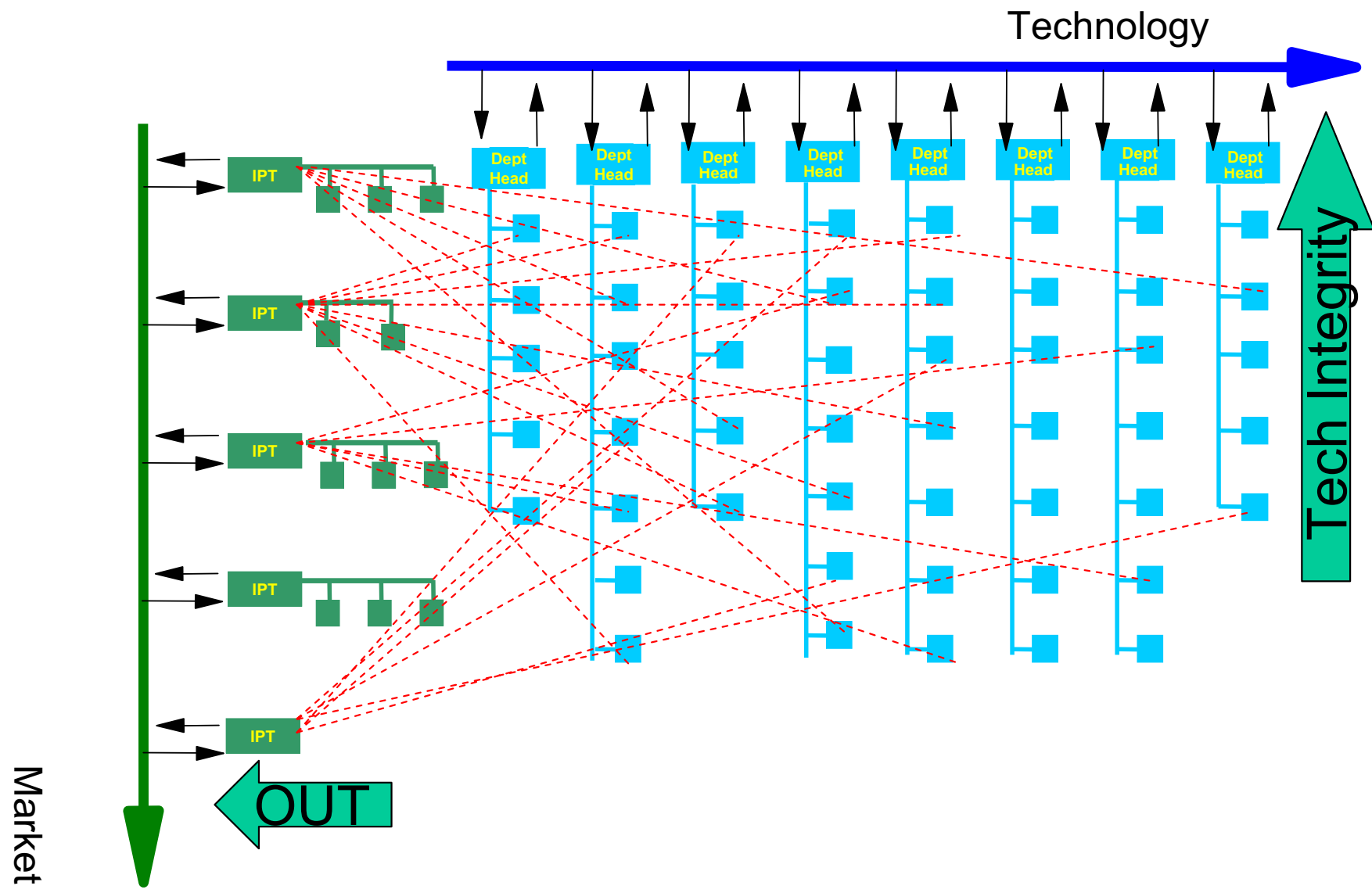


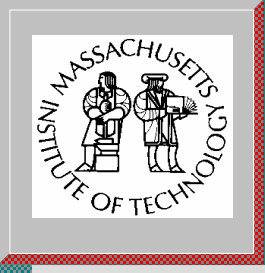
Some Problems



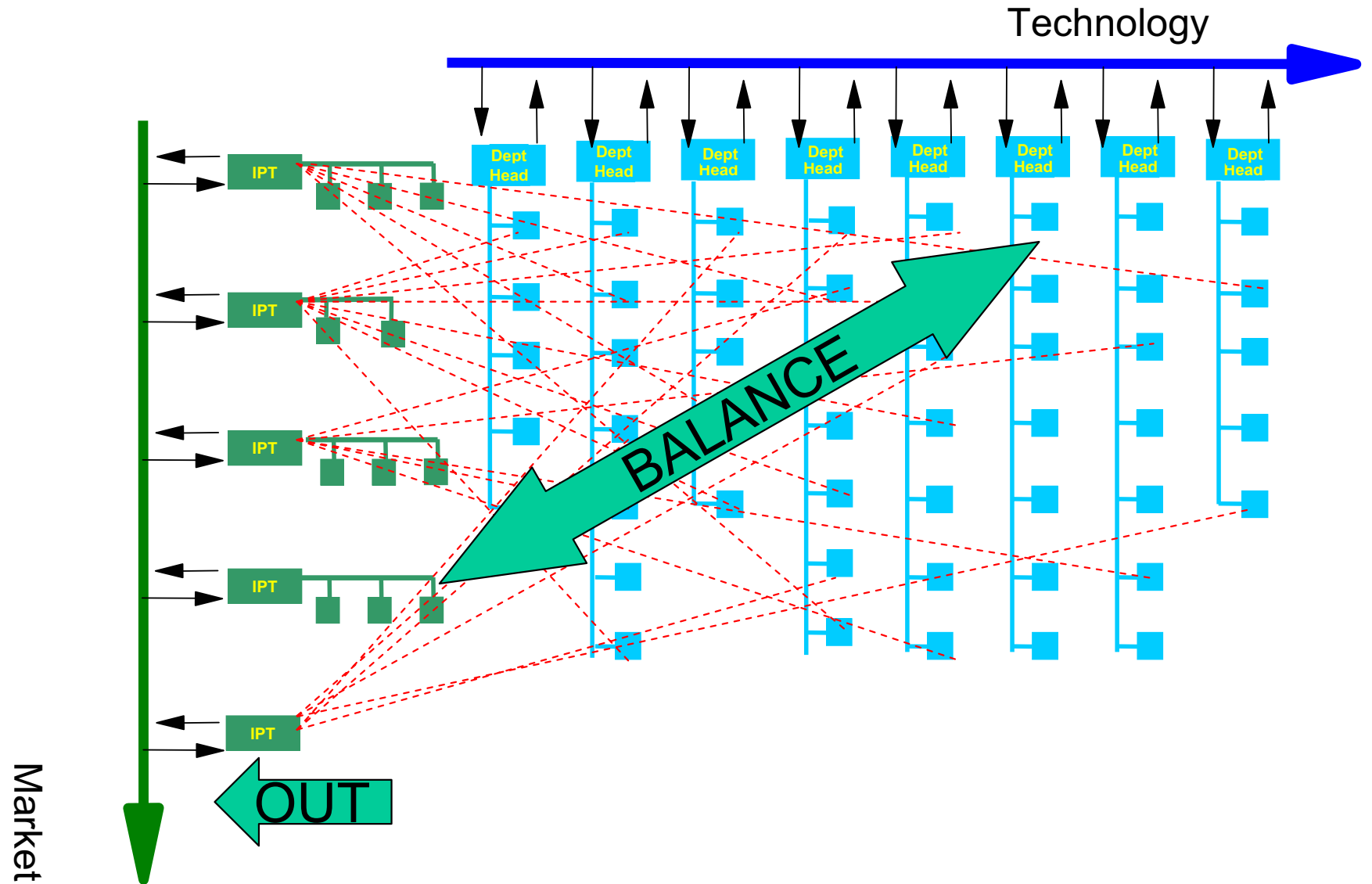


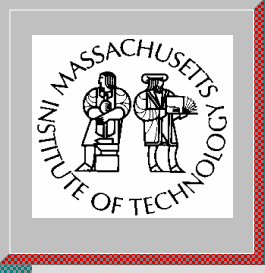
Problems with Imbalance



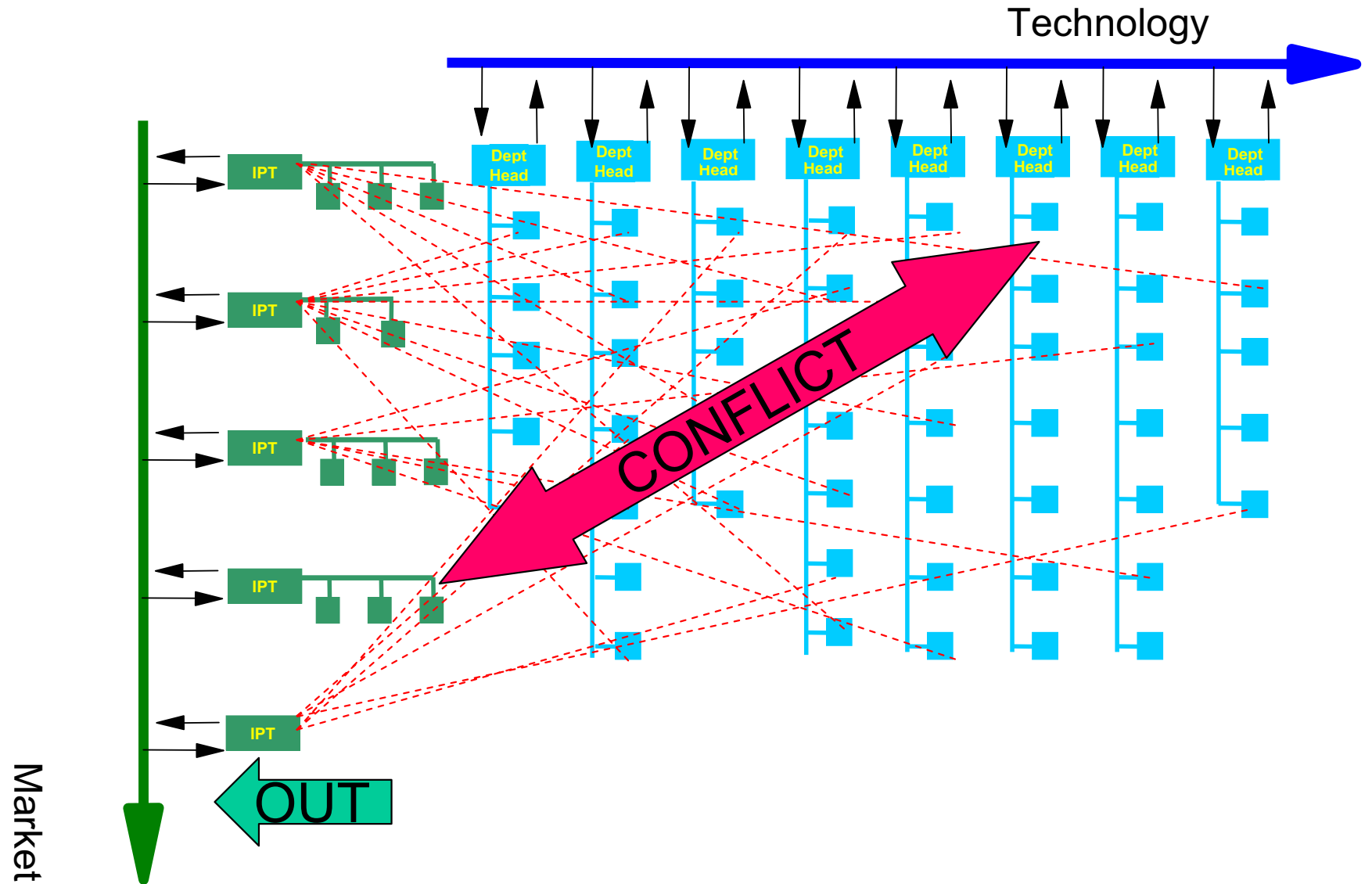


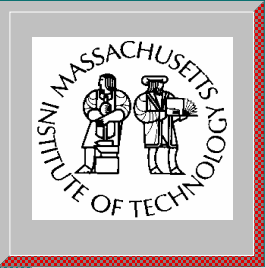
The Need for Balance



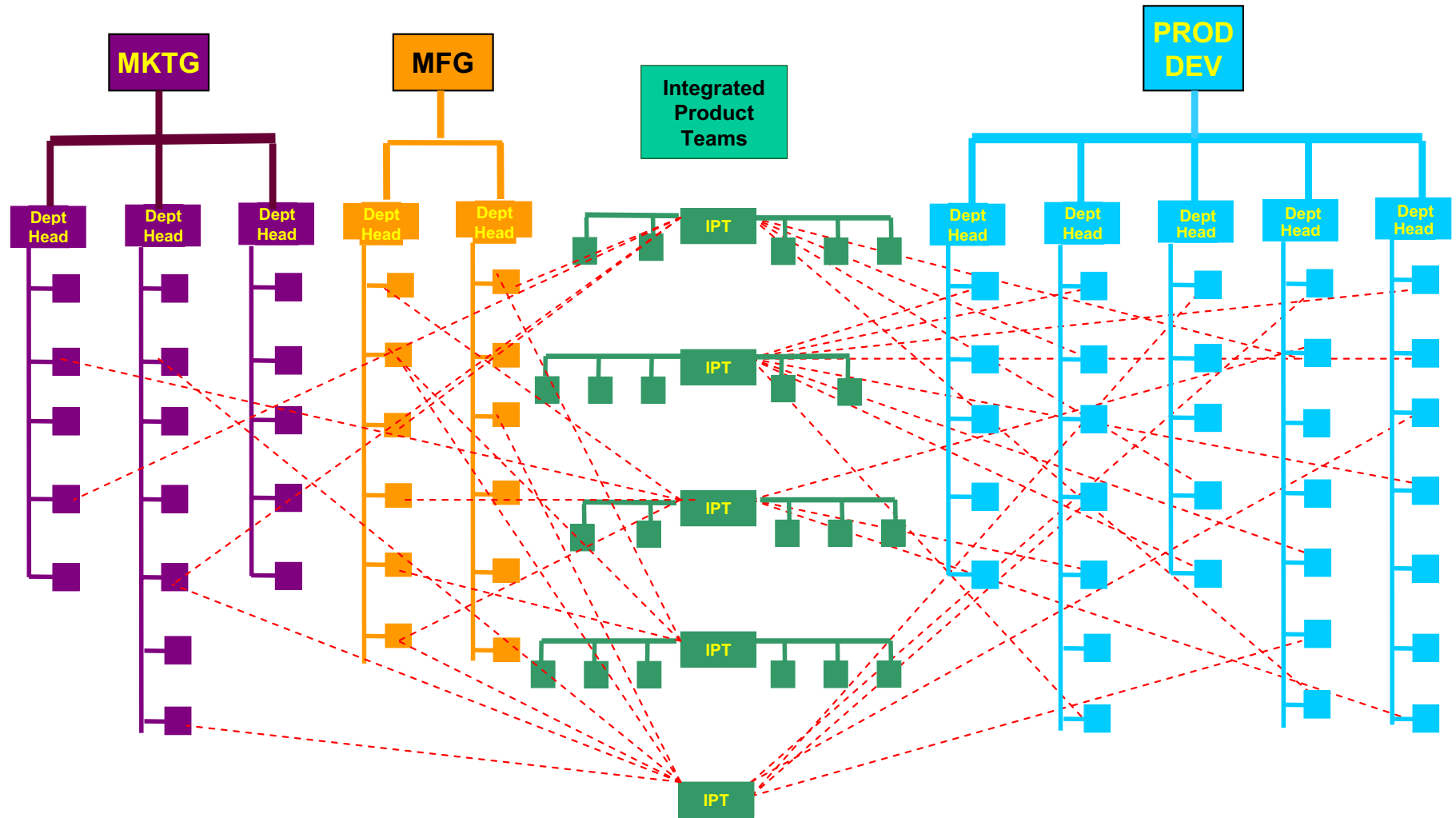


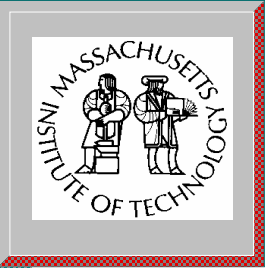
The Inescapable Conflict



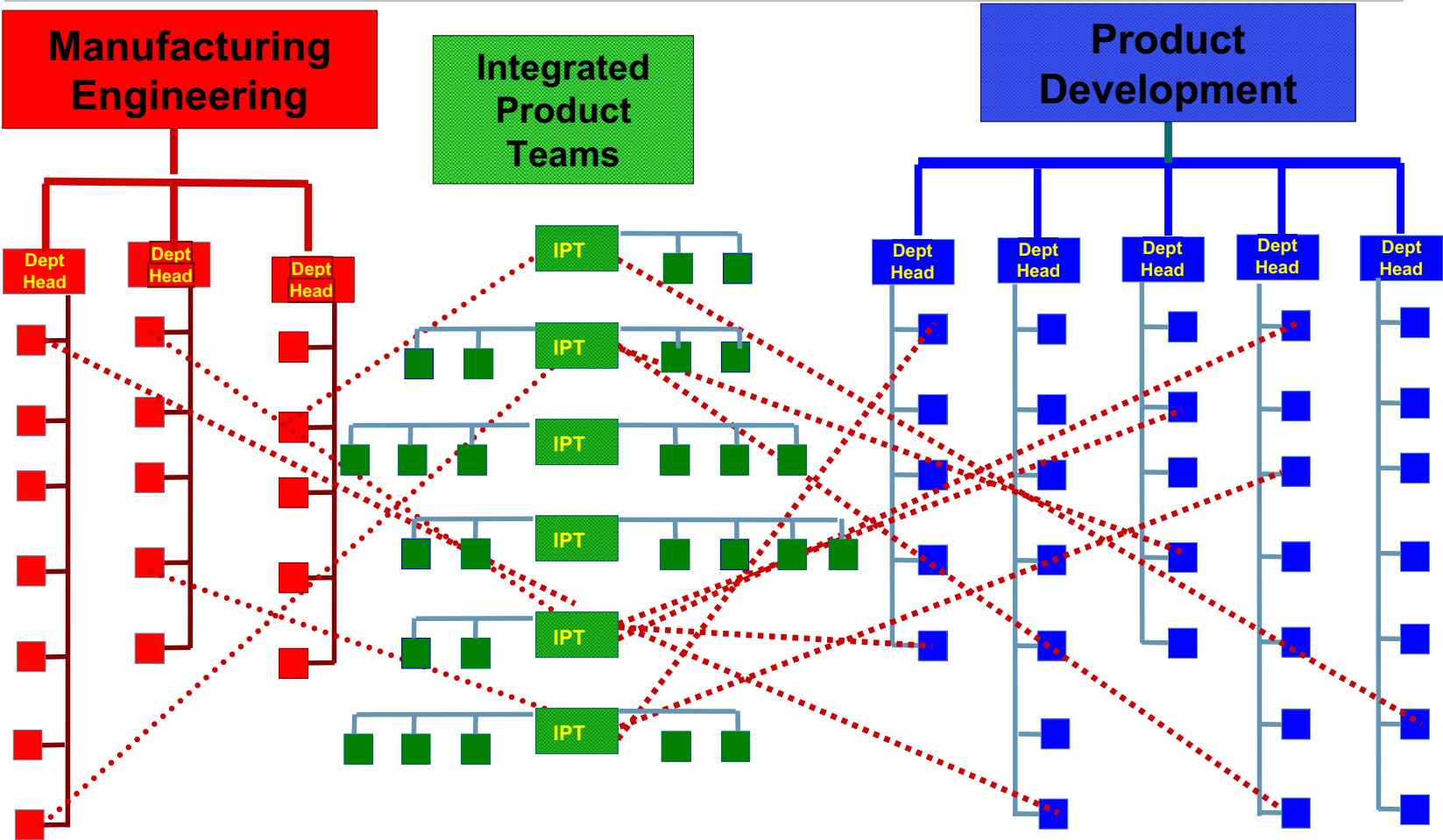


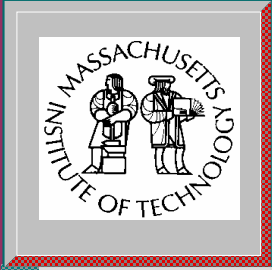
A More Complete Matrix Using Integrated Product Teams





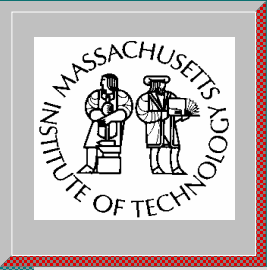
Matrix Connections to Product Development and Manufacturing Engineering



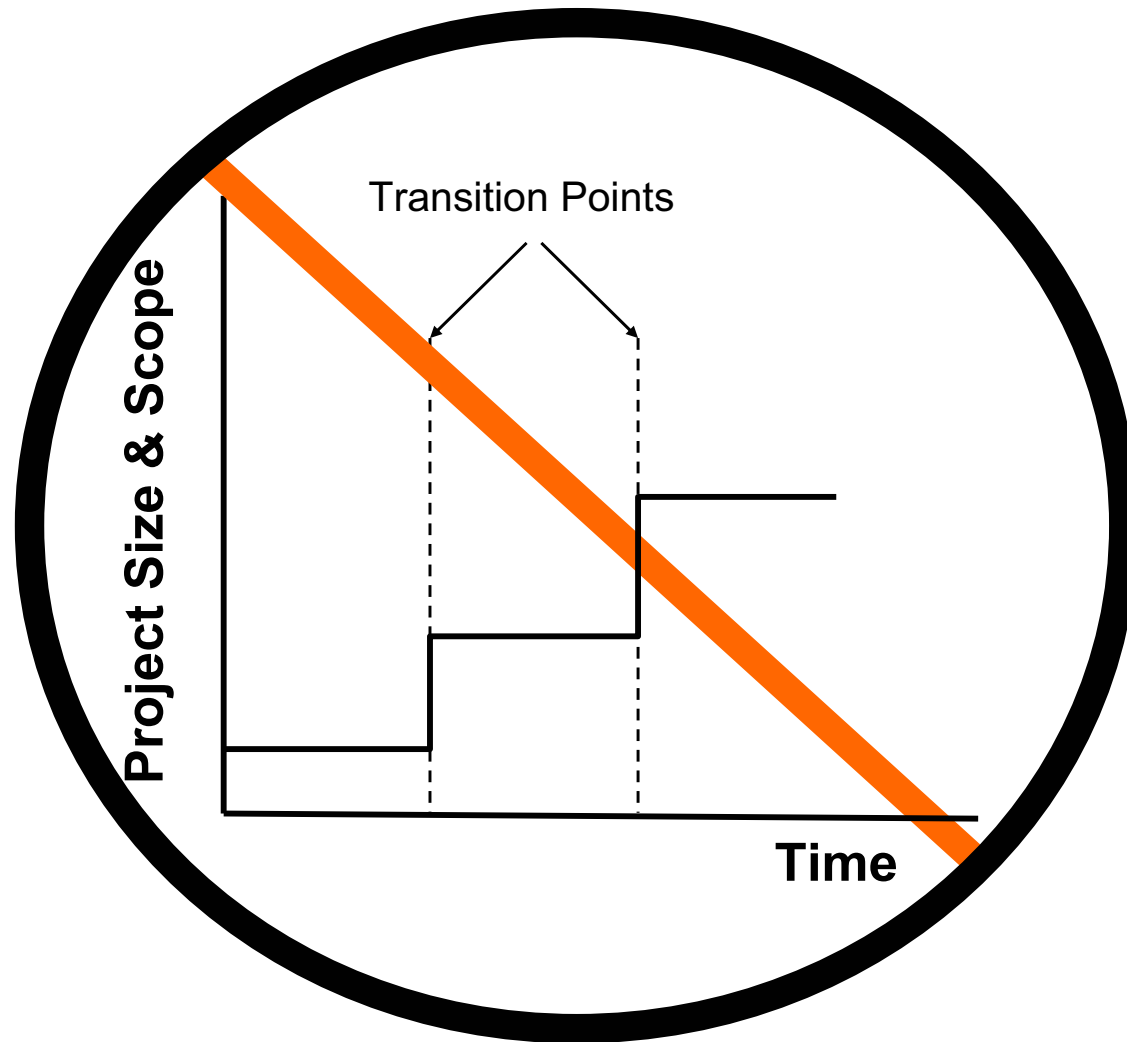


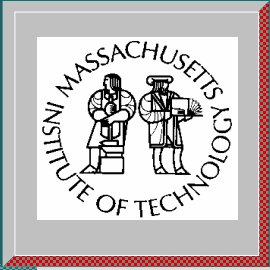
Management of Transitions

- The critical points of vulnerability in the life of a project are the points of transition.
 - Transitions can involve many parameters, for example:
 - People
 - Management
 - Leadership & leadership style.
 - Primary organizational responsibility and reporting relationships.
 - Nature of the work.
 - Types of knowledge required.
 - Physical location.
- To change all of these simultaneously is to court disaster.



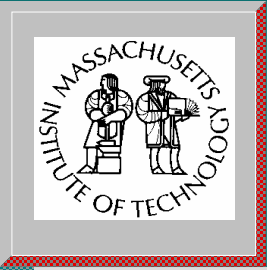
Management of Transitions II



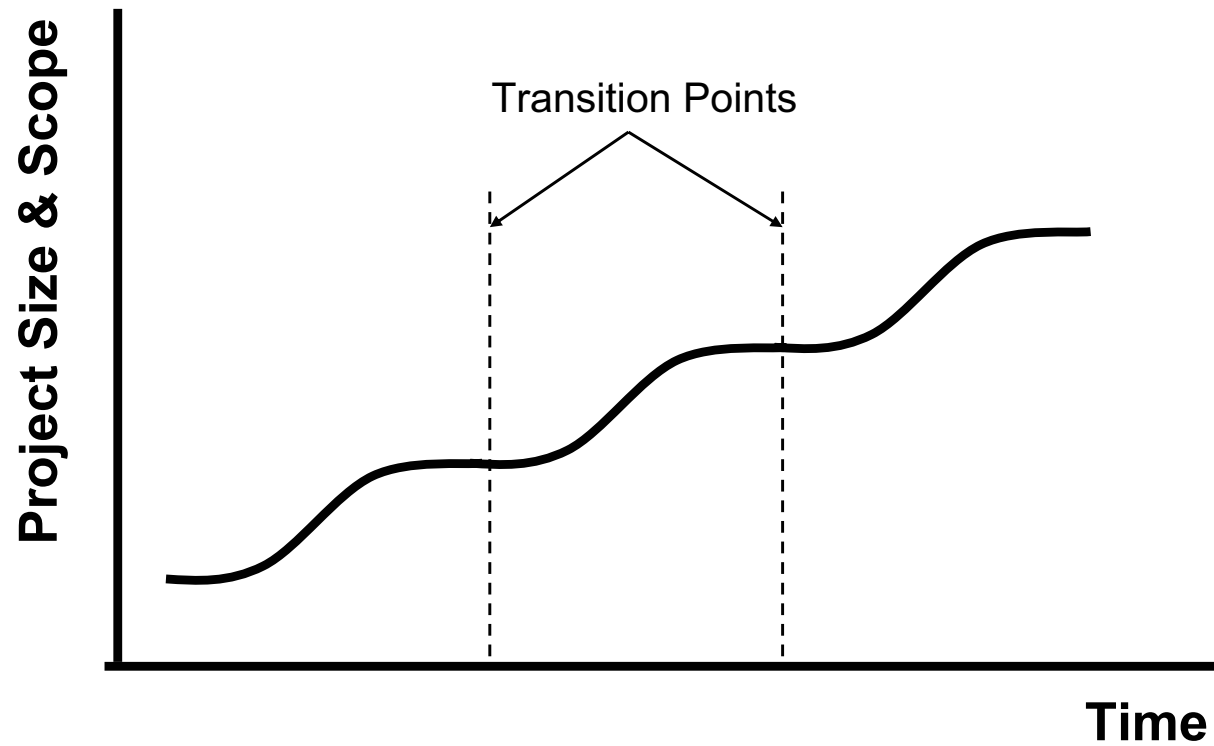


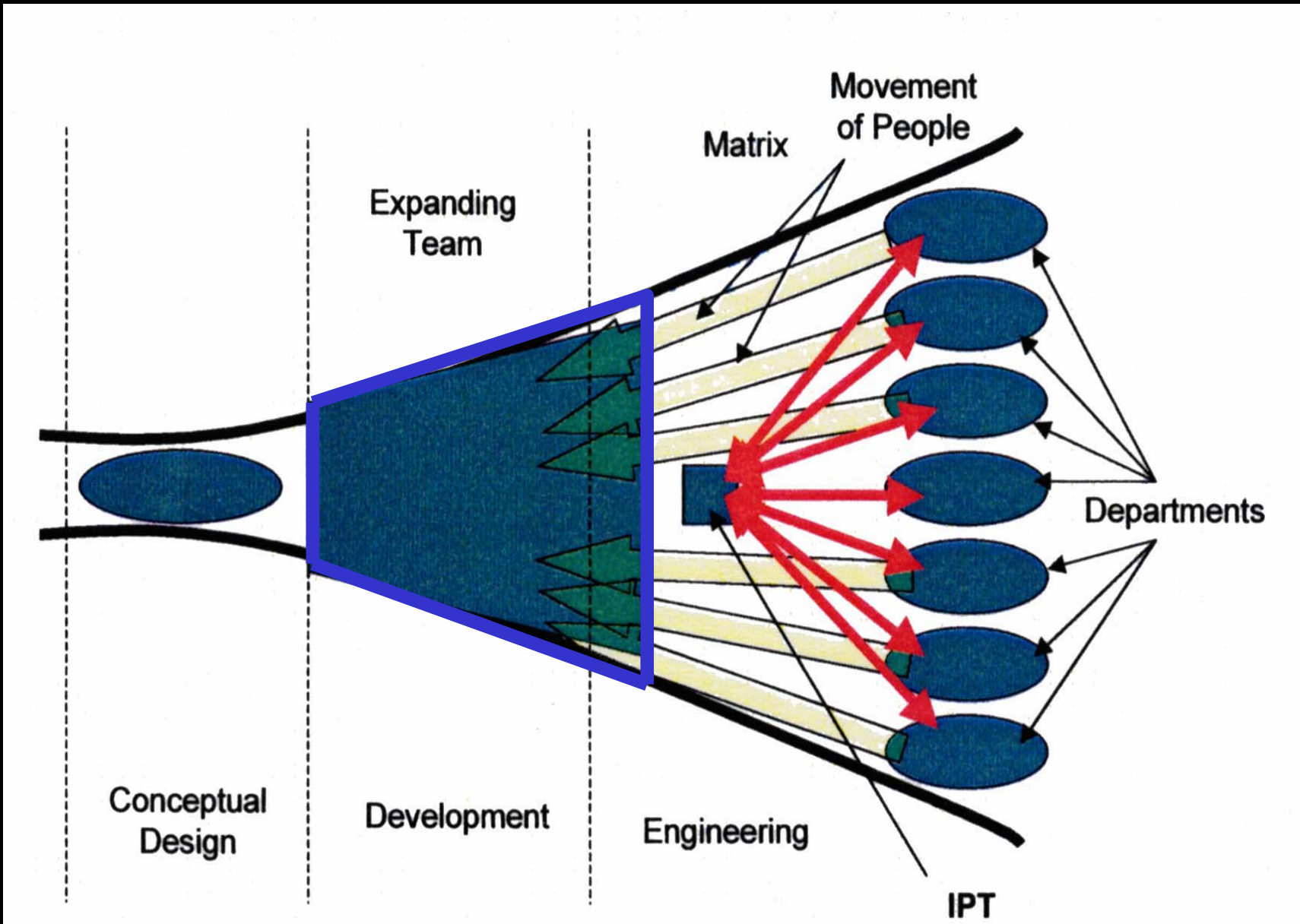
Management of Transitions IV

- Projects must be protected through transitions.
 - There must be areas of continuity to offset the areas of change.
 - Team size must grow in a gradual fashion.
 - This has implications for both organizational structure and physical architecture.
 - Both must be very flexible to allow this to happen along with a gradual transition in reporting relationship.
 - There should be an extra effort to retain a sense of ‘ownership’ among team members.
 - Avoid ‘runway management’.

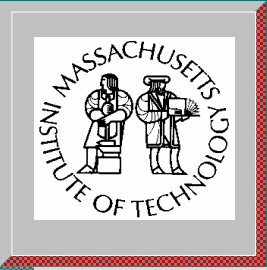


Management of Transitions III

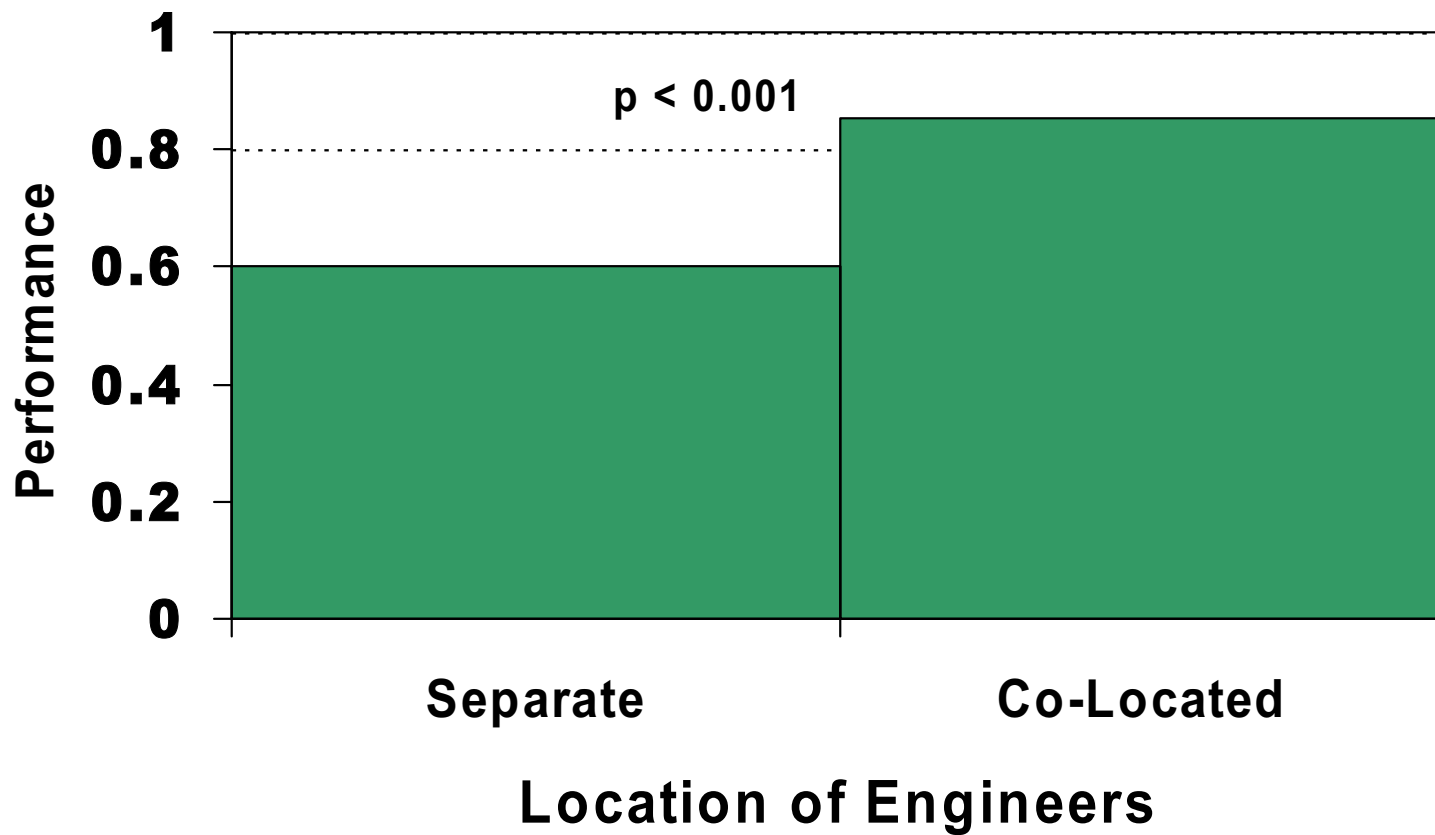


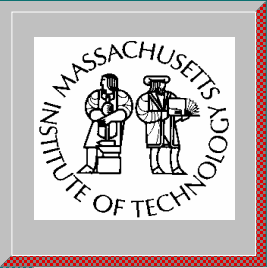


spatial order organizational order

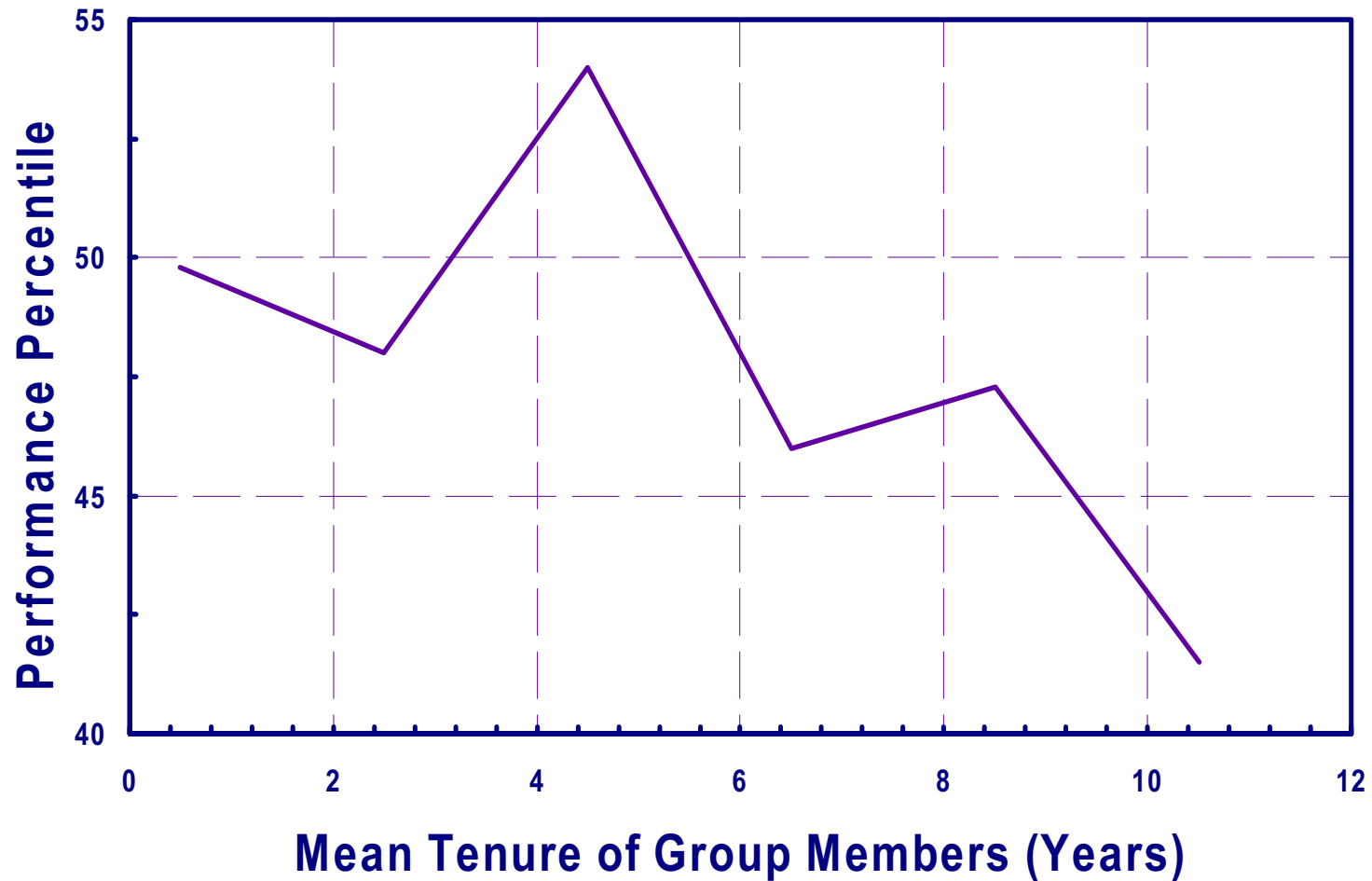


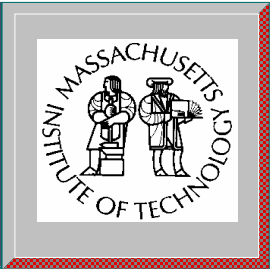
Transition Performance



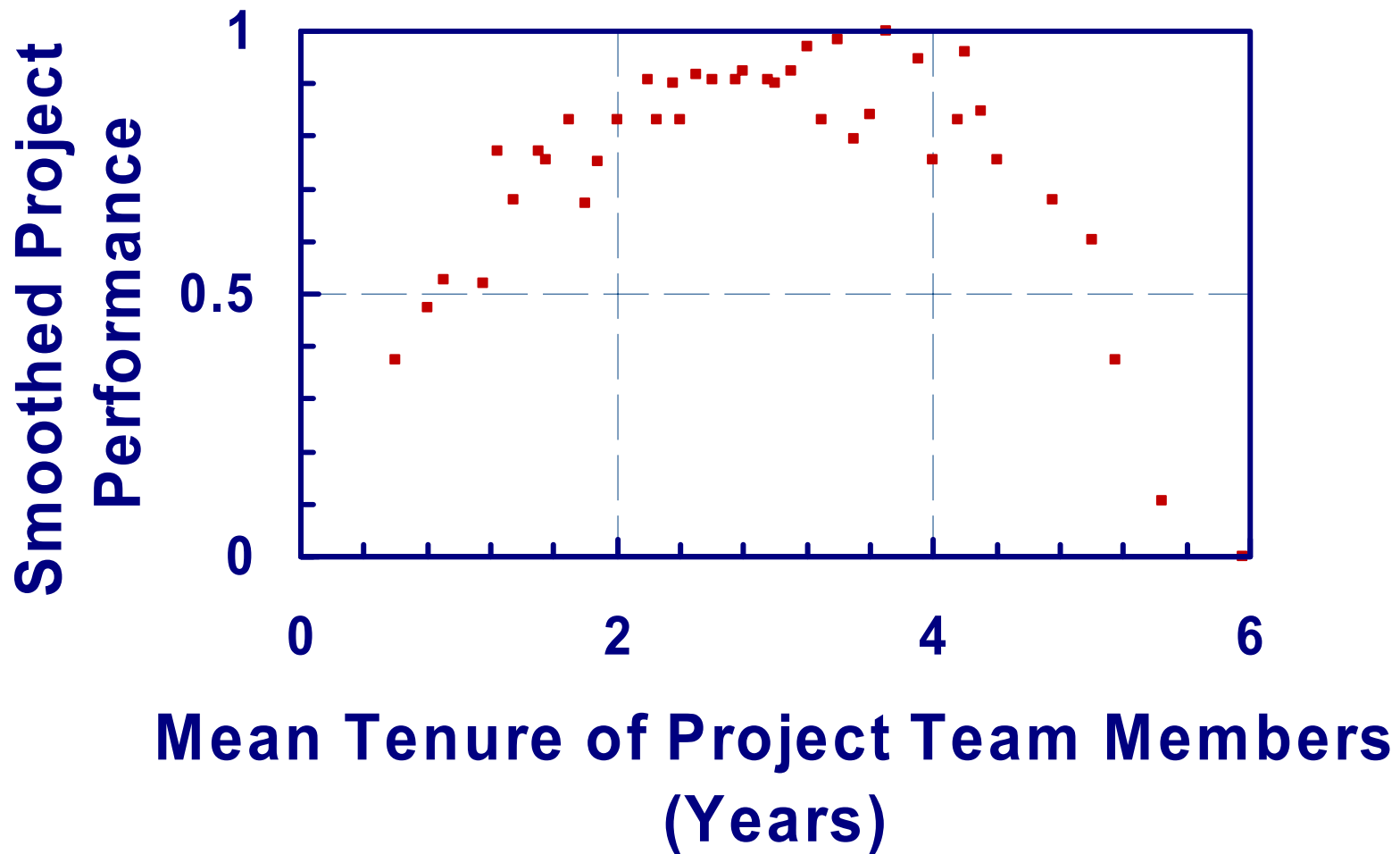


PERFORMANCE AS A FUNCTION OF GROUP AGE (PELZ & ANDREWS)

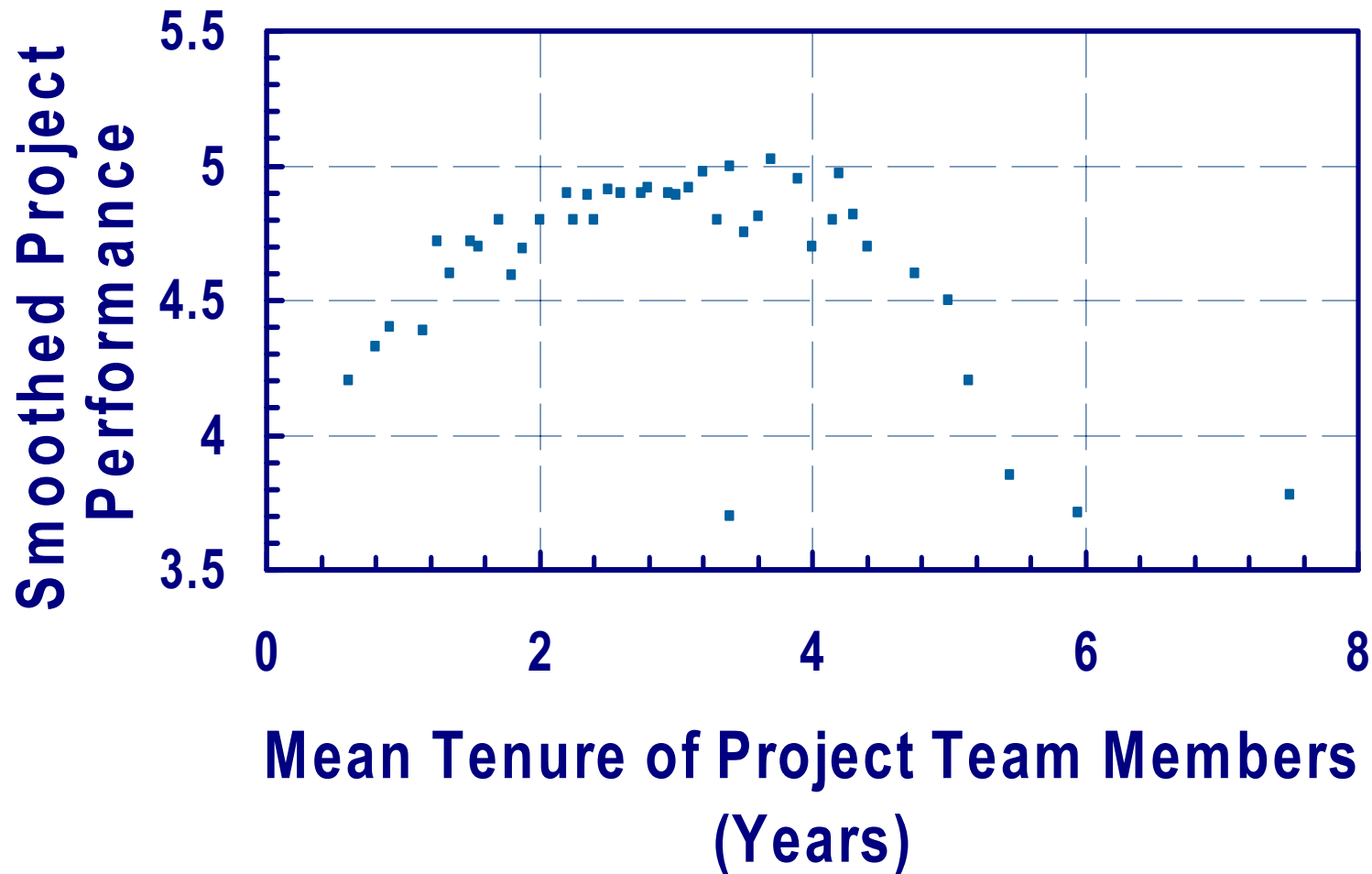
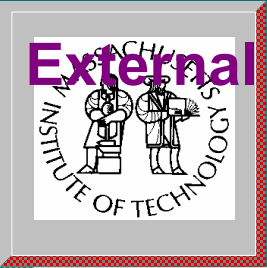


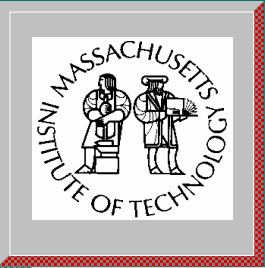


Project Performance as a Function of Team Age (45 Chemical Industry Projects)

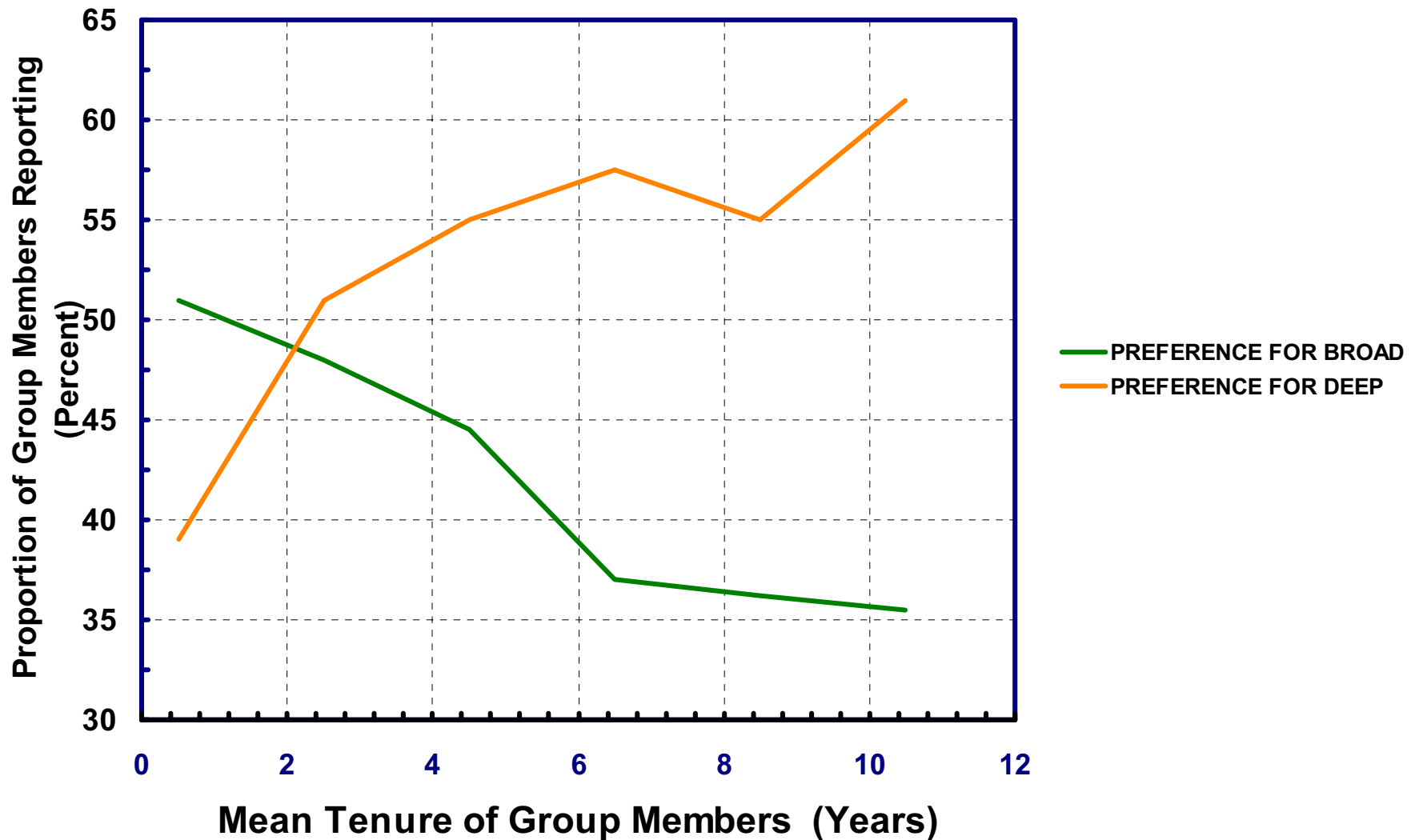


External Technical Communication as a Function of Team Age (45 Chemical Industry Projects)





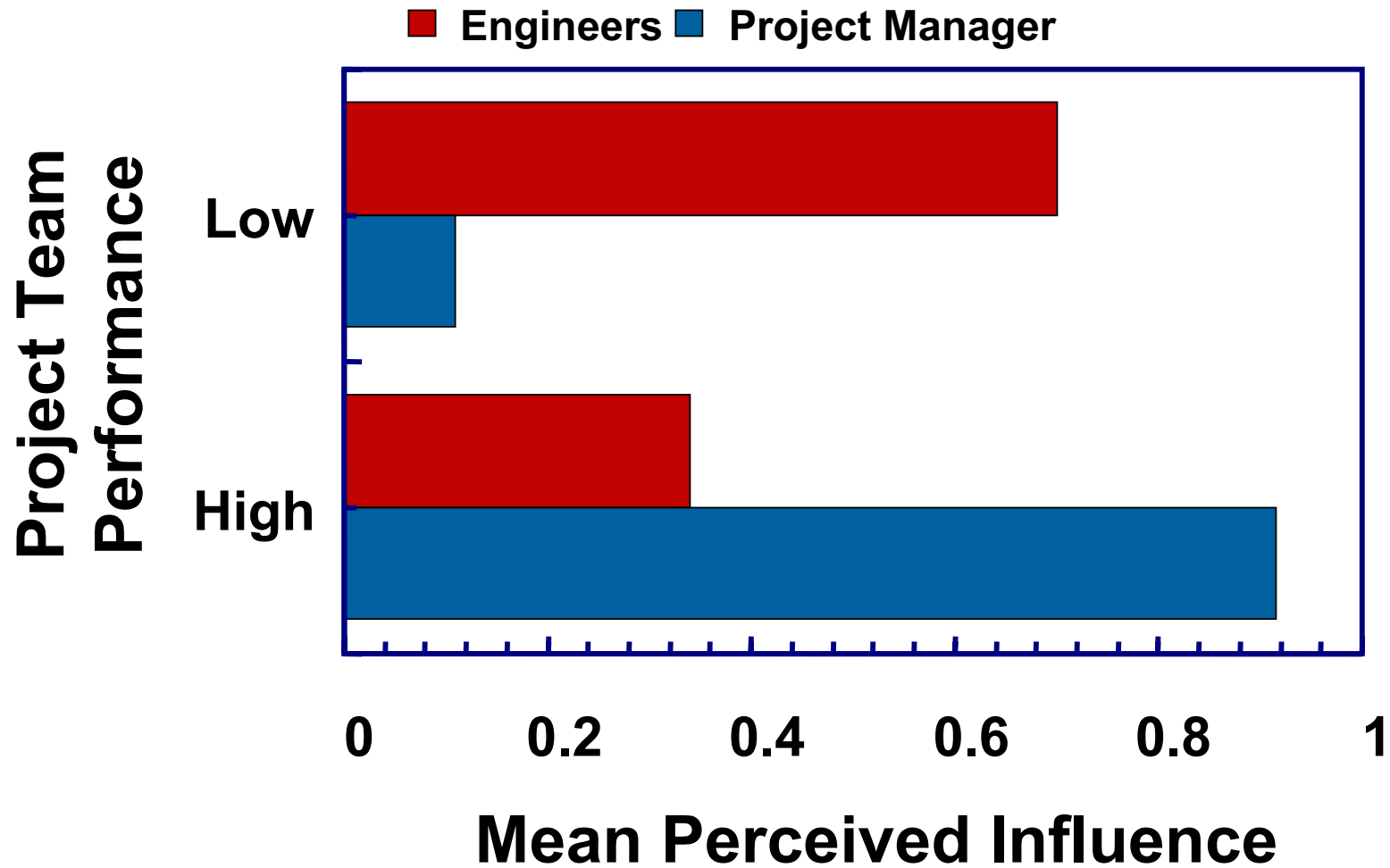
WORK PREFERENCES AS A FUNCTION OF MEAN TENURE (PELZ & ANDREWS)

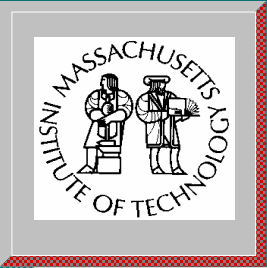




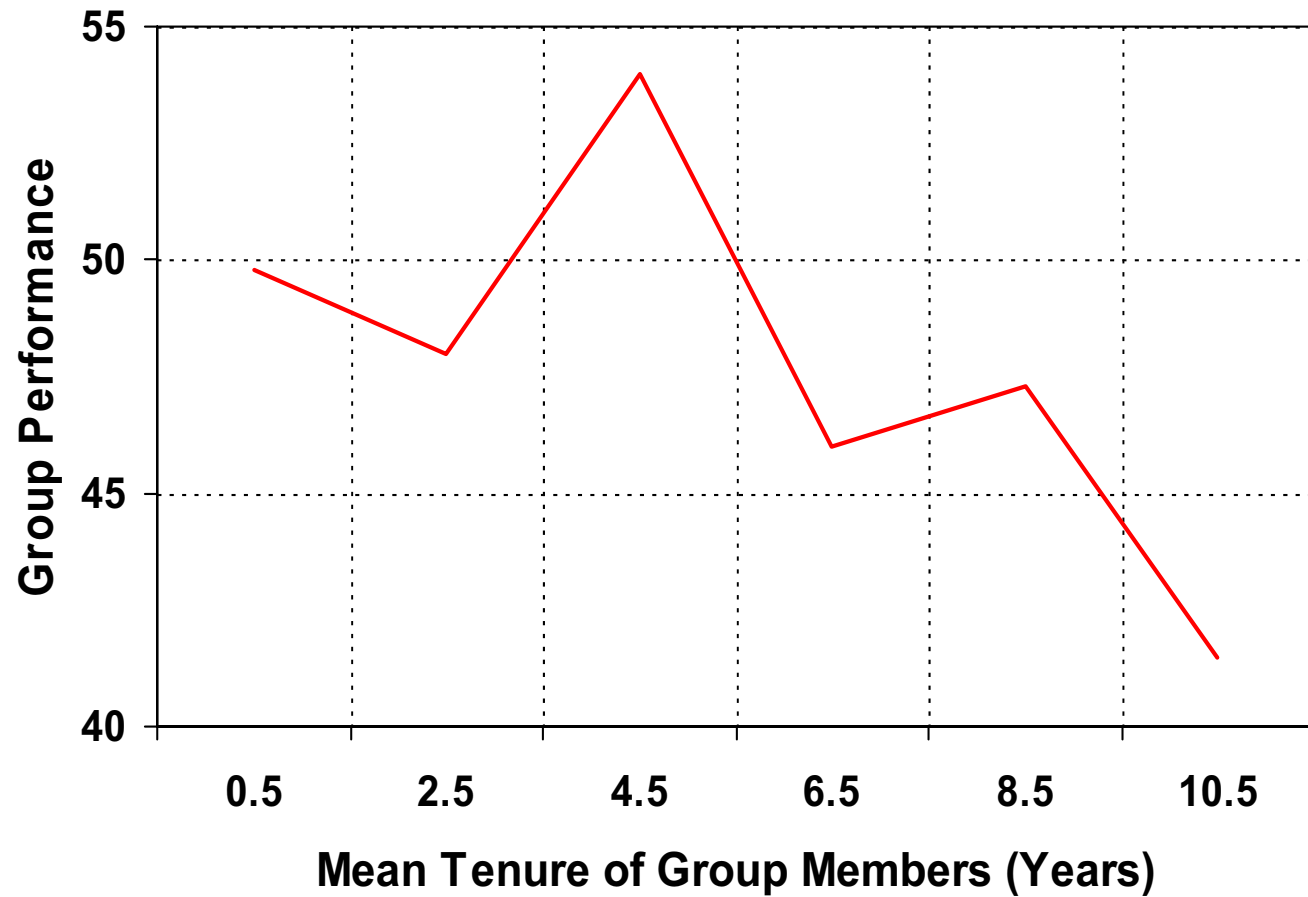
Perceived Influence Over Project Goals & Objectives

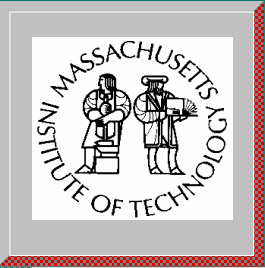
(Teams with Mean Tenure Greater Than Five Years)



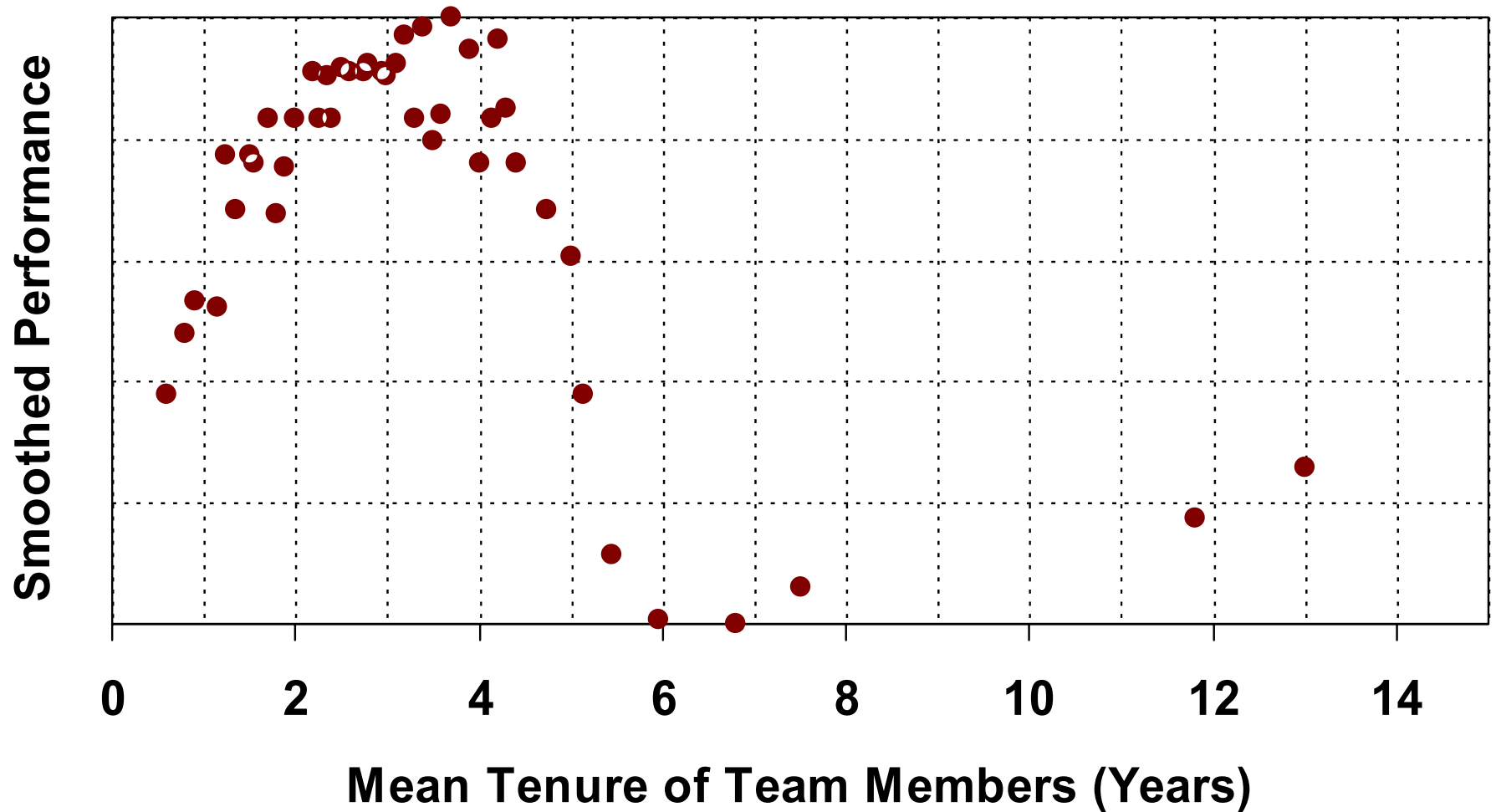


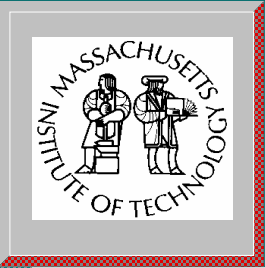
PERFORMANCE AS A FUNCTION OF GROUP AGE (PELZ & ANDREWS)



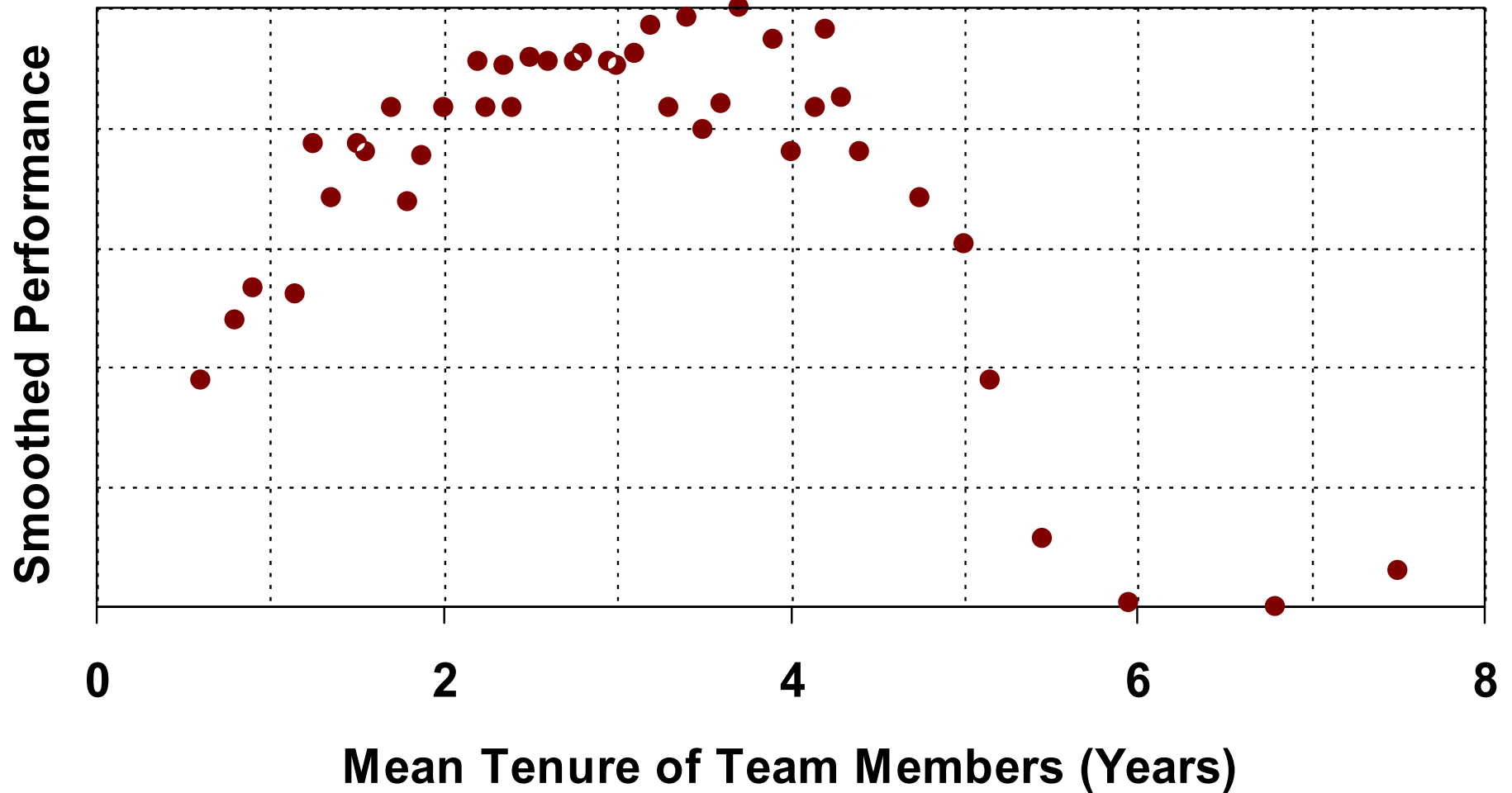


Project Performance as a Function of Team Age (45 Chemical Industry Projects)



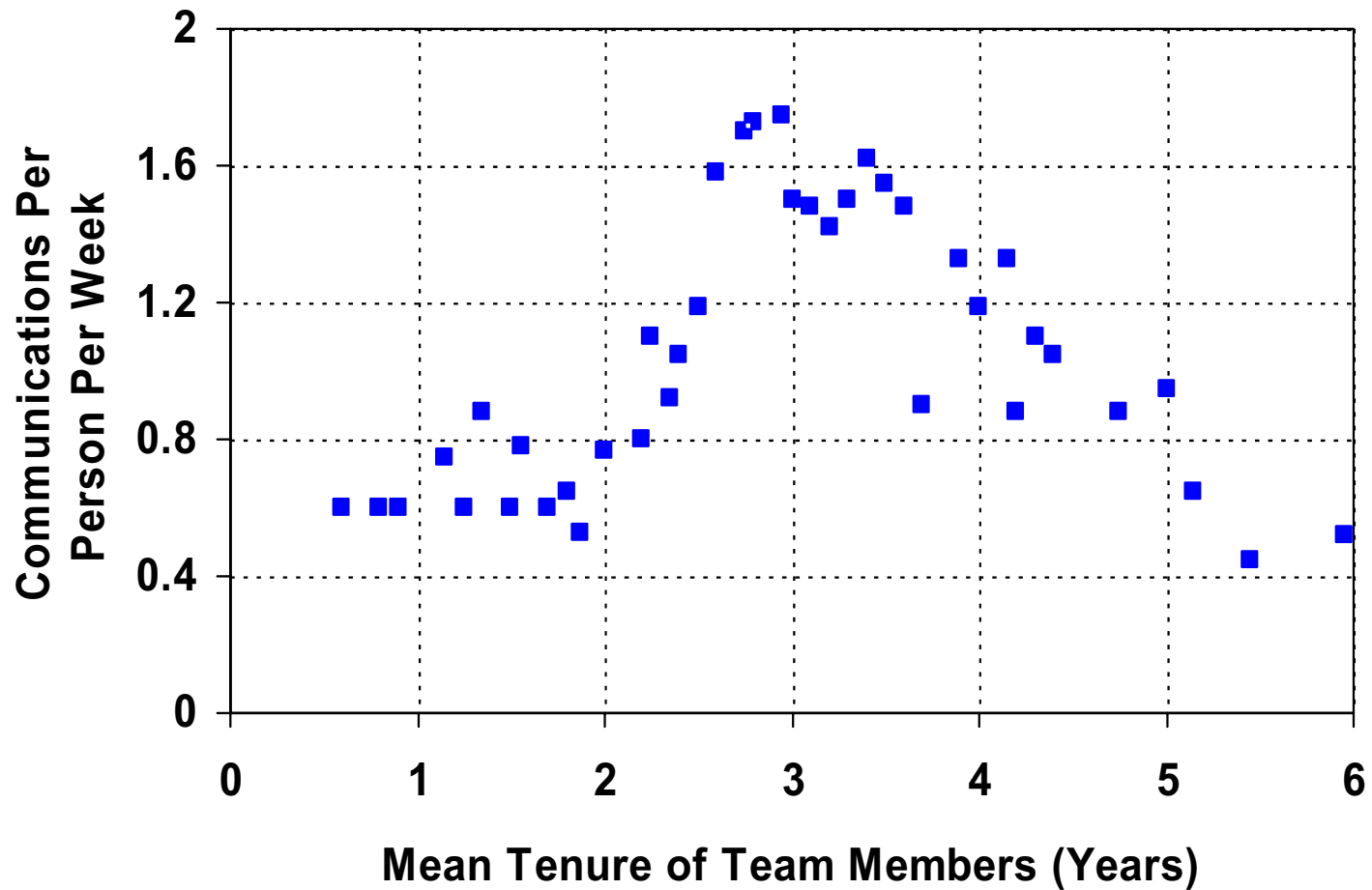


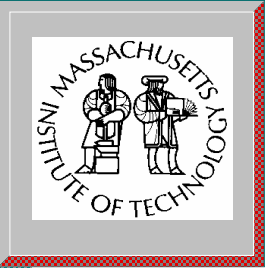
Project Performance as a Function of Team Age (45 Chemical Industry Projects)



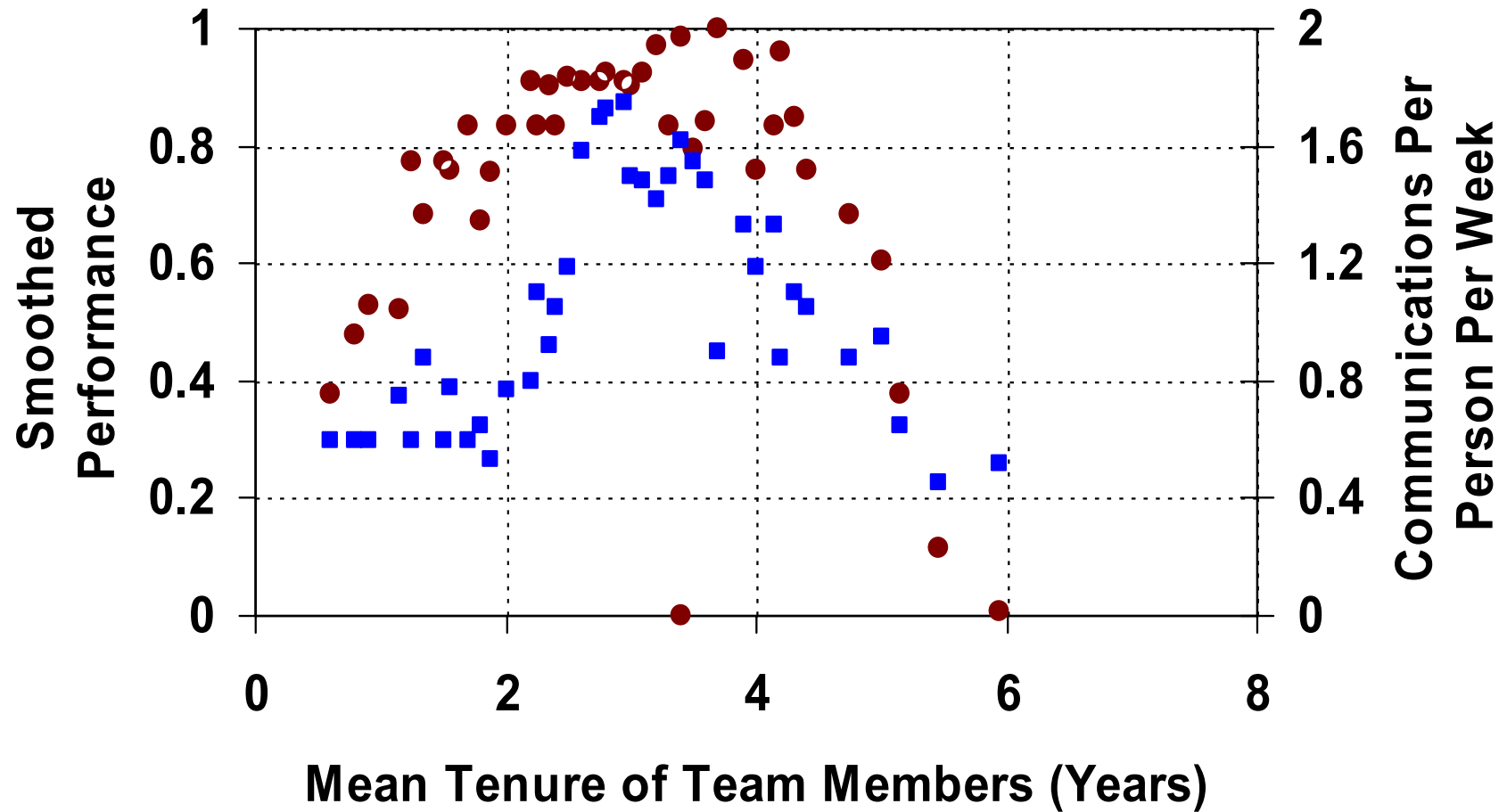


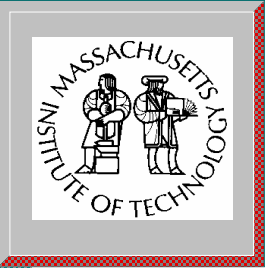
Project Performance and External Communication as a Function of Team Age (45 Chemical Industry Projects)



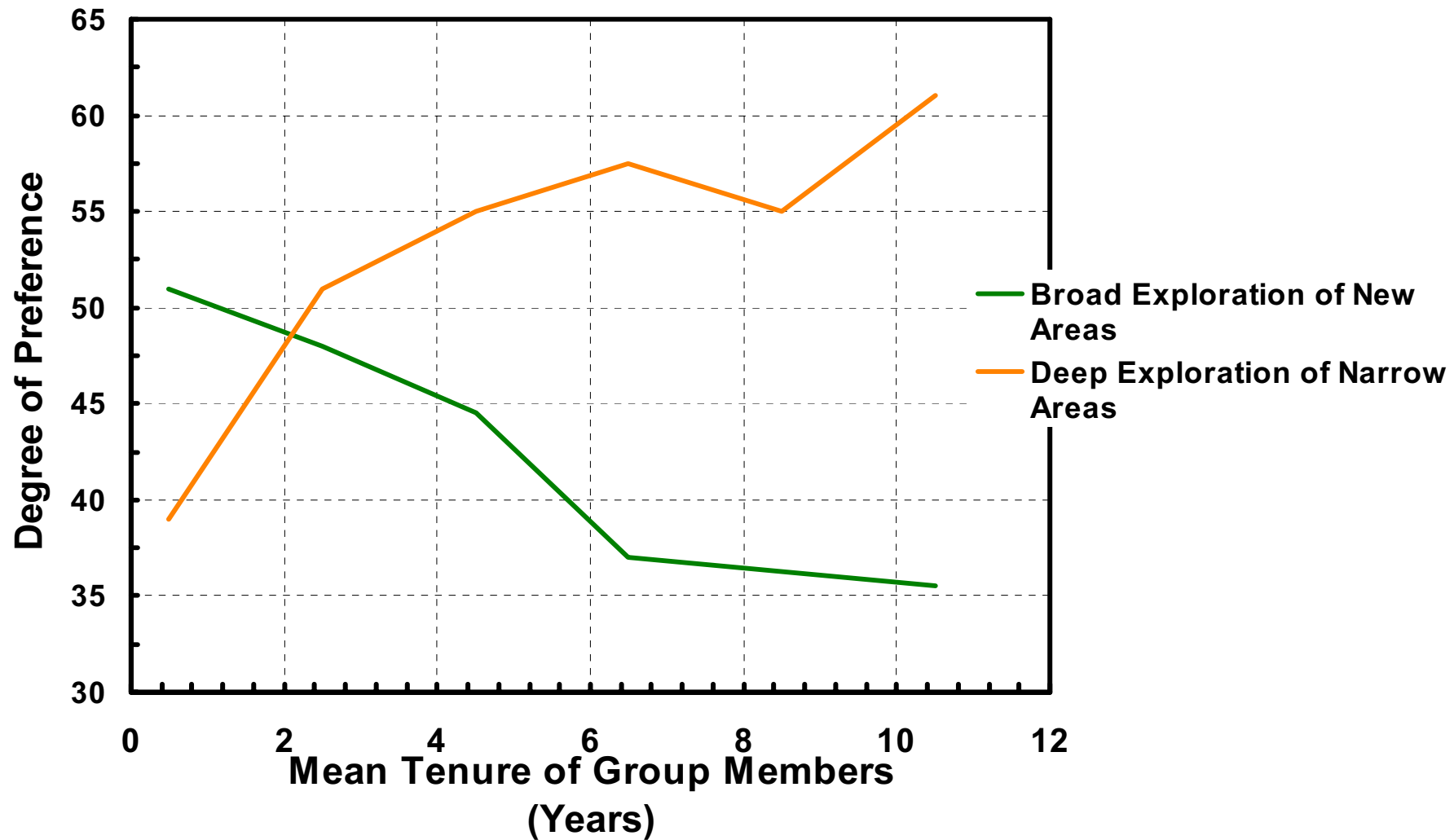


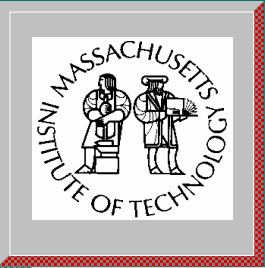
Project Performance and External Communication as a Function of Team Age (45 Chemical Industry Projects)



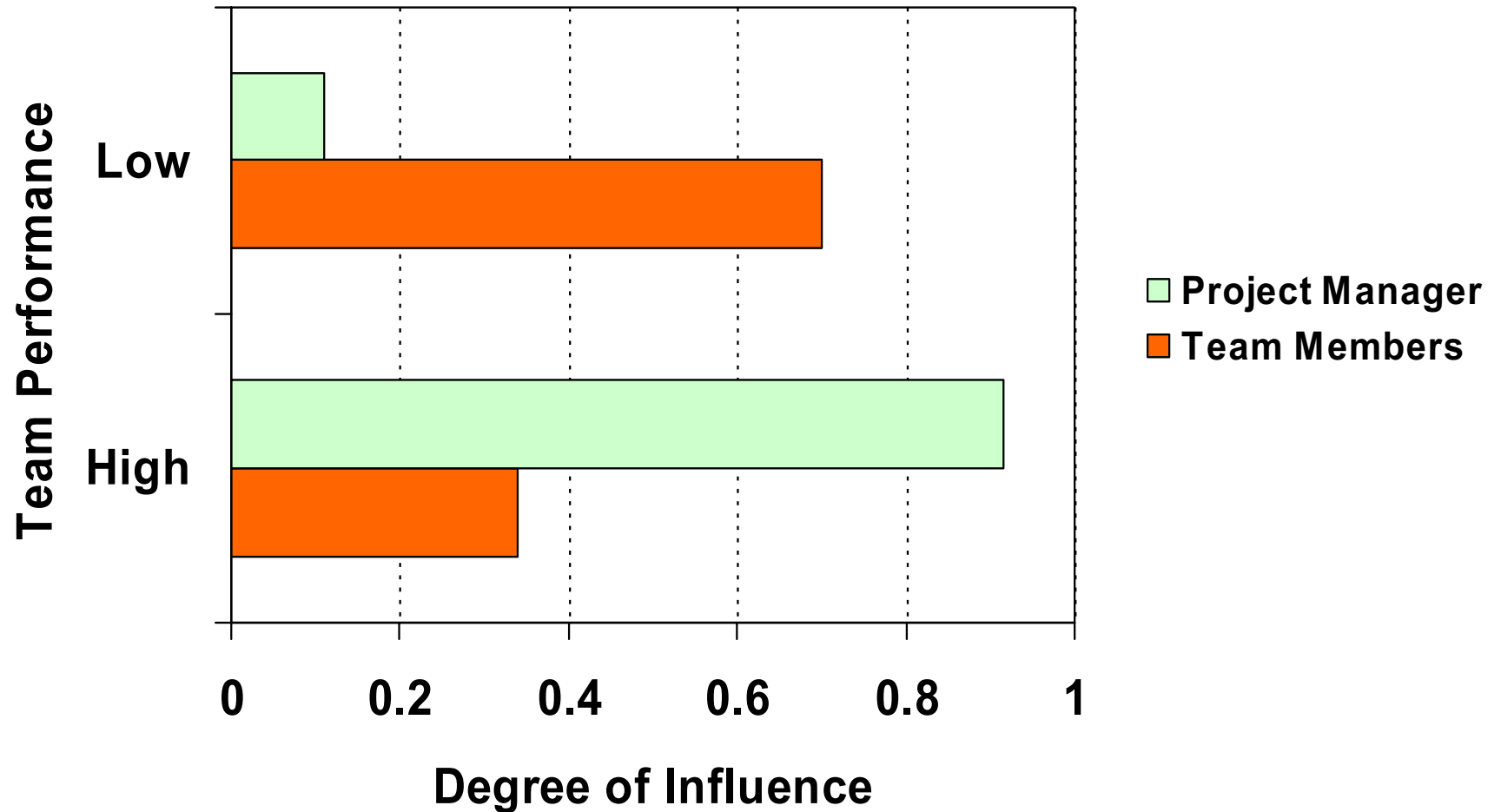


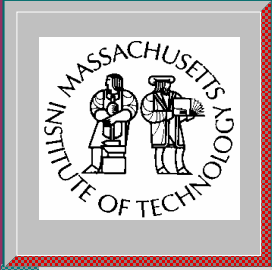
WORK PREFERENCES AS A FUNCTION OF MEAN TENURE (PELZ & ANDREWS)





Perceived Influence Over Project Goals & Objectives (Teams with **Mean Tenure Greater Than Five Years**)



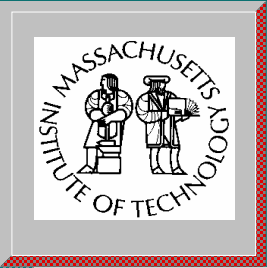


We Shape Our Buildings

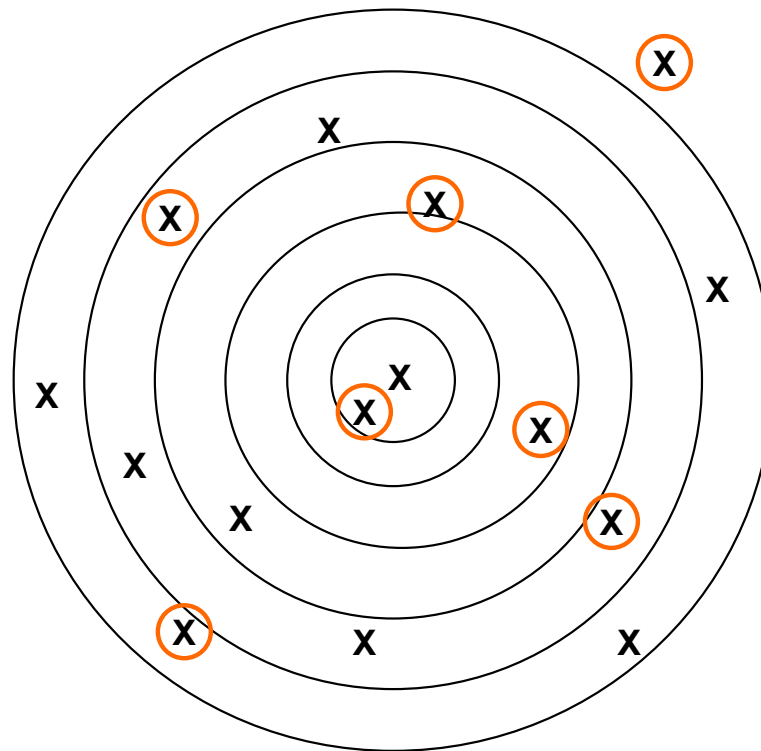
"On the night of May 10, 1941, with one of the last bombs of the last serious raid, our House of Commons was destroyed by the violence of the enemy, and we have now to consider whether we should build it up again, and how, and when. **We shape our buildings, and afterwards our buildings shape us. Having dwelt and served for more than forty years in the late Chamber, and having derived very great pleasure and advantage therefrom, I, naturally, should like to see it restored in all essentials to its old form, convenience and dignity."**

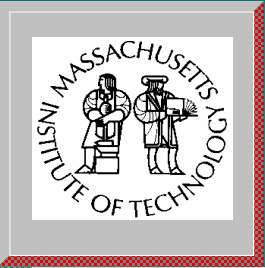
-WSC, 28 October 1943 to the House of Commons (meeting in the House of Lords).

Notes: The old House of Commons was rebuilt in 1950 in its old form, remaining insufficient to seat all its members. Churchill was against "giving each member a desk to sit at and a lid to bang" because, he explained, the House would be mostly empty most of the time; whereas, at critical votes and moments, it would fill beyond capacity, with members spilling out into the aisles, in his view a suitable "sense of crowd and urgency."

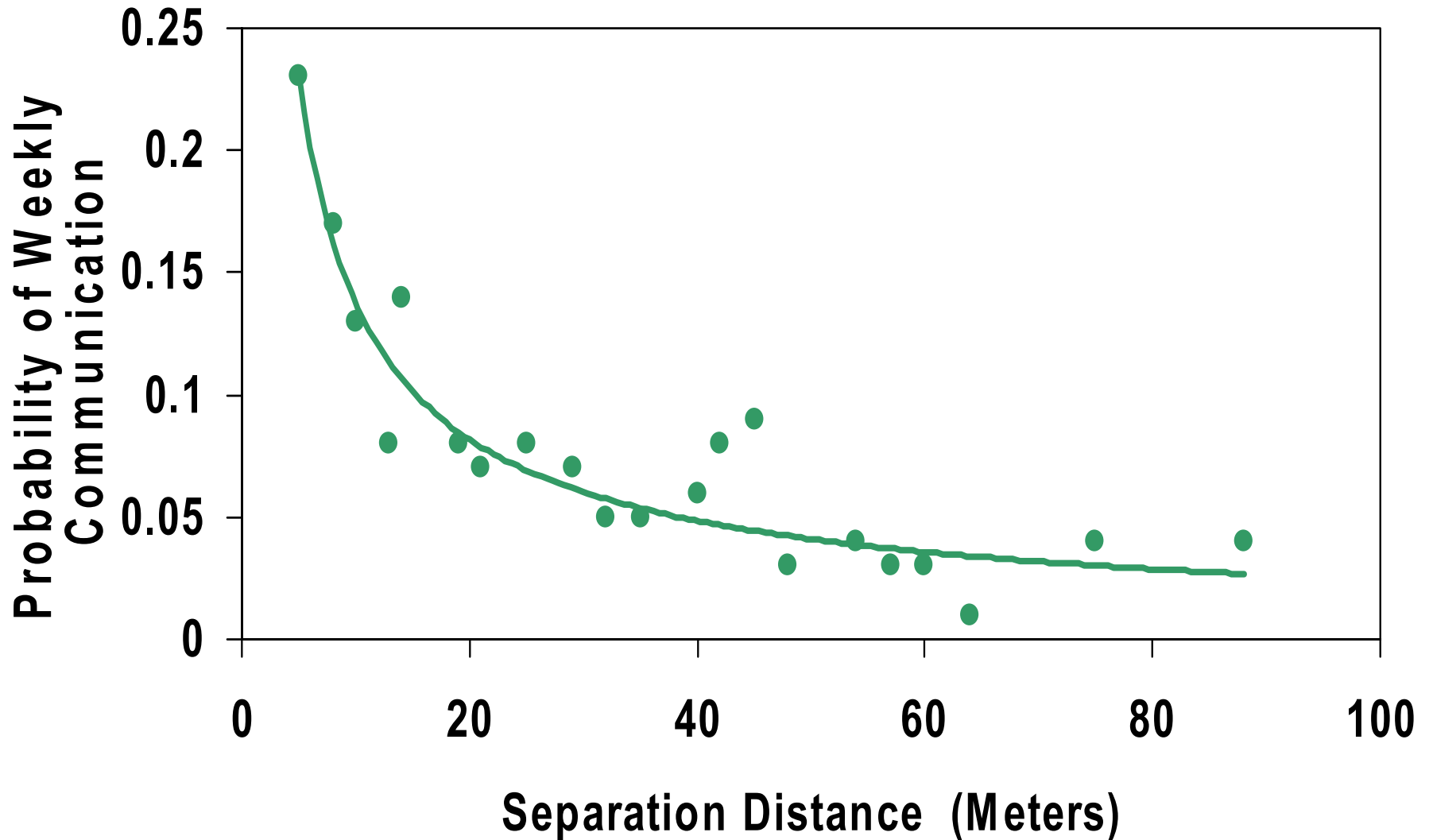


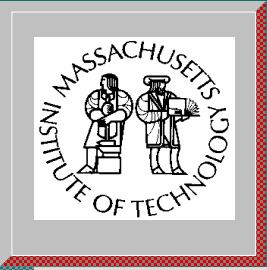
Proportion of Communication Partners as a Function of Distance



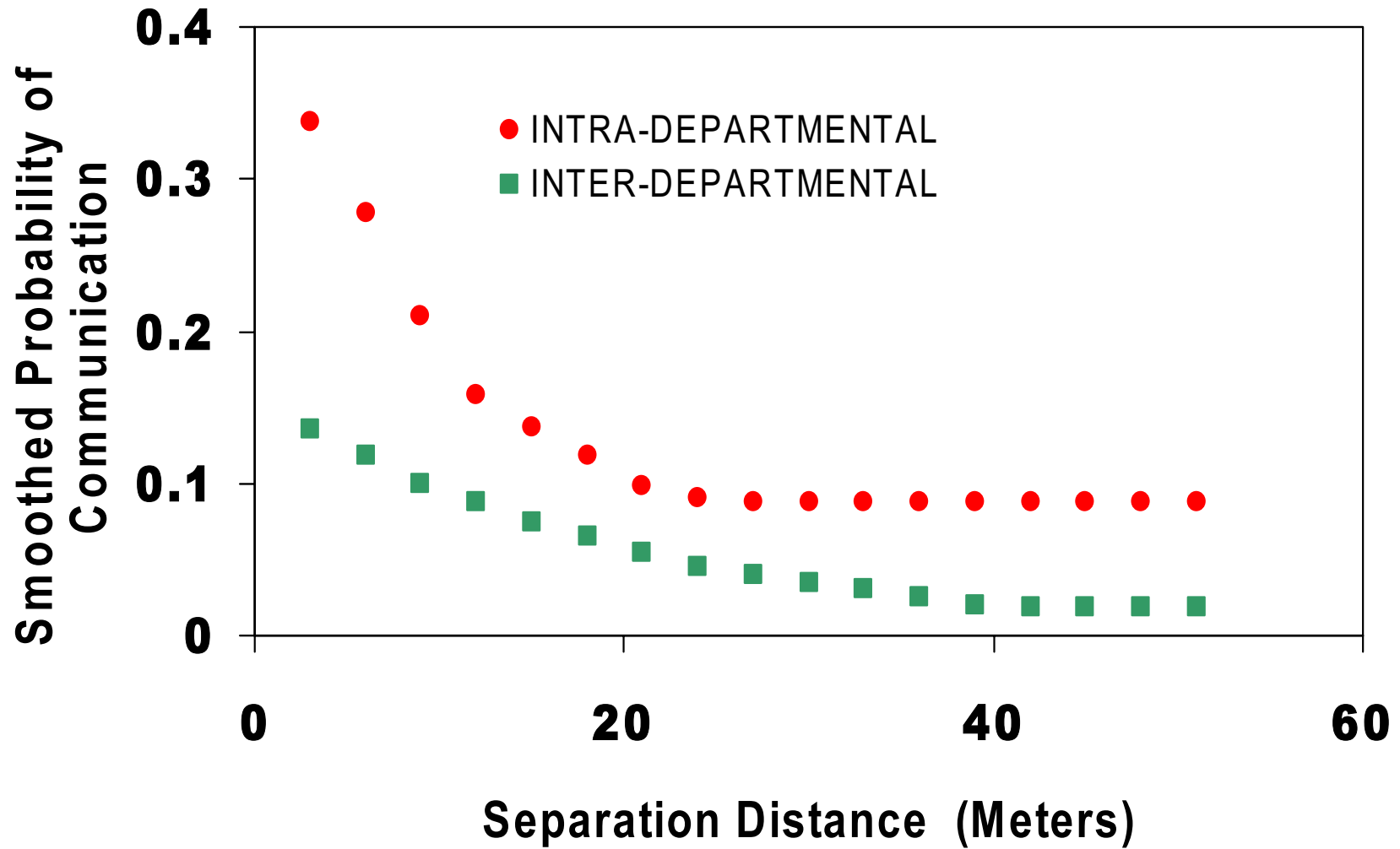


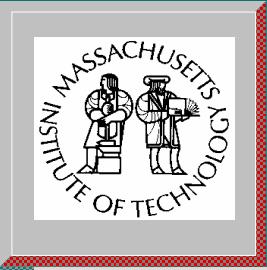
Probability of Technical Communication as a Function of Distance Between Work Stations



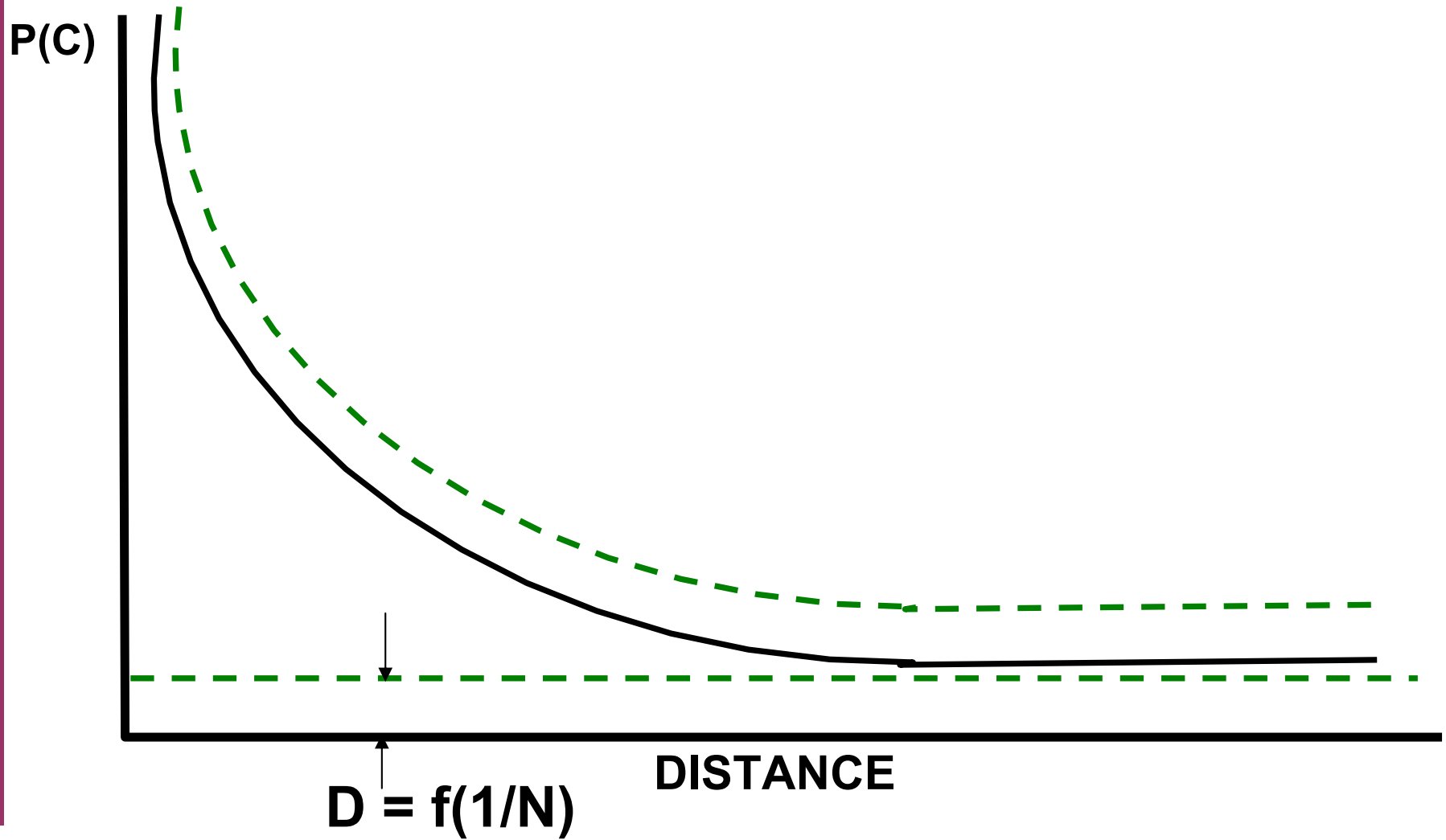


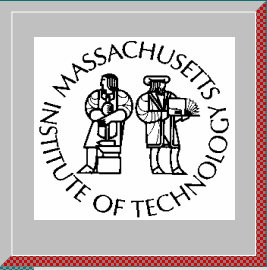
Intradepartmental and Interdepartmental Communication and Physical Separation



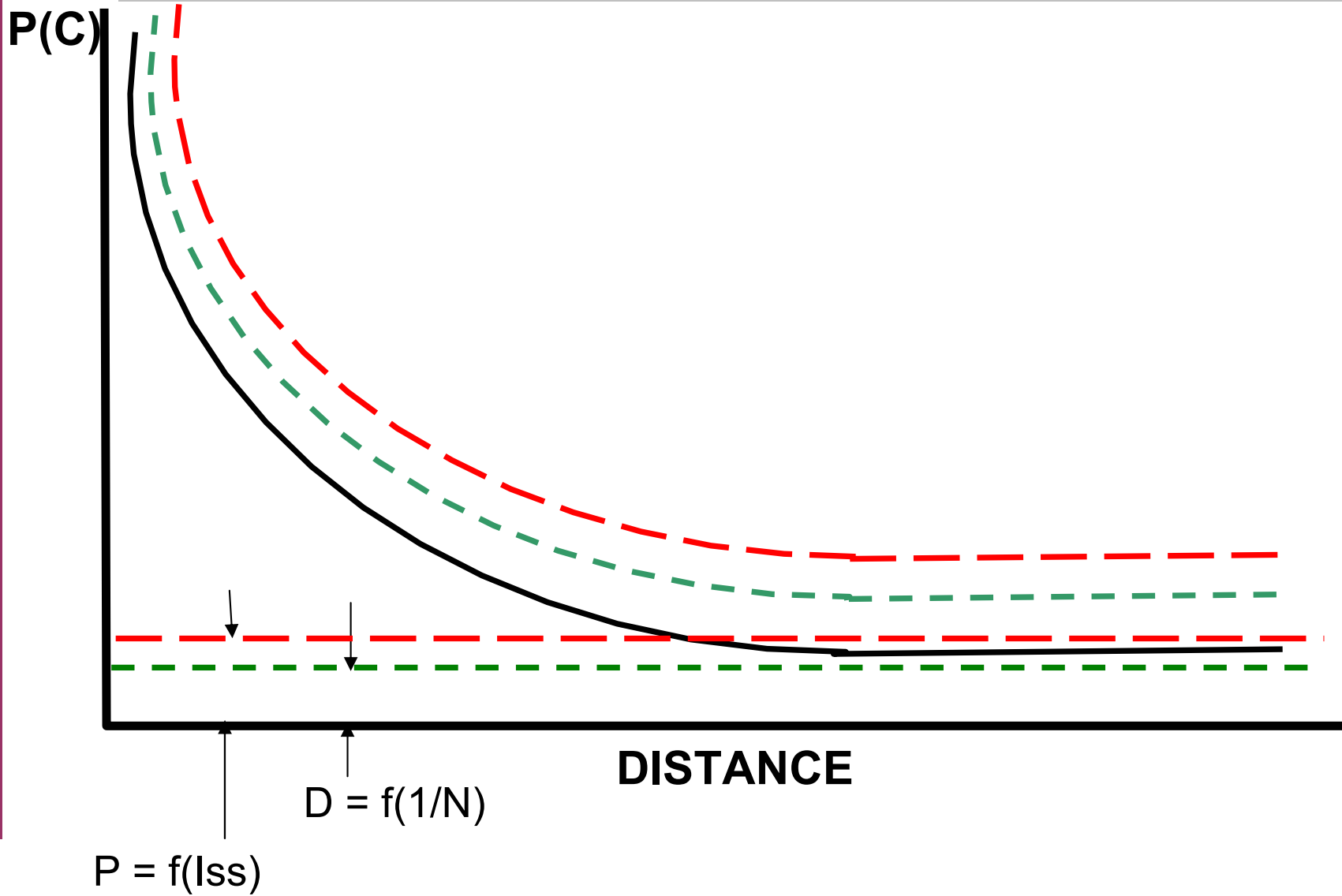


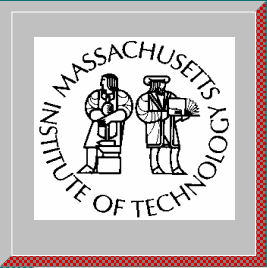
The Effect of Organization I



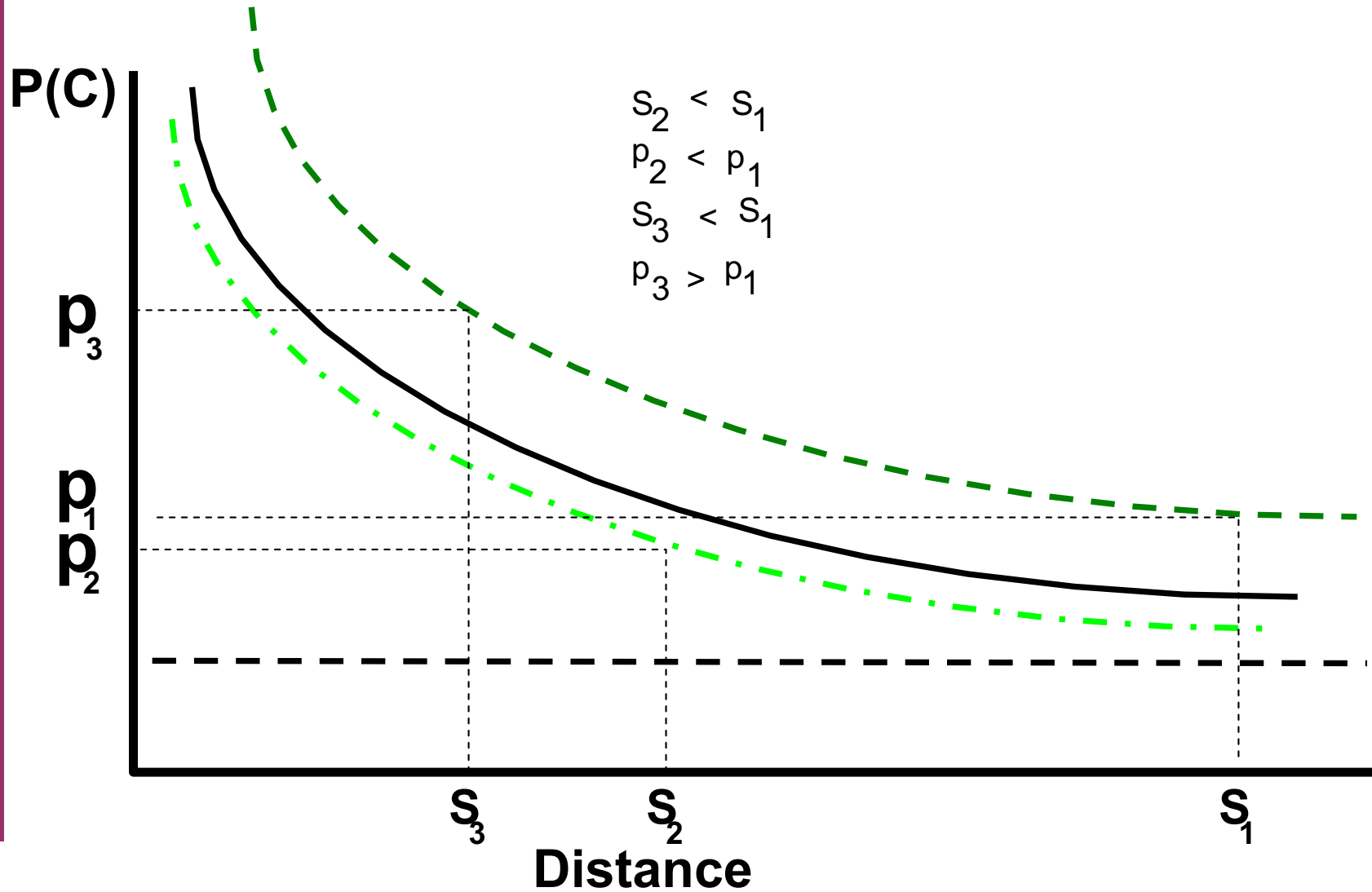


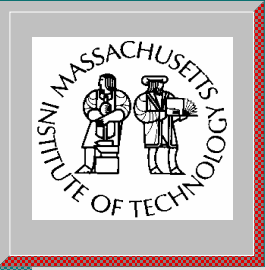
The Effect of Organization II



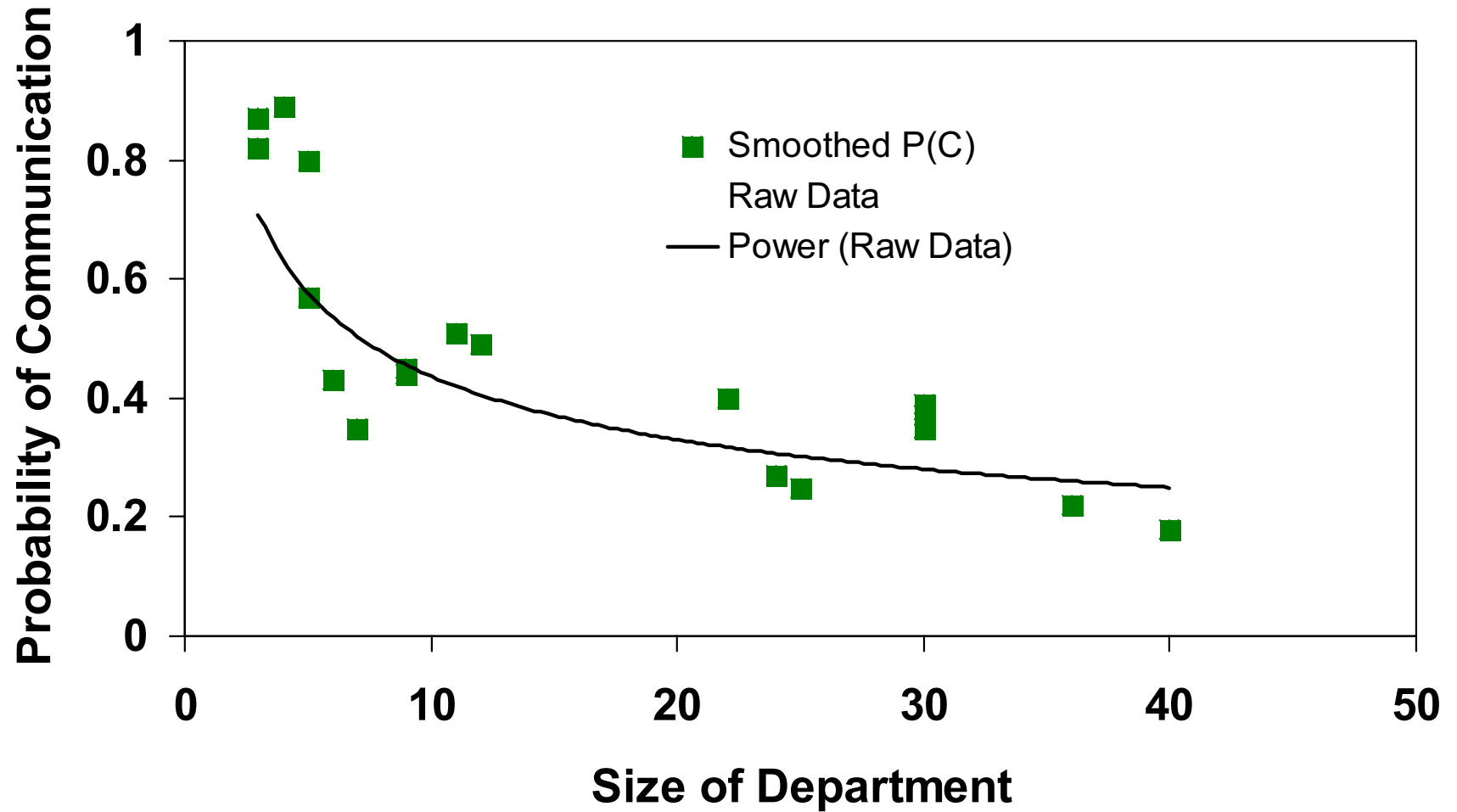


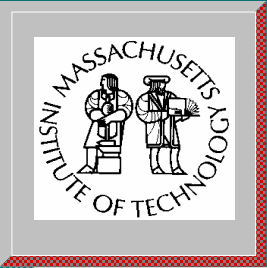
Some Obvious Points



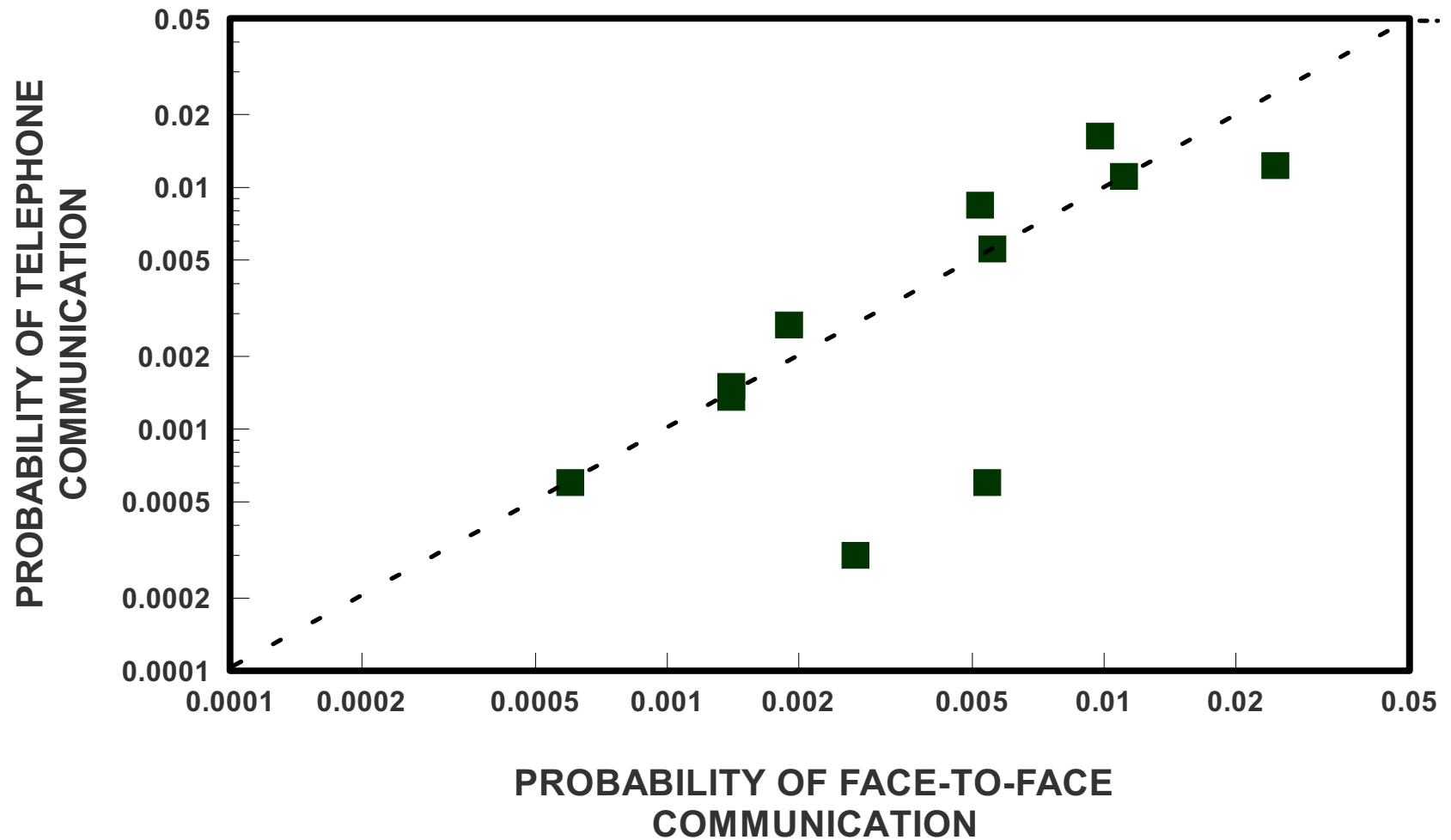


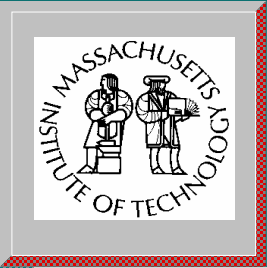
Departmental Size





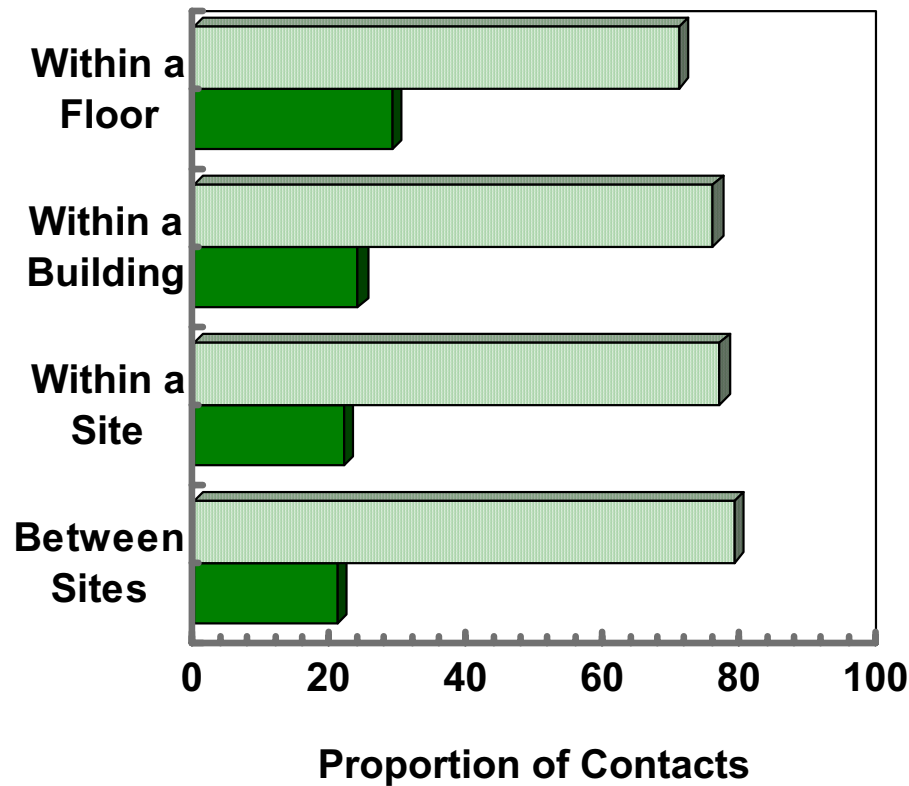
Face-to-Face and Telephone Communication





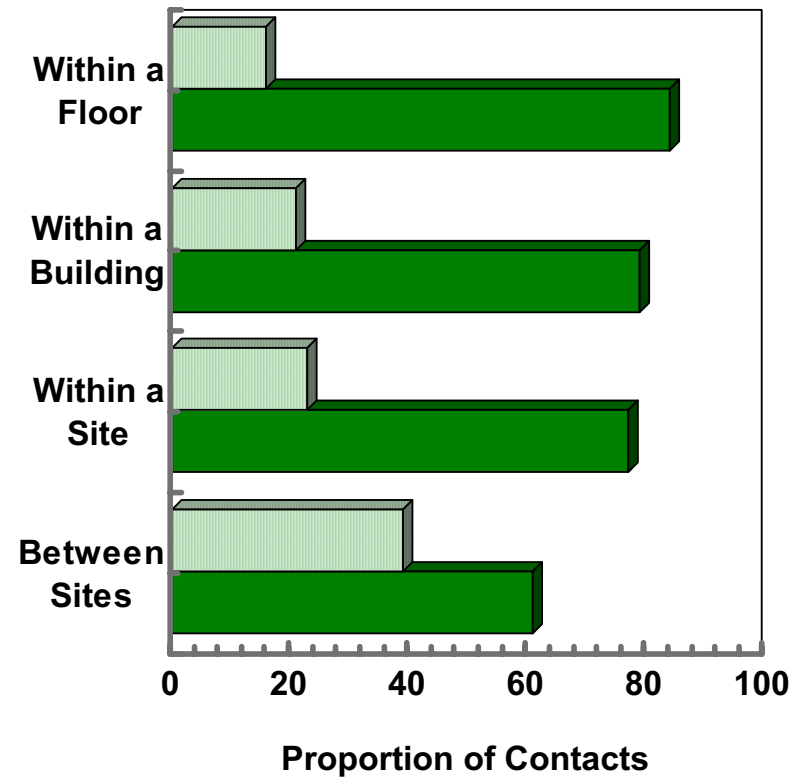
'Bandwidth' Limitation

Low Complexity Information



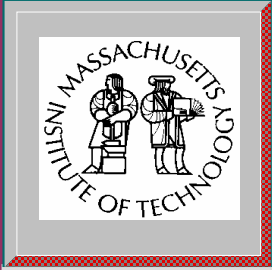
■ Face-to-Face ■ Telephone

High Complexity Information

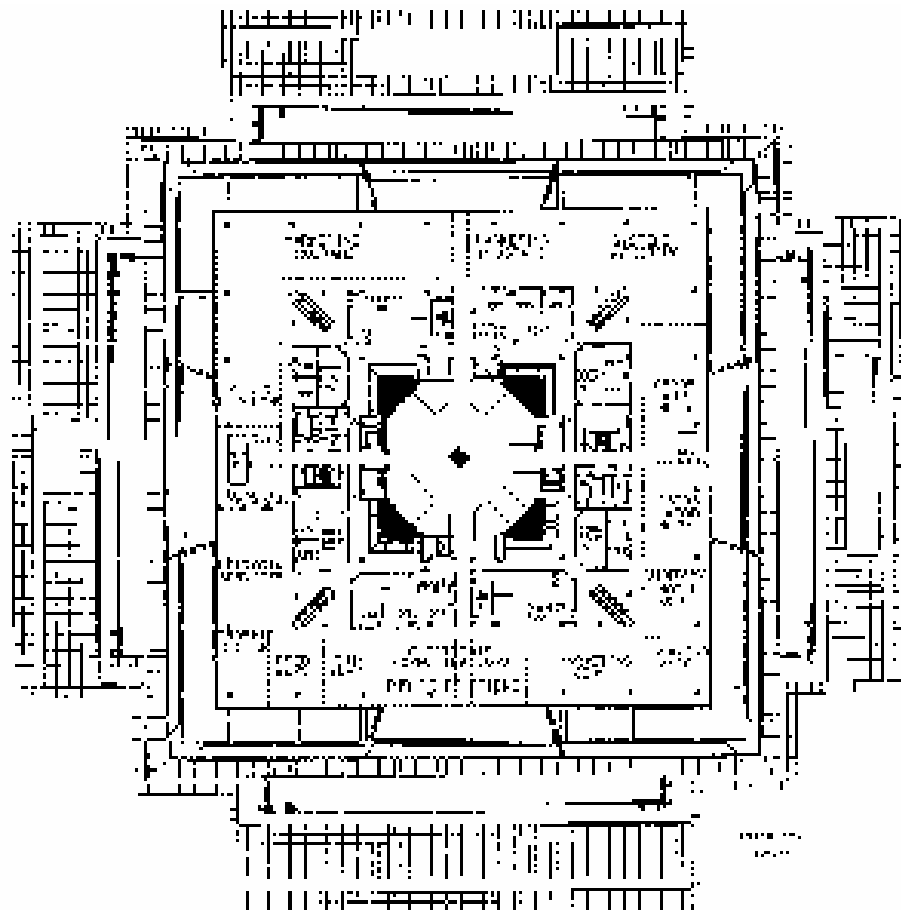


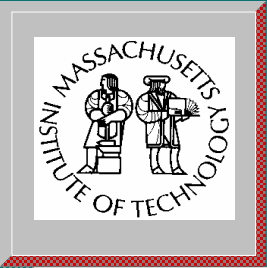
■ Face-to-Face ■ Telephone





Steelcase Third Floor





Effect of New Steelcase Building on Breadth of Communication

