Forces Underlying Patterns of Technological Adaptation in Multiple Service Environments

by

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Abstract

Research in the area of behavioral science has shown the importance of time and timing of technological adaptation at the organizational level. In particular recent experimental studies conducted by Tyre and Orlikowski provided evidence that the nature of patterns of technological adaptation, in most cases, are discrete and episodic, rather than gradual and continuous.

In this project, we show how theories based on such results apply to service operating units, and what organizational forces explain the patterns of adaptation, observed in such operating units.

Personal interviews with both managers and employees of each organization, allowed to gather the data and information, which the subsequent analysis would be based on.

The patterns of adaptation, one for each operating unit, were built . Such patterns were then studied in order to find out whether their shapes supported the theory of "Discrete Patterns of Adaptation", or not. Organizational forces, active in each operating unit, were then identified and analyzed to see if and, eventually, how their interactions could account for the shapes of the patterns previously built.

Thesis Supervisor: Marcie J. Tyre
Title: Associate Professor

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Chapter 1

Project Background

1.1 Introduction

Experience shows that making changes involves a wide area of uncertainty concerning both future implications and unforeseen problems. This is especially true when we consider the introduction of a new technology in a given operating environment. Problems arise since the time of first implementation, and significant adaptive effort is required as soon as the technology is in use. The success of further development activities and the formulation of new theories concerning the implementation of organizational changes, mostly depends on how closely the process of adaptation is understood. In particular, it is important to observe that the process of adaptation is mutual. Not only does the technology adapt to the environment of introduction, but it also affects such environment at multiple levels: practices and organizational structure may change after the introduction.

One of the most significant steps towards the improvement of our knowledge in the area of technological innovation, is that of better understanding the patterns of adaptation which follow the implementation of changes. An interesting, and, so far, relatively unexplored, area is that of "timing of adaptations". One of the most important unanswered questions, concerning the timing of adaptation, is whether changes are gradually implemented on a continuous basis, as opportunities arise, or occur in discontinuous and episodic patterns.

Another important matter is that of understanding what organizational forces help to

explain the observed patterns of adaptation over time.[1]

1.2 Timing of Technological Adaptation

Studies of timing of technological adaptation have so far involved two categories of researchers, respectively in the behavioral sciences and in the innovation sciences. The inherently different perspectives and approaches characteristic of these two branches of science, have led to conflicting theories and conclusions: patterns of adaptation are seen as gradual and continuous by innovation researchers, as discontinuous and episodic by behavioral researchers. Moreover, in most of the studies, the ability of identifying general trends in timing of adaptation, was constrained by the use of relatively short time frames.

The idea of continuous and gradual patterns of change, supported by innovation theories does not refer to individual technologies. Instead, it is based on the observation of the cumulative effects of several innovations introduced at different times and levels, in a given organization. In this perspective, change is seen as an ongoing process of response to emerging problems, not necessarily related to one another.

Accordingly, innovation researchers propose models of learning processes showing the same graduality and continuity. Based on these considerations, innovation theorists suggest that, in order to optimize the outcomes of newly introduced technologies, users should persistently be involved in adaptive problem solving activities. The "Learning Curve" (see fig. 1.1) provides a graphic representation of this concept, and constitutes one of the most popular models among innovation researchers. Behavioral researchers believe that experience generates routines and habits which become increasingly embedded in the minds of both groups and individuals, over time. Therefore, standard patterns of response are developed, and applied as familiar events and situations are faced. This tendency to relying on habits and routines, in turn, systematically reduces the chances of identifying new kinds of problems, that may arise, and may trigger inappropriate responses to new situations.

Such observations show that the level of human attention is not constant over time, and highlight the significance of the transition phase, that immediately follows the introduction of a given technology, in terms of learning outcomes. Although both the amount and

Figure 1.1 : A Continuous Pattern of Technological Adaptation

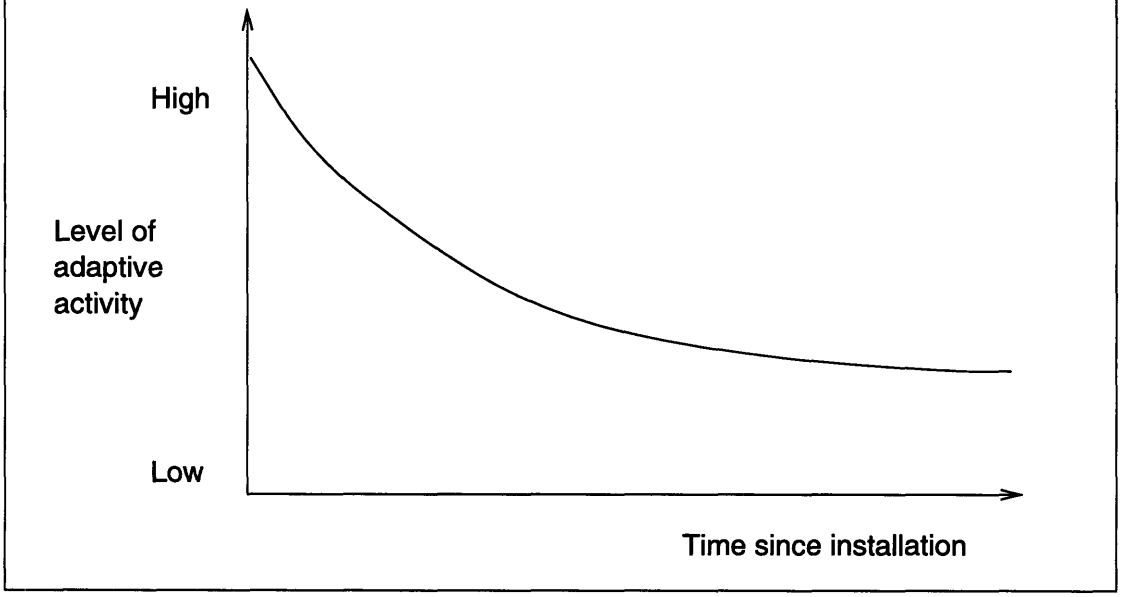
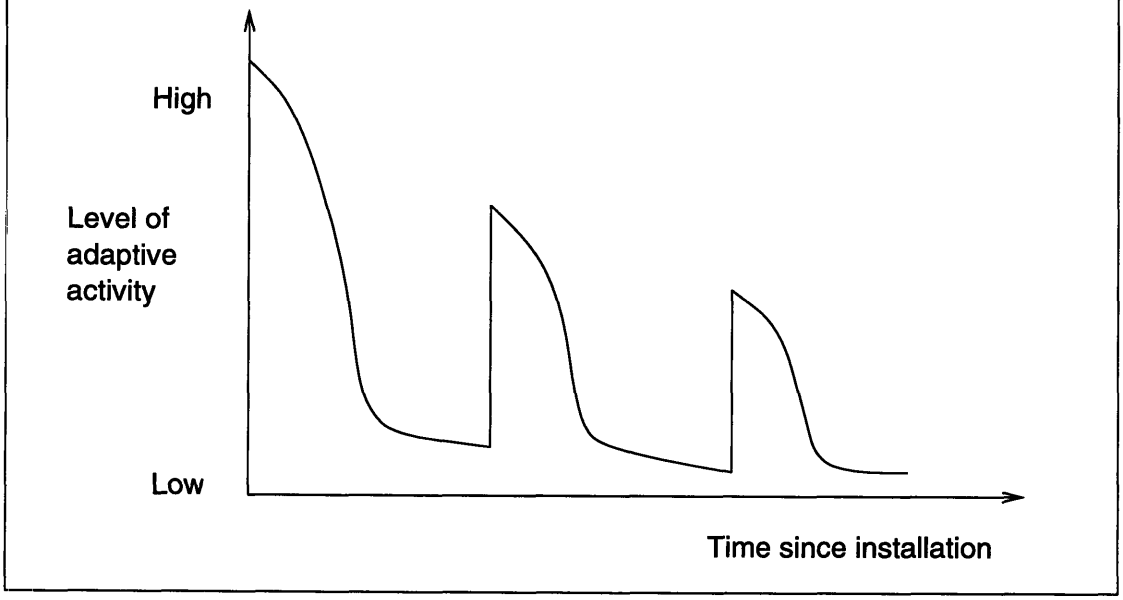


Figure 1.2 : An Episodic Pattern of Technological Adaptation



Source: Tyre and Orlikowski, 1993

the speed of learning depend on efforts made in the very beginning, when the level of human attention is particularly high, opportunities for improvement are sporadically provided by future interruptions of routine operations. Such interruptions, in fact, represent novel situations and have highly awakening effects on human attention. [1]

Based on the previous considerations, it is apparent how important it is for organizations to shape the process of adaptation according to their strategies, since the very beginning, when a technology is first introduced and put to use. This approach may in fact maximize the benefits from the innovation, through a well planned process of mutual adaptation of both the technology and the organization.

A clear understanding of how organizations confront the issue of timing technological adaptation has not been achieved yet. However, recent studies conducted on numerous European, U.S. and Japanese firm, showed strong similarities in the respective patterns of adaptation: evidence was found that most of such patterns are discrete and episodic (see fig. 1.2) and basically consist of cycles of relatively long periods of routine operations alternating with short periods of adaptive activity.

Both learning outcomes and strategic goals could benefit from the full exploitation of such episodic patterns of adaptation, however, this practice is still not well entrenched, especially because managers are not aware of its potentials. [2]

1.3 Forces Explaining Discontinuous Patterns of Technological Adaptation

As discussed in the previous section, based on recent studies, evidence was found that patterns of technological adaptation are mostly discontinuous and episodic. Current research is aimed to explain how such patterns are determined and, in particular, to identify the forces that affect the timing and intensity of adaptive efforts, within such patterns.

So far, several theories have been formulated, which might explain the patterns of adaptation experimentally observed. Such theories, as shown in the following, have significant

implications at two distinct levels: respectively the understanding and management of technological improvement. Each these theories proposes a particular force that, either individually or combined with any of the others, may account for the observed pattern of adaptive change.

A brief outline of such theories is provided in the following.

1.3.1 Economies of Scale in Problem Solving

Effective problem solving very often requires the interruption of routine operations and the shift of human attention from regular tasks to adaptive activities. Not only does such a shift represent a cost in itself, but it also has both direct and indirect financial impacts at several organizational levels, such as process, production, coordination and so forth.

Based on such considerations, it seems convenient to both minimize the number and the frequency of interruptions, and not undertake adaptive activities until a worthy number of changes, to be implemented, has been accumulated, over time.

However, once problems have been uncovered, any delays in solving them may entail severe costs as well. Therefore, a discrete pattern of technological adaptation may be explained as the result of a trade off between the costs of leaving problems unsolved and those of switching activities.

1.3.2 Management of Human Attention over Time

As pointed out in the previous section, in the beginning users have plenty of opportunities for critically observing new technologies and learning how they can be used. The levels of attention and creativity are very high at this stage, due to the novelty of the situation, thus users easily uncover problems and define new challenging objectives. However, in spite of arising problems or additional insights, that might be gained over time, further experimentation and significant changes become very unlikely to occur: adaptation efforts dramatically decrease, as habits and routines, acquired at early stages, become well entrenched and hard to modify. As a result, the patterns of use developed in the beginning often constrain further adaptation.

Other reasons explain why, as a given technology becomes familiar, problems and opportunities tend to be overlooked: as an example, production pressure, increasing with the use of the technology, determines a shift of human attention from adaptation activities to production-related issues. Moreover, standards and expectations concerning the technology in use are lowered so as to fit current achievements and capabilities.

Another barrier to adaptation is the fact that teams tend to lose their initial coherence and motivation: often, team members get involved in more urgent projects or ask to be assigned to more challenging tasks.

Based on these considerations, adaptation becomes increasingly difficult as technologies become familiar. Routine use is certainly a necessary phase of any process of adaptation; in fact, the data and experience required for further improvements, both in the technology itself and in the way it is applied, can only be obtained during periods of routine operations. However, interruptions are just as necessary as periods of regular use, because they create the conditions for critically reviewing and upgrading current routines and standardized practices. This, in turn, can explain how and why discontinuous patterns of adaptation are generated.

1.3.3 Slow Learning in the Form of Occasional Adaptation Leads to Fast Improvement

Different aspects and phases of learning can be optimized by creating appropriate sets of conditions in each situation. In particular, learning about a new technology requires both periods of regular use and periods of change. This allows learners to discriminate between inherent features of the technology itself and occasional responses occurring during the transition phases that follow the implementation of changes. Such a distinction would not be possible if changes were too frequent, because the system would permanently be in transient conditions. This in turn would prevent users from appreciating the effects of previously introduced changes, and from identifying opportunities for further improvement.

Criteria, objectives and expectations, need to be reviewed and upgraded over time in response to eventual changes that may occur either within or outside the organization. In this regard, interruptions represent significant opportunities for verifying such parameters

and adjust them according to current organizational strategies.

The redefinition of criteria and goals, regarding a given technology, generates new sets of problems and issues, which can only be identified by observing the technology in use. Thus, the importance of switching back to routine use of the technology is apparent. Moreover, such periods of routine operations increase future learning capabilities, by allowing users to apply newly acquired skills and to consolidate knowledge from previous learning experiences.

1.3.4 Lumpiness is Inherent in the Technology

Technical constraints often make given sets of changes inherently indivisible: therefore, all of them must be introduced at once, if any of them needs to be introduced. This again contributes to explaining why technological adaptation activities do not take place on a continuous, incremental basis, but occur in a discrete, episodic fashion: improvement cannot be pursued gradually and continuously over time because changes in one aspect of a given technology often require simultaneous changes in others.

1.3.5 Discontinuous Change is in the Eye of the Beholder

Adaptive change may appear to be continuous or episodic depending both on the time frame and on the metrics chosen by the observer. Therefore, processes of improvement that are apparently smooth and continuous if observed at the aggregate level, over a relatively long period of time, may look discontinuous if studied individually, at sufficiently close range.

As showed above and further discussed in the following, different perspectives lead to different explanations for the observed episodic patterns of technological adaptation. Each theory, in turn, carries significantly different implications for both managers and researchers: different lines of action should be pursued and different research questions should be answered, depending on which of the forces are recognized as major drivers.

Given the complexity of technical environments, we can expect that multiple forces are simultaneously effective. Therefore it seems important to be able to identify, and, possibly, rank, the most effective drivers in given environments, technologies, phases of a project and so forth. [3]

In particular, the purpose of this study, which builds on the work of Tyre and Orlikowski (1993, 1994), is that of understanding which forces have a major impact on the patterns of adaptive change observed in different kinds of organizations, with emphasis on service environments.

Chapter 2

Research Design and Methods

2.1 Introduction

The purpose of this study is that of analyzing the forces underlying discontinuous patterns of technological improvement: in particular, the study is focused on understanding how and to what extent each of these forces affects the pattern of adaptation in different environments.

As discussed in Chapter 1, five major forces have been identified:

1. Economies of scale in problem solving.
2. Managing human attention over time.
3. Slow learning in the form of occasional adaptation leads to fast improvement.
4. Lumpiness is inherent in the technology.
5. Discontinuous change is in the eye of the beholder.

Since in most cases either all the five forces or, at least, more than one of them are simultaneously effective, it is important to understand which of the five forces, if any, has a predominant role in a given environment. In the following, each force is briefly analyzed and categories of environments, in which such force is expected to have either a major impact or a negligible one, are suggested. Examples within each category are also provided.

2.1.1 Economies of Scale in Problem Solving

This force, which takes into account the costs involved in stopping and starting a given process and those associated with delays in problem solving, seems to play a major role in shaping the pattern of adaptation in all those environments in which continuity of service and reliability are crucial to the business.

The importance of a trade off between the costs of stopping production and those of delaying problem solving, is particularly felt in environments such as:

- Large scale manufacturing of consumer goods.
- Chemical plants.
- Power generation/supply systems.
- Any kind of process/service involving very interdependent, sequential operation.

In each of these environments, in fact, sudden and frequent interruptions of the process not only have a major impact in terms of transition, disruption and coordination costs, but also, usually determine high levels of customer dissatisfaction. Therefore, careful planning and scheduling of adaptive efforts, aimed to minimizing the number of interruptions, compatibly with the nature and urgency of the problems to be addressed, is apparently a major issue.

On the other end, there are several categories of environments in which, due to the nature of the process/service, economies of scale in problem solving are either not advisable or not feasible at all. Examples of such categories are:

- Maintenance services: both programmed and extraordinary maintenance services, are discontinuous and occasional by nature, therefore the time which can be allocated to adaptive problem solving is much more flexible. This means that problem solving does not need to be delayed until a worthy number of problems is accumulated, but each problem can be taken care of, as it arises.
- Warehouses: again the service is not continuous and not dynamic by nature, therefore the same considerations as above can be safely applied in this case too.

- Any processes/services in which a set of parallel independent activities is performed: the interruption of one activity is not as disruptive as in the case of strictly sequential processes: this means that other activities can be carried on at their usual pace while one of them is interrupted for problem solving purposes. Therefore in such environments, the pressure of undertaking large amounts of adaptation at a single time is not particularly strong.

2.1.2 Managing human attention over time/ Slow learning in the form of occasional adaptation leads to fast improvement

Since learning requires focused attention, we can expect that these two forces, although different in nature and (independently active) acting independently from each other (one another), have significant and correlated effects in similar categories of environments: particularly, in all those environments in which the nature of the processes leads users to lose focus and motivation, after a long enough period of routine use. Examples of such environments are:

- Highly automated processes: attention, and thus chances to learn from experience, is required occasionally, whenever problems arise on the line.
- Sequential routines of assembly/manufacturing processes, which lead the employees to respond automatically to any stimulus, almost without thinking.
- Administrative work, or anything that appears not intellectually challenging.

Moreover, given that learning implies human attention, we can expect that patterns of adaptation aimed to optimize the management of human attention improve(future?) learning outcomes too. This, in turn, suggests that the two forces lead to similar patterns of adaptation: such patterns, as observed in Chapter 1, are characterized by periods of routine operations interrupted, by relatively brief episodes of adaptation.

2.1.3 Lumpiness is inherent in the technology

In many environments, technical reasons prevent the introduction of individual changes on a continuous, incremental basis: that is, in order to implement a given technological change, other changes are required within the same system. Therefore, certain technological changes are indivisible by nature, and make technological improvement a discrete process. Examples of environments where inherent lumpiness is a particularly strong force are:

- Development and manufacturing of high-tech products: most high-tech products, in fact, consist of large numbers of highly interconnected components. Therefore both assembly and compatibility issues make it impossible to improve individual components without making any other changes, at least in the most closely related components.

- Processes in which timing of operations is crucial: we can think for example of some chemical process or even of baking processes in which each operation must take a well defined amount of time and the time between one operation and the next cannot exceed given limits. In these kinds of environments, in fact, excessive waiting time between critical operations, may lead to product deterioration and rejection. Therefore, if we speed up one operation, by introducing new equipment or by operating the existing one at a higher speed, we also need to increase the speed of other operations.

2.1.4 Discontinuous change is in the eye of the beholder

This force is apparently the most subjective of the five and may apply to most environments, if appropriate time metrics and perspectives are used in observing the evolution of adaptive technological changes.

A better understanding of the impact of the five forces in given environments would certainly help management in scheduling the length of periods of adaptive learning, and in timing the switch between routine operations and problem solving.

As an example, if economies of scale in problem solving seems to be of major importance to a business, it may be advisable to schedule relatively long and not too frequent periods of adaptive problem solving (and, perhaps, decrease both frequency and length of such periods

over time, since the number of problems and their importance usually decrease as the process of adaptation gets close to completion). Whereas, if management of human attention over time is the most important issue, we can think of frequent and brief interruption of routine operations in order to deal with problem solving and learning matters.

These issues will be studied in depth in the following, with reference to service environments.

2.2 Research Design

This study focuses on the innovations introduced in multiple service environments, over the past few years. A wide range of changes was examined within each operating unit, with focus on both the process of implementation and the following phase of adaptation.

Several MIT on-campus service environments were included in the research:

1. Physical Plant Services: respectively Mail, Custodial and Maintenance/Repair Service.
2. Food Services: Sloan Refresher Course, Faculty Club, Lobdell.
3. Sloan Computer Service.

This choice of operational units ensured variety of environments, within the service business, and thus maximal generalizability of results.

2.3 Research Methods

Personal interviews, with managers and employees of each operating unit, and field visits provided the data and information required for this study.

In particular, the interviews lasted from one to three hours each, and many of the participants were contacted again during the next stages of this project, for upgrades about ongoing changes and further information regarding already implemented ones.

The interviews started with broad and general questions regarding the innovations introduced in the environments over the past three years, such as:

- What changes, large or small, have been implemented in the service over the last few years?
- What was involved?
- When did the changes occur?
- How long did it take to implement such changes?
- Were the changes introduced as soon as they came up, or saved for some later time?

The purpose of such questions was that of having the participants talk, without any guidance and constraint, about the activities undertaken, as they experienced them. This kind of approach allowed for gaining a basic knowledge of both the service itself and the changes that occurred, which, in turn, generated opportunities for further, more specific, questions.

At this stage, respondents, depending on the nature of the service environment they belonged to, were given appropriate lists of categories of innovation, which were explained to be of interest for the purposes of the project. Such lists included a few examples within each category, in order to avoid misunderstandings, due to a high level of abstraction.

As a result, the lists, at the higher level of abstraction, consisted of six main categories, referring to broad areas of innovation:

- Personnel
- Service
- Technology and tools
- Organization
- Skills
- Others

Each of these categories was further broken down into lower level categories, specific to each service unit. In turn, each of the lower level categories was accompanied by actual examples, which the respondents were supposed to be familiar with.

The purpose of such lists was that of helping participants to recall innovations, which they might have forgotten about or thought of as insignificant, and thus deliberately omitted, during the first part of their interviews.

The respondents were then asked to fill out a time-chart, showing when innovation activities were undertaken, either for problem solving and improvement purposes, or due to the occurrence of unusual events, which somehow affected the smoothness of routine operations. The temporal duration of such activities was also reported on the same time-chart.

Finally, for each of the innovations they mentioned, participants were asked to rate the size of the change itself, and the intensity of adaptive effort it required over time. Both variables were measured on a 0 to 10 scale.

"Size of Change" is a variable which represents the impact of a given change on the corresponding operating unit. Since a change can affect the operating unit as a whole, or just part of it, for the purposes of this definition and of the following one, we refer to the part of the operating unit, affected by the change, as "system". On a 0 to 10 scale, a change of size 10 represent a dramatic change which affects the whole system, at all levels: structure, practices, policies, strategy, and so forth, are modified. A change of size 0 means that the corresponding activities leave the whole organization unchanged, or, in other words, no changes occur. Therefore, the values of the chosen 0 to 10 scale represent the percentage of the whole system which is modified by a given change, divided by ten.

"Intensity of Adaptive Effort" is a variable which represents the amount of effort put into an adaptive activity per time unit. On a 0 to 10 scale, an intensity of size 10 means that all the resources available are fully used for the purposes of a given adaptive activity, in a given time unit: this in turn means that all the effort that the system can possibly put into any activities is concentrated in that specific adaptive activity; as an example, if the resources available consist of 5 employees, all of them are dedicated to such activity, full time, during a given time unit. Similarly, an intensity of size 0 means that no effort is put into the corresponding adaptive activity: either the activity is not undertaken, or it is not an adaptive activity. Therefore, the values of the chosen 0 to 10 scale, represent the percentage of the potential effort that the system could actually put into any activities per time unit,

which is actually put into a particular adaptive activity during a given time unit, divided by ten.

As discussed in depth in Chapter 4, the analysis of the data was conducted both at the level of the single operating unit, and across organizations. The temporal adaptive patterns for the innovations, within each organization, were plotted and examined, in order to find out whether their nature was lumpy and episodic, or relatively continuous. Then, the analysis focused on the investigation of underlying forces, which could explain the identified patterns. Finally, the patterns and organizational forces previously identified were compared across different service environments.

Chapter 3

Data and Preliminary Analysis

3.1 Introduction

The data collected during the first phases of this study is presented in this chapter, using both tables and graphs. The chapter is divided in seven sections, each regarding one specific environment. Each section begins with a brief outline of the environment itself and of the changes that occurred over the past few years.

The outline is meant to explain what changes occurred in the environment, how they occurred and what kinds of problems were faced in planning, scheduling and implementing such changes. Such outline is accompanied by a table that summarizes the most important features of the changes occurred, such as:

1. Nature of the change.
2. Time of implementation.
3. Reasons for such timing of implementation.
4. Size of the change.
5. Intensity of adaptive effort

A bar graph, showing the size of each change, as defined in Chapter 2 (Section 2.3), against the time of its first introduction, follows each table. In the graph, the heights of the bars

measure the size of the correspondent changes on a 0 to 10 scale, as respondents rated them during the interviews. The time scale uses months as basic time units. When multiple changes are observed during the same month, the correspondent bars are displayed in different colors, one on top of the other.

3.2 The Mail Service

The Mail Service is currently one of the three major areas, which the Physical Plant Department consists of, the other two being the Maintenance/Repair Service and the Custodial Service.

Starting in 1993, MIT management felt that the Institute was losing money through many of its services. Thus consultants were hired, but, according to their recommendations nothing could be saved by reengineering the Mail Service.

At that time the Mail Department was located in Building 24 and worked in cooperation with Graphic Art. The Interdepartmental Service was mainly handled by custodians, who would collect the mail from each office and provide desk-delivery service during the daytime. Custodians would attend to cleaning tasks in the evening and night shifts.

Only later, in 1994 the Physical Plant Department realized that interesting savings could be made by redesigning the Mail Service as it was already happening both in the Custodial and in the Maintenance/Repair Service. Thus, a comitee was established, with the purpose of looking into current operations and suggesting better practices.

The first step towards improvement was recognized to be that of hiring a supervisor for the redesign project, someone with prior experience in mail services. A nationwide search, undertaken in November 1994, led to final job interviews in December 1994. The current manager was then hired. Her primary task was that of supervising and promoting the reengineering process, which officially started in February 1995.

Two issues were immediately identified:

1. More efficient way of handling the outbound mail would lead to huge savings

2. Decentralization of the inbound mail would save time and make the service more effi-

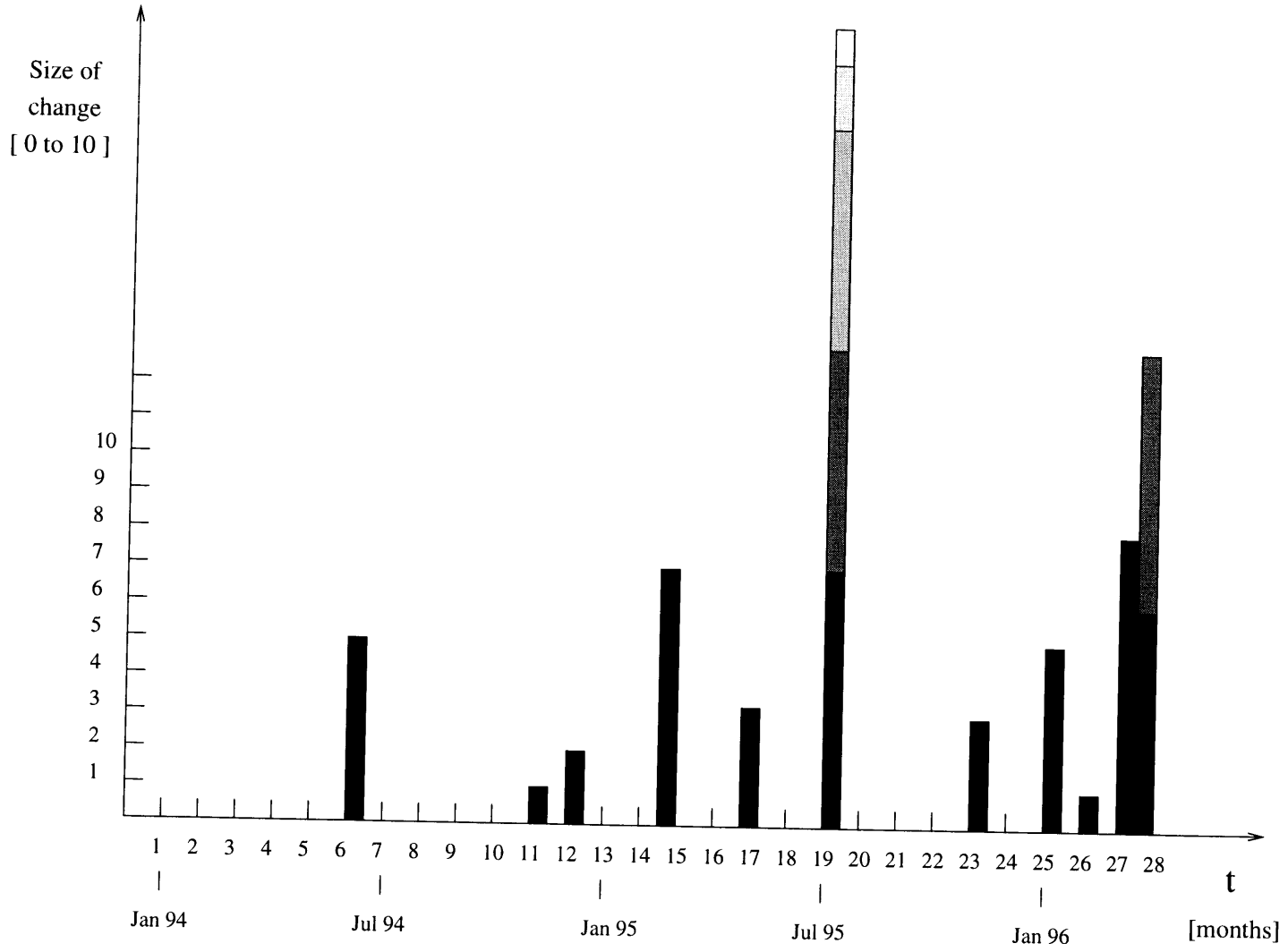
Table 3.1 : Features of the Innovations in the Mail Service

Time	Type of innovation	Reasons for innovation	Size	Intensity
Jun.95	Re-engineering Plan	Loss of money by MIT through on campus services led to review practices and look for more efficient ones.	5.0	9.0
Nov.95	Looked for re-engineering supervisor. Position advertised	The re-engineering process needed coordination in order to start	1.0	4.0
Dec.95	Interviews for the position of supervisor.	The re-engineering process needed to be started	2.0	5.0
Feb.95	Re-engineering process started	A supervisor was hired	7.0	8.0
Apr.95 May.95	Negotiations with the Unions for redefining jobs	Organizational changes required changes in the tasks and competencies at all levels	3.5	5.0

Time	Type of innovation	Reasons for innovation	Size	Intensity
Jul.95	Started use of outside carriers for outbound mail	They apply bulk charges by weight. Fiscal reasons	6.0	1.0
Jul.95	The first 8 DMCs were in place	Decentralize inbound mail. Fiscal reasons	7.0	8.0
Jul.95	New machine for weighing and rating the mail was purchased	Speed up mail processing Fiscal reasons	6.0	4.0
Jul.95	"Tracer" software was purchased	Store delivery records Fiscal reasons	1.0	3.0
Jul.95	New computers were purchased	Change to more computerized work. Fiscal reasons	2.0	4.0
Nov.95	Plans to accomodate operations in new location (WW15)	Avoid continuous trips between old/new location	3.0	6.0
Jan.96	Started construction in WW15	Move operations to WW15 as soon as possible	5.0	6.0

Time	Type of innovation	Reasons for innovation	Size	Intensity
Feb.96	Training session on safety issues	Accident on the job	1.0	3.0
Mar.96	MIT campus was totally re-zoned	Assign teams of employees to zones. More efficient task distribution	7.0	7.0
Mar.96	Team were formed and assigned to respective zones of competence	Shift from individual to team work.More efficient use of human resources	8.0	9.0
Mar.96	Operations were moved to WW15 Post Office started delivering the incoming mail to WW15	Construction works had been completed	6.0	5.0

Figure 3.1 : Size versus Timing of Changes in the Mail Service



cient.

In order to get started with a new organization, the supervisor redefined the jobs of all employees. This was a significant effort especially because it involved long renegotiations with the Unions. The negotiation of the newly defined jobs took a couple of months (April-May 1995) and ended with the introduction of three categories of workers:

- Level C: people who basically just sort the mail
- Level B: people who both sort and deliver
- Level A: people who not only sort and deliver but also run the machines, know postal regulations and fill postal forms.

Once the jobs were redefined, a new training program had to be designed, especially for Level A employees who needed to learn how to run the machines and how to use specific softwares. Training, although not as formalized as the one required in the beginning, is an ongoing process, because new hired people keep being trained by more experienced ones.

July 1st of 1995, was chosen as starting deadline, mainly because of fiscal reasons. However, having this implementation begin in the Summer had another advantage: it allowed to hire students, as temporary help. Two major actions were undertaken. The first one concerned the outbound mail (especially the international mail): prior practice had individuals place stamps on envelopes, therefore mail expenditures applied to the single piece of mail leaving the Institute.

The Mail Department contacted different outside carriers, which could meter the mail locally, in the countries to which the mail was sent, and would apply bulk charges: carriers would bill the Institute by the pound, not by the piece, thus allowing for large savings. This arrangement with outside carriers was made in July 1995 and led to a total of $ 66,000 saved over the next 7 months.

The second action concerned the decentralization of the inbound mail: as it was mentioned above, according to the current practice, custodians were in charge of delivering the mail to each desk. The comitee figured that a significant amount of time could be saved through the introduction of DMCs (Decentralized Mail Centers): these would be locked

rooms, placed in convenient locations in every building (mainly in the basements due to lack of space). Such rooms would be provided with a number of mail boxes equal to the number of people registered in the building.

Although according to the plan all the DMCs were to be operative on July 1st of 1995, only 8, out of 36, were in place by that time. The reasons for that delay being of two natures: first of all strong opposition by the customers who liked the previous system better. Second, a significant amount of construction work was required to implement the DMCs: often the issues were both that of finding or creating the right location within a certain building, and that of providing it with locks, so that access to the DMCs could be restricted to authorized people only.

The installation of new DMCs continued at a rate of two to four DMCs per month. Currently, 26 DMCs are in place, thus another 10 are still to be installed. The installation of these last DMCs, according to the manager, will be the most troublesome, either because in the correspondent buildings there is not enough space, or because customer opposition is particularly strong.

Another problem that came along with the installation of the first DMCs was the co-existence of two different systems: the old one (desk-delivery) in certain areas, and the new one in others. The service appeared to be far less manageable in this phase of transition, especially because the old system required people to work on delivery during the daytime, whereas according to the new system the interdepartemental mail is picked up from the DMCs at 5:15 p.m. and delivered by 10:00 p.m. of the same day. This in turn required to move people from the day shift to the evening shift: basically this was achieved by moving one person as soon as four new DMCs were installed.

Even though the new system disappointed many customers, at the time of first introduction, it now works very smoothly and apparently ensures the delivery of the whole interdepartmental mail (more than 40,000 pieces of mail per day) in just five hours, between 5:15 p.m. and 10.00 p.m.

In order to test the speed of the service, the manager periodically sends out a chain letter which is supposed to reach every building on campus and get back to her with a record of times and places in which it was respectively mailed and received.

Back again in July 1995 new software/hardware equipment was purchased and installed:

- new computers
- a software called "Tracer": basically a data base, which stores information and records of delivery. Such records are particularly useful whenever proof of delivery is required.
- a new machine which weighs and rates the mail.

After the Summer of 1995 another issue was considered: most of the operations were still located in Building 24, whereas the offices were concentrated in the new location (Building WW15): this created some functional problems because personnel needed to move back and forth pretty often during the day, thus wasting time and delaying operations.

Plans for construction works in the new location, in order to accommodate the operations as well as the offices, were made in the Fall of 1995 and the actual work started in January 1995.

One of the major issues faced at this stage, was that of providing the facility, which was previously used as a warehouse, with air-conditioning. In fact, mail cannot be handled in a hot and humid place because envelopes tend to stick to one another.

Another improvement, that was planned in the same period of 1995, regarded the incoming mail: up to that time the MIT Mail Service would send out trucks to the Post Office, 4 times a day, to collect the mail, because it was previous management's believe that MIT constituted a Postal Zone itself, and thus was not entitled to mail delivery by the Post Office. According to the Postal Regulations though, since the MIT campus does not have a single zip code (it actually has two), it does not constitute a Postal Zone: therefore the Post Office should deliver the incoming mail to the Mail Department, on campus.

Arrangements were made so that the Post Office would deliver the incoming mail, thus avoiding four daily pick up trips. Unfortunately, Building 24 (current location) did not offer enough space for trucks to come in and effect delivery, therefore an agreement was made that the Post Office would start delivering as soon as the operations were moved to the new location (Building WW15).

More training was provided to the employees in February 1996. The focus was mainly on

safety issues, especially on how to handle packages containing hazardous materials, due to a recently occurred accident: a package containing samples of hepathitis viruses was dropped and the contents was spilled all over the operations' floor, thus exposing the personnel to the virus.

At the beginning of March 1996, the MIT campus was completely rezoned, for mail delivery purposes, and teams were accordingly formed and assigned to specific zones. This represented a radical change in the operations: in the past a single person was assigned to a given building and everyone would work independently.

On March 25th of 1996, the operations were finally moved to the new location. Since the facility was ready at that stage, moving just involved the transportation of the machinery from the old location to the new one. The job was done over one weekend, so that the operations were not affected or slowed down.

More innovations are planned for the Summer of 1996:

1. Complete the installation of DMCs by the end of July.
2. Purchase more softwares and computers.
3. Make arrangements in order to be able to offer packaging service.

By the Summer of 1997 they plan on

1. Centralizing the receiving rooms (currently 3 in 3 different locations on campus) into a single shipping room.
2. Purchasing a new machine: an optical reader, which would significantly speed up the operations.

3.3 The Maintenance/Repair Service

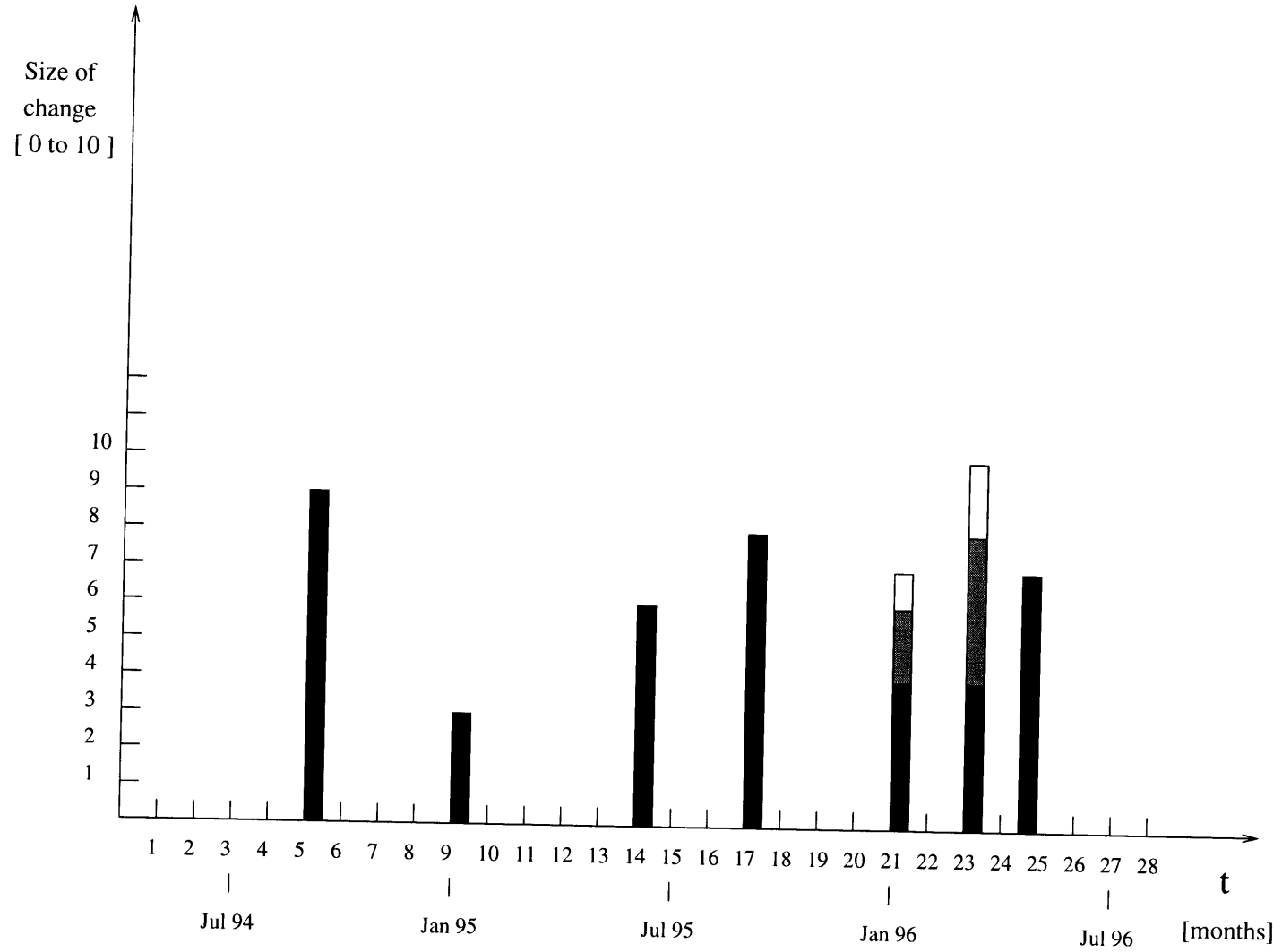
The Maintenance/Repair Department employs about 115 people in 5 major work areas:Building Maintenance, Construction and Renewal, Emergency Response, Utilities Distribution, Building Management and Protection.

Table 3.2 : Features of the Innovations in the Maintenance/Repair Service

Time	Type of innovation	Reasons for innovation	Size	Intensiy
Sept.94	Planned re-engineering process	structure unchanged for the past 20 years. MIT urged more efficient organization	9.0	9.0
Jan.95	Negotiations with the Unions	New organization required task/skill redefinition at all levels	3.0	6.0
Jun.95	MIT campus was divided in 5 zones	Assign a multi-skilled team to each zone	6.0	7.0
Sept.95	Pilot project: the first team (East campus) was rolled out	Test effectiveness of new team-based organization Done as soon as possible	8.0	8.0
Feb.96	Information sessions at customer locations (5 zones)	Introduce the new system to customers	2.0	3.0

Time	Type of innovation	Reasons for innovation	Size	Intensity
Feb.96	Employees submitted lists of preferential working areas	Need to form teams as soon as possible	1.0	2.0
Feb.96	The Maintenance Mechanic position was defined and advertised	Need for fexible people who would support teams	4.0	4.0
Mar.96	Staffing of teams was decided	Need to start teams' roll-out as soon as possible	4.0	6.0
Mar.96	Renovation of the space currently occupied by management of dept.	Accomodate Central Operations (Resource and Backup)	4.0	6.0
Mar.96	Training sessions for coaches and team members	Have them get started very quickly (new tasks/skills)	2.0	2.0
Apr.96	Second team was rolled out	Success of pilot project	7.0	7.0

Figure 3.2 : Size versus Timing of Changes in the Maintenance/Repair Service



The whole department is currently going through major organizational and structural changes which in turn, both directly and indirectly, affect current practices. The old system, which had not been changed for over 20 years, was quite rigid and hierarchically structured. Individuals were assigned very specific tasks by their direct supervisors, according to customer requests.

The new structure, which is currently in the process of implementation, is based on teamwork, empowerment and responsabilization of employees, and coaching more than supervising. MIT campus has been divided into 5 zones: A, B, C, D, E, and, according to the plan, each zone will have a multiple-skilled team (consisting of as many electricians, plumbers, heat/vent mechanics, maintenance mechanics etc. as required by the specific zone), based in a convenient location (near or within the zone itself.) Customers will be able to contact their team directly either by e-mail or by voice mail.

Besides the 5 decentralized teams, there will be three Resource Teams: respectively Clerical, Technical and Stock Team, which are supposed to provide centralized support to the local operations. Moreover a Project & Backup Team is being formed: such a team is supposed to provide help and support in all the situations which the decentralized teams cannot handle themselves.

The Maintenance/Repair Service started to be reviewed at the end of 1993: the first Strategic Plan was developed over the next year, but it was not until the Fall of 1994 that an actual re-engineering process began, with the help of a team of external consultants. One of the most interesting features of the re-engineering process is that employees of all levels and representatives of the customers were involved in the decision making process, thus gaining a broader perspective and preventing the redesign from neglecting some of the key issues.

The redesign of the whole system took a few months and its implementation was delayed mainly due to bureaucratic issues, such as negotiations with the Unions, and organizational problems, such as forming the teams, defining the new zones, finding convenient locations for the teams, within their working areas.

At the end of the Summer of 1995, MIT campus was rezoned. In September 1995 the first team, in East Campus (zone E), was rolled out. This first roll out was primarily meant to be a pilot project, with the purpose of testing the effectiveness of the new system. The

pilot project lasted for about six months, and resulted in a success, especially in terms of customer satisfaction.

While the pilot test was run, further steps towards the implementation of the new system were undertaken :

1. During the first week of February 1996 information sessions were held at different customer locations (5 zones.)

2. Individuals were required to submit their preferences in terms of primary working area by February 23rd 1996.

3. The Maintenance Mechanics position was introduced and advertised, and interviews were scheduled for hiring.

4. Team assignments were decided during the first week of March 1996.

5. Team staffing was announced on March 8th 1996 (73% of the employees were assigned thier first choice working area.)

6. Training sessions for both coaches and team members started on March 11th 1996.

7. The second team, assigned to zone D, was rolled out on April 22nd 1996.

Further plans include the roll out of the remaining decentralized teams (zone A, B, C) and of the Resource and Backup teams by the end of the Summer of 1996. The roll out schedule will vary according to the problems faced in each zone (often it is a matter of finding an appropriate location for the team.)

Another project, which has been recently undertaken (March 1996), is the renovation of the space currently occupied by the Management of the Department (Buildings E18 and E19), in order to accommodate the Central Operations: both the Resource Team and the Backup Team. This project is expected to be completed by May 1996.

Two of the most significant issues which, came up during the implementation of the redesign process are:

1. Need for extensive training.

2. Need to upgrade current communication systems.

The shift from the old organization to the new team-based one represented a cultural shock for many of the employees, who had been working in the Maintenance/Repair Service for long time (apparently most of the employees had worked there for more than 15 years, and a good number for as much as 30 years). It was very difficult to change their practices and have them think as a team. Besides periodic official training sessions, most of the updating is done over e-mail and through newsletters communication on a weekly basis. New employees are given special attention and required to attend training sessions which help them get started with the job.

Most of the training is focused on teamwork issues and tries to enhance a proactive strategy: in the past one employee would attend to a given task only when specifically required to do so and when the correspondent paperwork was properly filled out. The idea now is that each team member is responsible, within the limit of his/her competence, for the smooth operation of the various plants and systems, in a given area. Therefore he/she can, and should, go ahead and fix anything that appears to be out of order, without waiting for customer requests and related paperwork.

Communication has become an issue since the decision was made of having 5 decentralized teams, located in different campus zones. In fact, this arrangement can slow down and delay the exchange of information between the Central Operations and the teams: e-mail systems and voice mail systems are already in use; electronic clipboards are in the process of being implemented.

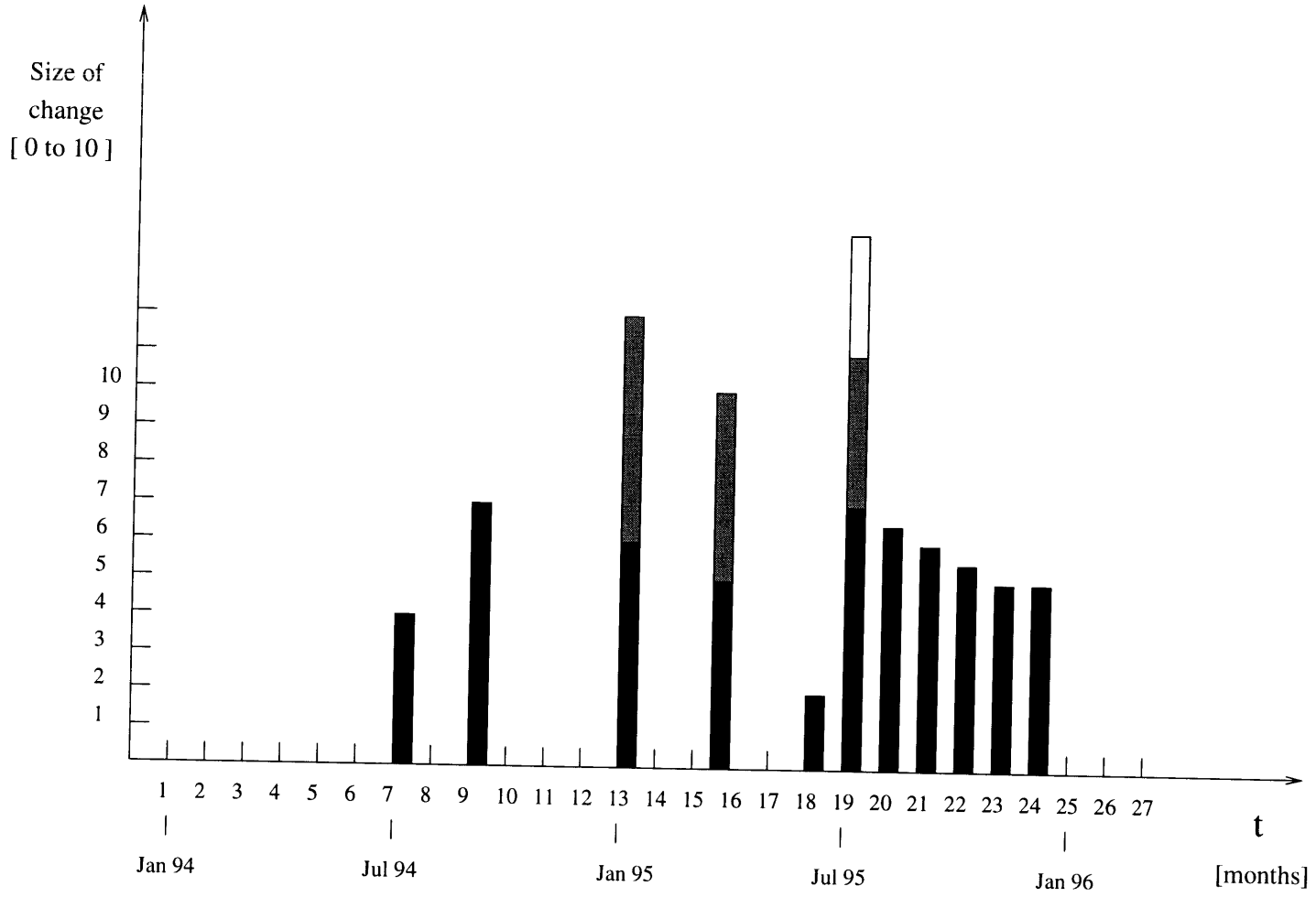
The first stage of implementation of the re-engineering plan did not require any immediate lay-offs. However, the improved effectiveness of the new practices will allow for reducing the number of employees by 20 or 30. This will not occur suddenly and will not require drastic measures: in fact, many employees are in an age range close to that of retirement. Some of them will retire by the end of this fiscal year and simply will not be replaced.

Table 3.3 : Features of the Innovations in the Custodial Service

Time	Type of innovation	Reasons for innovation	Size	Intensity
Jul.94	45 new employees hired & trained	New fiscal year started	4.0	3.0
Oct.94	A Redesign Team was estabilished	First dramatic budget cut by MIT	7.0	9.0
Jan.95	Pilot project: first team roll-out	Test the effectiveness of the new organization	6.0	7.0
Jan.95	Products and tool delivered to the team room	Save time to the members of the team	6.0	5.0
Mar.95	Punching system was suppressed	Save time to the members of the team	5.0	2.0
Mar.95	Keys to buildings assigned to team supervisors	Save time to the members of the team	5.0	1.0

Time	Type of innovation	Reasons for innovation	Size	Intensity
Jun.95	Custodians submit requests for job assignment	Success of pilot project: need to form other teams	2.0	1.0
Jul.95	First team roll out after pilot	Success of pilot project:	7.0	7.0
Jul.95	Team rooms provided with computer and e-mail service	The team should be easy to reach. Fast communication	4.0	3.0
Jul.95	35 new employees hired & trained	New fiscal year started	3.0	3.0
Aug.95	Second team roll out	Success of previous ones	6.5	6.5
Sept.95	Third team roll out	Success of previous ones	6.0	6.0
Oct.95	Fourth team roll out	Success of previous ones	5.5	5.5
Nov.95	Fith team roll out	Success of previous ones	5.0	5.0
Dec.95	Sixth team roll out	Success of previous ones	5.0	5.0

Figure 3.3 : Size versus Timing of Changes in the Custodial Service



3.4 The Custodial Service

The Custodial Service basically consists of two categories of activities: cleaning and furniture handling (moving, replacing, and so forth), according to customer standards and/or specific requirements. Since the early seventies, the service had been facing increasing difficulty in meeting customer needs: two major issues were making it harder and harder to keep up with the workload.

The first factor was the budget cutting policy, currently pursued by MIT, which resulted in progressive staff reduction. The second issue was the increased number of buildings to take care of (MIT campus was growing and thus many more man-hours were required.)

As a result, the ratio "Number of custodians/Square footage", was dramatically decreasing. This called for effort in redesigning the service with the purpose of making it more efficient.

Redesign activities started in 1972 right after the first dramatic budget cut (the money allocated to the service was cut down by 50%), which, in turn, determined a 30% decrease in staff. These first redesign activities did not affect the practice itself, but mainly consisted in improved zoning and shift scheduling. Further adjustments followed rather regularly, over the past 20 years, just in response to further cuts.

Only in 1994 it became evident that minor adjustments were not enough and that a better practice together with accurate rezoning and teamwork were necessary. In October 1994, a Redesign Team was established to look at current practice and identify potential ways of improving it. The Redesign Team consisted of a supervisor chosen within the department, a team captain from outside, a consultant and three custodians (one for each shift: day, evening and night.)

The team worked on this project for eight weeks (October 1996, through December 1996) and came up with a redesign proposal, which was expected to ensure:

1. Cost reduction by reducing supervisory staff and expanding working areas without hiring new employees.

2. Consistency of quality of service across campus.

3. Improved customer service, featuring also weekend service.

4. Teamwork for improved quality of work life.

After the approval of the redesign proposal, a twelve-week pilot project was started (January 1995, through March 1995), in order to test the effectiveness of the redesign policies, in the real working environment. Two teams of custodians and respective coaches were chosen and assigned to selected locations.

During this testing period, the employees were still required to punch in and out, and to pick up keys and assignments at the beginning of their shift, but tools and supplies were already stored and timely delivered to a conveniently located team-room, thus avoiding the inconvenience of custodians carrying them to the working site, on a daily basis.

At the end of the pilot period (end of March 1995), further improvement, within the redesign plan, were made: the in and out punching system was removed, and keys to the buildings assigned to the team supervisors.

The team roll out process started in the Summer of 1995: custodians were asked to fill in assignment forms, where they could list personal preferences, in terms of shift and work zone. The actual teams were formed by July 1995, and assigned to the respective area zones. At the same time each team room was provided with e-mail service, in order to enhance communication between customers and team members.

On July 9th of the same year, the first four teams were rolled out. During the following months, more roll outs took place, at a pace of four teams every month (August 6th, September 10th, October 8th, November 5th and December 8th): typically 2 evening shifts and 2 night shifts, until all zones were covered.

The redesign involved both the redefinition of the area zones (new partition of campus buildings) and the assignment of a specific number of hours per operation (such as, sweeping, washing, waxing) to each new zone. This allowed to properly decide how to staff each team: two people were involved, full time, in such activities for two months.

New employees are hired once a year, according to Union regulations. An average of 30 to 45 people are hired on July 1st every year. A high turnover rate allows for reducing

the number of employees, according to current budget constraints, without lay offs. Newly hired custodians are required to take a three day training course, which includes videos and demonstrations.

3.5 The Sloan Computer Service

The Sloan Computer Service consists of two main groups: the Operation Group and the Project Group.

The former is in charge of student, faculty and staff support activities, on a daily basis, and is divided into two subgroups: one of them in charge of the computer laboratories (student support), the other in charge of faculty and staff support activities. Each of the subgroups is in turn split into two areas of competence: PCs and Macs.

The latter is involved in major innovation and improvement projects, on a full time basis. As an example, one of the most significant innovation projects, which the Sloan Computer Service has lately undertaken, is that of introducing videoconferencing systems and facilities for long distance conferences, lectures and job interviews.

In the Fall of 1993, the so called CUC software, developed at Cornell University, was first installed in Sloan. The software works over the Internet: its first version was slow and did not allow for verbal interactions. It would display the images of the people in separate windows, and the conversation was carried out typing. The current version displays a microphone on the screen, which allows for verbal communication. One of the primary disadvantages of the CUC software is a consequence of the fact that it works over the Internet: therefore, when the Internet is particularly busy the motions of the people displayed on the screen appear very slow, and the audio is not very clear.

In the Summer of 1994, ninety trial PictureTel audio/video systems were installed on Sloan PCs. Although the system provided great color and audio, it was, and still is, not widely diffused: as a result, the effectiveness of the product, as a communication device, was constrained by lack of networking effects.

At the end of August 1994, the decision was made of investing on the installation of a fully equipped videoconference room. Many problems were faced in the implementation

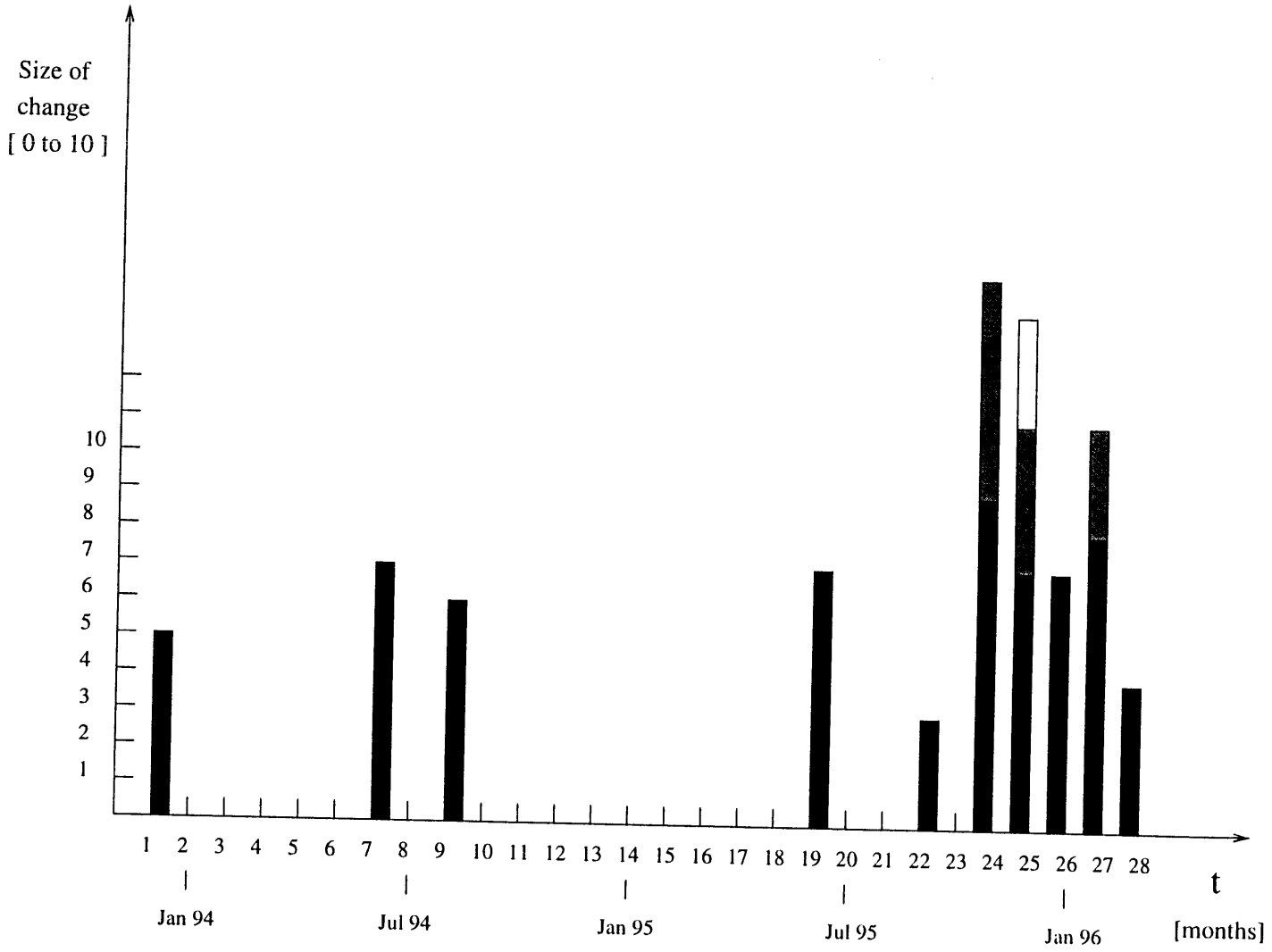
Table 3.4 : Features of the Innovations in the Sloan Computer Service

Time	Type of innovation	Reasons for innovation	Size	Intensity
Dec.93	Installed CUC software.	Software was offered by Cornell university	5.0	4.0
Jun.94	90 PictureTel audio/video systems installed on sloan PCs	The systems were offered by PictureTel for trial purposes. Summer Break	7.0	5.0
Aug.94	Decision of investing on a fully equipped videoconference room	Upgrade educational technology. Catch up with other schools	6.0	7.0
Jun.95	PictureTel agrees on donating videoconference equipment	School asked for donation, given budget constraints	7.0	3.0
Sept.95	Installed new virus protections	More viruses due to shared disks (with Windows 95) Problem needed immediate attention	3.0	4.0

Time	Type of innovation	Reasons for innovation	Size	Intensity
Oct.95	Trading Room equipment in place	Faculty members suggestion	6.0	8.0
Oct.95	Two groups were formed: Project and Operation Group	More focus needed on project work. Videoconference room project was very demanding	9.0	9.0
Nov.95	ViewNet software was installed	Donation by Viewnet	4.0	3.0
Nov.95	Started installation of Picture-Tel videoconference equipment	Done as soon as possible Class requiring equipment was starting in Feb.96	7.0	8.0
Nov.95	A new employee was hired to join the Project Group	Videoconference project was very demanding and the deadline for the classroom was getting close	3.0	2.0
Dec.95	Videoconference equipment installed in E56	Difficulty in finding a suitable classroom delayed the installation	7.0	7.0

Time	Type of innovation	Reasons for innovation	Size	Intensity
Jan.96	A new employee was hired to join the Project Group	Help was needed to meet the Feb.96 deadline	3.0	2.0
Jan.96	The videoconference room was completed	Need to meet the Feb.96 deadline	8.0	8.0
Feb.96	Several plug-ins for laptops were installed in the Tang Building	Many students already had laptops and incoming ones, starting from June 96 will be required to have one	4.0	4.0

Figure 3.4 : Size versus Timing of Changes in the Sloan Computer Service



of this project, in particular, that of finding an appropriate location. Most of the rooms available were not large enough to accommodate a suitable number of people, others had illumination problems which made the use of a videocamera impossible, and so forth.

At the beginning of June 1995, Sloan asked PictureTel for a donation of videoconference equipment. PictureTel agreed on giving two large, room-size videoconferencing systems on lease. PictureTel ensured that it would keep upgrading the systems with new versions; Sloan would have to pay for maintenance service. In the past years, donations of both hardware and software by major computer companies had been frequent. Recently, probably due to smaller profit margins, companies have become quite reluctant in donating hardware; however, they still donate a fair amount of software.

Starting in the Fall of 1995, not long after the introduction of Windows 95 in the PC laboratories, the Sloan Computer Service faced serious problems with viruses. These problems, which had lately intensified , were mainly due to the fact that an increasing number of students owned laptops and tended to share diskettes with others. Thus, new virus protections were installed.

According to the manager, until a few years ago, one of the primary concerns was that of securing software; nowadays, viruses represent the biggest threat, thus new virus protections are periodically installed.

At the end of October 1995, the equipment for the Trading Room was in place. The Room is provided with very advanced machines and software which display the news, financial data, information about stocks, currencies and so forth. The screen can handle customized programming: for example there are portfolio management systems and many other support tools, which allow for transferring data into spreadsheets and displaying graphs. The Trading Room project was suggested and strongly encouraged by some faculty members, who used similar, but less sophisticated systems, in other schools. The project started to be planned on in the Fall of 1994.

In November 1995 ViewNet donated a software, which would allow students to interview with companies' representatives over the Internet.

Again in November 1995 PictureTel started the installation of the two, room-size, video-conference systems mentioned above: one of them was intended to be reserved for long

distance conferencing only, whereas the other was meant to support the videoconference classroom project. Such a project would allow for teaching locally and divulgating in eight different sites.

In the same period there was a significant organizational change: originally all the employees would work both on new projects and on daily support services, the only distinction being the one between the PC group and the Mac group. Since the videoconference project was started, it was observed that people could hardly concentrate on new projects, if they were continuously interrupted by customers asking for support, information and so forth. Therefore, two groups were formed out of the number of employees currently available: the Project Group and the Operation Group, whose specific tasks and responsibilities were discussed in the beginning of this section.

At the end of November 1995, a new employee was hired to join the Project Group and help out with the videoconference project. The classroom, in fact, had to be ready by late January 1996, because the simultaneous local, and long distance, lectures were scheduled to start on February 6th of 1996.

As it was mentioned above, the biggest issue was that of finding an appropriate room within one of the Sloan Buildings. All the classrooms available in Building E52 were too small for the purpose, because they could not accommodate more than 35-45 students. Moreover some of the areas in the Tang building were not available yet, due to ongoing construction works.

A solution to the problem came in late December 1995: permission was obtained to locate the classroom in building E56. The equipment was installed in just ten days and the room was ready by the end of January 1996. Another employee joined the Project Group during the month of January.

In February 1996, several plug-ins for laptops were installed in the Tang Building, because, starting from June 1996, all incoming students will be required to have their own computer (mainly laptops.) By the end of May 1996 a new e-mail system, Eudora, should be in place. Such a system has the advantage of being free of charges.

Currently the Sloan Computer Service is also involved in the development of tools, that will allow employees to manage the laboratories of the Tang Building from Building E52,

thus avoiding time-wasting trips back and forth.

3.6 The Faculty Club

Until the end of 1993, the Faculty Club offered both dining and catering services. In late 1993 the dining service was shut down, due to major financial problems. Apparently, as observed in many other environments across campus, the re-engineering crunch policy, pursued by MIT, dramatically affected the amount of financial support that the Institute allocated to the service.

Customer dissatisfaction made reconsider this decision of shutting down the dining facility, and big effort was put in making it worthwhile to stay open. Due to such effort, the process took long time: it actually stretched from the end of 1993 to the first half of 1994. However, the Faculty Club was finally converted into a facility strictly used for catered events.

Currently the service is broad and comprehensive: conferences, weddings and any other events are taken care of, providing not only food and drinks but also flowers, visual facilities and so forth. Typical customers are MIT departments, administrative offices, faculty, and a few groups affiliated with the institute. Not many students refer to them for their catered events.

The catering service has been significantly improved over time. In the Summer of 1994 they introduced a new wedding package, the chef's monthly specials, and new catering brochures and menus. During the Summer of 1995, several pieces of audio-visual equipment were purchased and Ethernet drops were installed in all rooms, for Internet use.

New products are introduced sporadically during the year, only relatively big changes are saved for Summer or Winter Break. The introduction of new products may occur in two different ways:

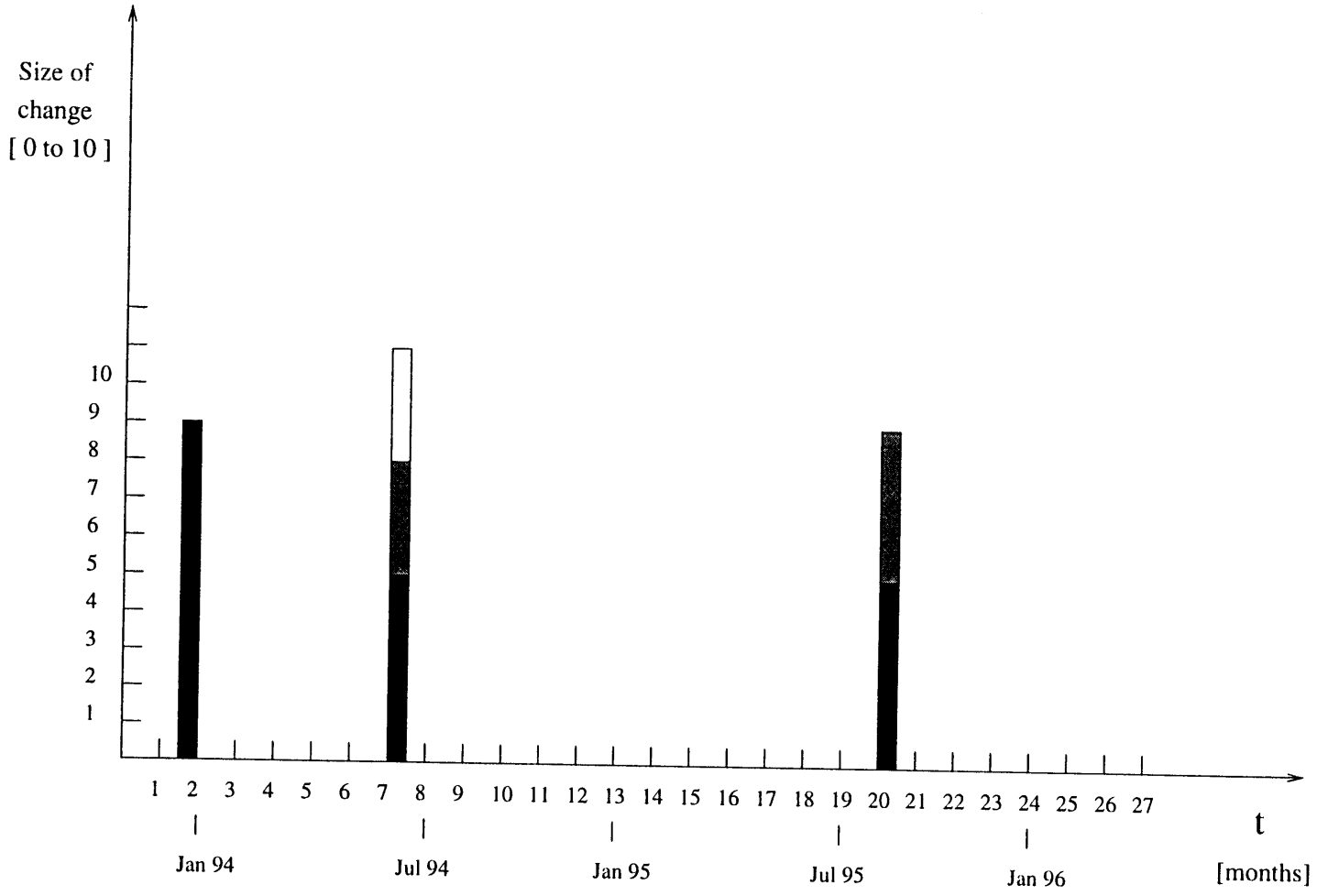
1. New ideas are proposed directly to the customer, according to the particular type of event.

2. New ideas are introduced in the chef's monthly specials, for testing purposes, and

Table 3.5 : Features of the Innovations at the Faculty Club

Time	Type of innovation	Reasons for innovation	Size	Intensity
Dec.93	Dining Service shut down: catered events only	Money loss: MIT stopped subsidizing	9.0	7.0
Jun.94	Introduced chef's monthly special	Chance of testing new products. Cheaper for customer	3.0	4.0
Jun.94	Introduced wedding packages	Chance of testing new products. Cheaper for customer	3.0	3.0
Jun.94	Purchased several pieces of audio visual equipment	Customer request; upgrade the facility. Summer Break	5.0	5.0
Aug.95	Purchased several pieces of audio visual equipment	Customer request; upgrade the facility. Summer Break	5.0	5.0
Aug.95	Installed Ethernet Drops	Customer request; upgrade the facility. Summer Break	4.0	6.0

Figure 3.5 : Size versus Timing of Changes in the Faculty Club



eventually reproposed in different occasions, if they seem to be popular and potentially interesting.

Equipment, accessories and environment are upgraded regularly, possibly as soon as it appears to be necessary, else during a break. The current manager and chef have been working in the Faculty Club for the past three years. New employees are hired twice a year, respectively during Summer and Winter Breaks, which are considered relatively quiet periods and thus allow for more intensive training. However, employees are permanently trained during the whole year. Managers meet on a weekly basis to discuss the scheduled events and consistently allocate tasks and decide shifts.

3.7 Lobdell

The Lobdell Food Course is one of the largest dining facilities on MIT campus. Most of the customers are students, therefore all the changes implemented in the service are aimed to meet students' requests and preferences. Surveys, usually held at the end of each semester, allow to test the effectiveness of current practices and obtain input for further improvement, directly from customers. Input for change often comes from outside vendors, who either present new products or suggest the introduction of ones already adopted in other schools' dining facilities. According to the managers, no changes are ever made in the middle of a semester: new ideas are usually saved for the beginning of the next one. Not only does this policy prevent from interrupting regular operations, but it also gives the opportunity of offering something new at the beginning of the new semester.

Turn over rate is negligible: many of the employees currently working at Lobdell have been there for 15-20 years. As showed in the following, most of the changes actually implemented over the past few years concerned either the nature or the quality of the product.

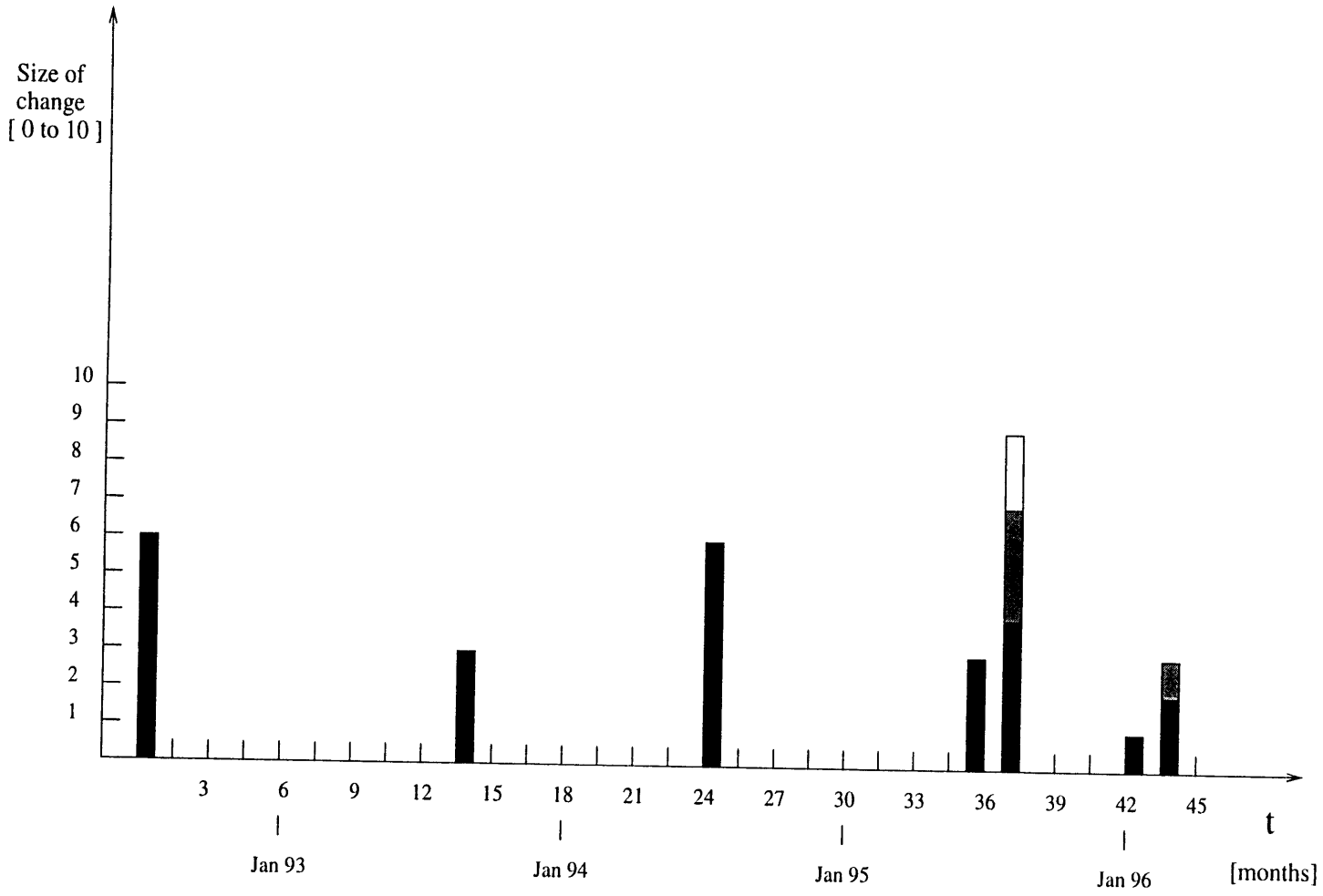
In September 1992 the Burger King stand was first introduced in the facility. The introduction of Burger King was strongly encouraged by students, and resulted in a success, but required very intense adaptive effort: not only a significant amount of construction work was required in order to build the Burger King stand, but also employees had to be

Table 3.6 : Features of the Innovations at Lobdell

Time	Type of innovation	Reasons for innovation	Size	Intensity
Jul.92	Started working on the introduction of Burger King	On customer request, taking advantage of Summer Break	6.0	7.5
Sept.93	Introduction of Avanti Coffee	Upgrade quality of product	3.0	2.0
Jul.94	Started working on the introduction of D'Angelo	On customer request, taking advantage of Summer Break	6.0	7.0
Jun.95	Introduction of Baskin & Robbins	Increase product variety Summer was a good period for testing	3.0	4.0
Jul.95	Started working on the introduction of the Vegetarian Stand	High demand for healthy food. Summer Break	4.0	6.0
Sept.95	Introduction of Arizona Iced Tea and Fresh Samantha drinks	Good quality/price, healthy product. Summer Break	2.0	1.0

Time	Type of innovation	Reasons for innovation	Size	Intensity
Sept. 95	Removed Baskin & Robbins	Bad quality/price resulted after Summer test	3.0	2.0
Jan.96	Introduced packages of carrots	Demand for fresh, healthy products. Winter Break	1.0	1.0
Feb.96	Paper plates replaced foam ones	Customer complaint	2.0	2.0
Feb.96	Introduced Best Health drinks	Increase variety and meet demand for healthy products	1.0	1.0

Figure 3.6 : Size versus Timing of Changes at Lobdell



specifically retrained, in order to learn standard, Burger King's, food preparation methods. The process of adaptation took about six months.

In September 1993, due to frequent customer complaints, concerning the quality of coffee, a new brand, "Avanti Coffee", was introduced.

In September 1994, The D'Angelo's stand was first opened. This was again a customer driven innovation. As it happened two years before, with the introduction of the Burger King stand, major effort was required and the whole process took about four months to complete.

In June 1995 an attempt was made of increasing the variety of products by introducing a Baskin & Robbins ice cream machine. The idea was that of testing the new product over the Summer, when demand was supposed to be high, and see how well it could sell. Sales over the Summer were not as good as it was hoped: customers found the product too expensive relatively to its quality. As a result, in the beginning of September 1995, the Baskin & Robbins ice cream machine was removed.

Again in September 1995, the increasing demand for healthy products, led to the introduction of the Vegetarian Station, and of the Arizona Iced Tea and Fresh Samantha drinks.

In January 1996, small packages of carrots were added to the list of items to take out. In February 1996, "Best Health " drinks were first introduced. Moreover paper plates were adopted in replacement of foam ones, according to customer request.

3.8 The Refresher Course

The Refresher Course is a relatively small dining facility, offering snacks and quick meals. Customers are mostly students and faculty of the Sloan School of Management.

In September 1995, a particularly challenging situation was faced: the manager could not be on the premises for personal reasons, therefore a substitute was temporarily hired. The new manager could not keep the operations as smooth and efficient as they, previously, used to be. Sales decreased due to ineffective management.

The actual manager was back to work at the end of December 1995 and decided to

improve the business by introducing a significant amount of minor changes that customers required. Management believes in customer satisfaction and sees the business as an MIT service, not as a profit driven organization. Therefore, prices are rarely increased, and the introduction of new prices is usually done at the beginning of the next semester.

Small changes and improvements, not involving construction works, are mostly planned on and introduced before the beginning of each term, mainly taking advantage of holidays and breaks. All the changes are customer driven: at the end of any semester, guests are asked to fill in a survey with the purpose of evaluating current quality and effectiveness of service, and that of giving suggestions for further improvement.

Major changes, especially those requiring construction works, are saved for the Summer when business is much slower and the facility is closed for a longer period.

In order to please their customers, they try to introduce small changes at the beginning of each semester, something for students to look forward to, when they go back to school.

Changes are decided and implemented by a team of three people: the General Manager, the Manager and the Executive Chef.

At the organizational level, no major changes have occurred over the last few years: there are five employees: one chef and four interchangible ones. All of them are involved in meetings and training sessions, mainly focused on the improvement of their approach to the customer. Each employee averages 35 working hours per week.

Most of the changes lately implemented, concern either the product itself, the quality of the service or the image of the facility. A detailed list of such changes is provided in the following table .

Table 3.7: Features of the Innovations at the Sloan Refresher Course

Time	Type of innovation	Reasons for innovation	Size	Intensity
Jul.94	Facility cleaned and repainted	Summer Break	3.0	4.0
Aug.94	Introduced hot meal special	More variety. Summer Break	5.0	7.0
Aug.94	Replaced Donkin' Donuts with freshly baked pastries	Improve quality. Offer new products in the Fall	3.0	3.0
Aug.94	Replaced Pizza Hut with homemade calzones	Better quality/price. Offer new products in the Fall	3.0	4.0
Jan.95	Replaced Snapple drinks with Twister	Customer complaint: Snapple was too expensive	1.0	1.0
Jul.95	Introduced Baskin & Robbins	More variety. Summer Break	3.0	4.0
Sept.95	Removed Baskin & Robbins	Bad quality/price. Sanitary problems	3.0	2.0

Time	Type of innovation	Reasons for innovation	Size	Intensity
Sept.95	A substitute for the manager was hired and took over the job	The actual manager could not be on the premises for personal reasons	9.0	3.0
Dec.95	The actual manager came back to the job	No other reasons to stay away from the job	9.0	9.0
Jan.96	Introduced Fresh Ground French Roast and Flavored coffee	On customer request. Winter Break.	1.0	2.0
Jan.96	Different warmers and brewers for different coffee flavors	On customer request. Winter Break.	1.0	2.0
Jan.96	Introduced 1/2 sandwich	On customer request. Winter Break.	2.0	1.0
Jan.96	Introduced meal special: 1/2 sandwich & soup/chowder/chilly	On customer request. Winter Break.	2.0	1.0

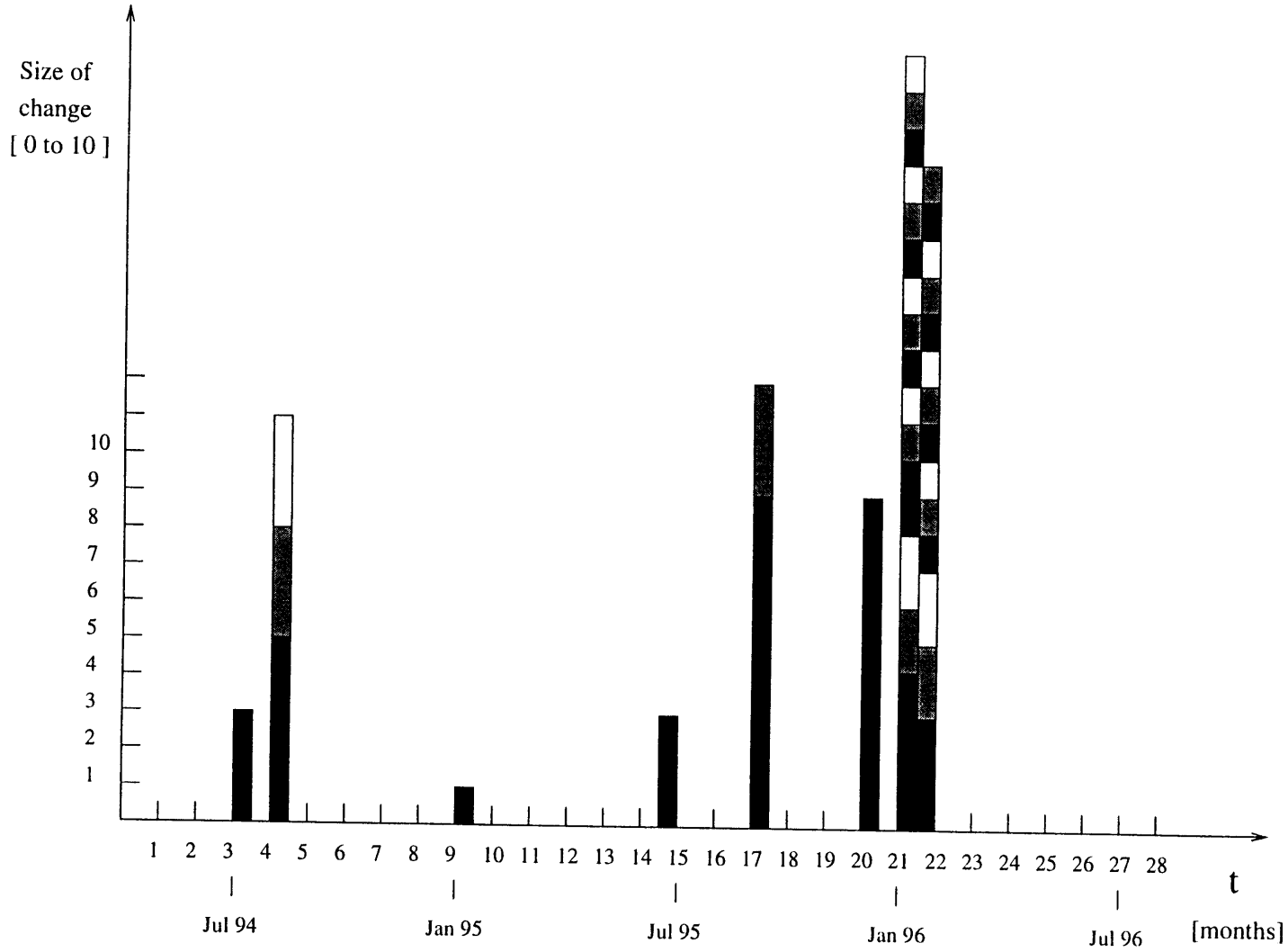
Time	Type of innovation	Reasons for innovation	Size	Intensity
Jan.96	Increased fresh fruit selection now kept fully stocked	On customer request. Winter Break	1.0	2.0
Jan.96	Replaced some hot entrees with ones more appealing to students	On customer request. Winter Break	2.0	4.0
Jan.96	Increased number of coffee warmers and brewers	Improve quality and speed of service. Winter break	1.0	2.0
Jan.96	Repaired bulk creamers to make a mirror image on both sides of coffee island	Improve quality and speed of service. Winter break	1.0	2.0
Jan.96	Bought two more coffee grinders to keep up with flow	Improve quality and speed of service. Winter break	2.0	3.0
Jan.96	Changed coffee cups to Green Mountain Coffee: 10-16-20 oz.	Improve quality and speed of service. Winter break	1.0	1.0
	one lid fits all cups		1.0	1.0

Time	Type of innovation	Reasons for innovation	Size	Intensity
Jan.96	Personnel changes: replaced head cashier and catering person	Improve quality of service. Winter Break	3.0	5.0
Jan.96	Created coffee island, like a small coffee house	Improve image. Winter Break	2.0	4.0
Jan.96	Changed uniforms colors: red and black (like Sloan School)	Improve image. Winter Break	1.0	1.0
Jan.96	Changed signage colors: red and black (like Sloan School)	Improve image. Winter Break	1.0	1.0
Jan.96	Changed lunch bags' colors: red and black (like Sloan School)	Improve image. Winter Break	1.0	1.0
Jan.96	Facility cleaned and painted	Improve image. Winter Break	4.0	6.0
Jan.96	Purchased framed pictures and decorations	Improve image. Winter Break	1.0 1.0	1.0 1.0

Time	Type of innovation	Reasons for innovation	Size	Intensity
Jan.96	Garnished deli with fresh lettuce and loafs of bread	Improve image. Winter break	1.0	1.0
Jan.96	Moved desserts to higher traffic area, more attractive display, added home made ones	Improve image. Increase sales. Winter Break	1.0	2.0
Jan.96	Changed from 4 oz. portioned meat to shaved meat in deli	Improve image. Increase sales. Winter Break	1.0	2.0
Jan.96	Changed from sliced bread to fresh baked loafs, sliced to order.	Improve quality of product Winter Break	1.0	1.0
Jan.96	Added hot dogs and introduced them in value meal packages, as well as chilly dogs	Increase variety of food. Winter Break	1.0	3.0
	Alternate chilly with chicken, beef and veggie stews		1.0	3.0

Time	Type of innovation	Reasons for innovation	Size	Intensity
Jan.96	Replaced Twister drinks with Frutopia	Customer complaint: too expensive, not worthy Winter Break	1.0	1.0
	replaced Yoplait yoghurt with Dannon		1.0	1.0
Jan.96	Increased number and variety of bagels, muffins and scones	High demand. Winter break	1.0	1.0
Jan.96	Offering homemade banana bread	Inexpensive to make, good taste. Winter Break	1.0	2.0

Figure 3.7 : Size versus Timing of Changes at the Sloan Refresher Course



Chapter 4

Analysis and Results

4.1 Introduction

After a preliminary analysis of the data, it is important to assess whether the environments, which were chosen as object of this study, show patterns of adaptation that support the theory of lumpiness, discussed in Chapter 1, or not. The first step, in order to understand the nature of such patterns, is that of observing how the intensity of adaptive effort, allocated to each activity, is distributed over time.

The tables presented in Chapter 3, show the intensity of adaptive effort (see Chapter 2, Section 2.3) for each innovation activity, at the time of first introduction.

The values of such initial intensities are reported on a 0 to 10 scale, as respondents rated them, relative to their particular environments, during the initial set of interviews. For the purpose of identifying and analyzing patterns of adaptation, more data is required, regarding the transition phase, immediately following the introduction of a given change. First, it is necessary to know the duration of such a transition phase, or, in other words, how long it took before the organization could readjust to regularly smooth operations, since the time of first introduction.

Second, we need to know, at least at a qualitative level, how the intensity of effort evolved over time, during the transition phase.

In order to obtain this further information, participants to the first set of interviews

were contacted again, at this stage of the project, and asked to identify significantly accurate trends for the intensity of effort over time in each activity.

Given the nature of the changes observed, whose transition phases, in most cases, stretched over months, and the length of the yearly operative time compared to the non operative one, it seemed reasonable to discriminate between the shapes of such trends, for all those changes whose transition phases were at least as long as one month, and assign standard, relatively sharp shapes, to all those changes whose transition phases lasted less than one month.

The results of this further investigation were then plotted to obtain the distribution of adaptive effort over time, for each innovation, as shown in the following graphs (solid line.) When more than one activity was either undertaken, or ongoing, during a given month, a cumulative intensity of adaptive effort was obtained by adding up the contributions of such activities over time (dashed line.) Therefore, in the graphs, the cumulative intensity of adaptive effort mostly overlaps with that of individual activities (solid line), with the exception of those periods characterized by sets of nested activities (dashed line.)

The area bounded by the lines defining the intensity of effort over time for a given activity, represents the total adaptive effort invested in such activity. Correspondingly, the lines describing the evolution of the cumulative intensity of adaptive effort in a given period of time, bound an area representing the cumulative adaptive effort, across activities, over that period of time.

In the following, the graphs are used as basis for analyzing patterns of adaptation and identifying the major forces that explain the natures of such patterns.

For the purpose of this analysis we can group the service environments in three major categories:

1. Physical Plant: including Mail Service, Maintenance/Repair service and Custodial Service

2. Computer Services: Sloan Computer Service

3. Food Services: including Faculty Club, Lobdell and Refresher Course

The reasons for this grouping are the similarities either in type of service or organizational structure, and in the nature of changes and reasons for their implementation.

The three areas of the Physical Plant Department, provide extensive services throughout all MIT campus, operate without interruptions all year round, mostly according to fixed daily schedules, and provide their services without direct interactions with individual customers.

Over the past few years, All of them have been going through major organizational changes, mostly aimed to improve the financial efficiency of their operations. Such changes are mainly consequences of the MIT Re-engineering Plan, which had a dramatic financial impact at the service level.

Since most of the activities undertaken in these environments are part of a larger organizational process, they are not effectively independent. However, for the purposes of this study, whose focus is on timing of implementation, they will be analyzed as separate changes.

The three services grouped in the Food category operate in close interaction with customers, mainly students and faculty members, thus, their business is strongly affected by the academic calendar and related events. All of them went through series of mainly customer driven innovations, aimed to improve the quality of products, the effectiveness and speed of service, the image of the facility and the financial efficiency of the business. They all resented the budget cutting policy pursued by MIT management, however, none of them responded with major organizational changes, for cost cutting purposes. The reduced budget, that the Institute decided to allocate to each of these services, eventually determined a correspondent reduction in range and variety of products or services offered.

The Sloan Computer Service constitute a separate category itself, because of the inherently different nature of the service and ways of providing it. The services provided are of two kinds, each of them involving different levels of interaction with customers. Part of the service, in fact, consists of student, faculty and staff support activities, involves frequent interactions with customers and is significantly affected by the academic calendar.

The remaining activities are project oriented and mainly focused on installment of new equipment and improvement of the existing one. This second set of activities, although partly customer driven, does not involve direct interaction with customers and is still affected by

the academic calendar, but in a different way: support activities usually slow down during breaks, whereas project activities proceed at their usual pace during such periods, and often intensify, due to important deadlines to be met at the beginning of new semesters.

4.2 Physical Plant

If we closely observe the patterns of adaptation regarding the Mail Service, the Maintenance/Repair Service and the Sloan Computer Service (see fig. 4.1, 4.2, 4.3), we notice strong similarities. First, as observed at the beginning of this chapter, most of the changes introduced are part of large scale processes of organizational innovation, which, in turn, represent exceptional events in the given environments.

Second, since such organizational changes are triggered by common causes, they also start in the same period (Summer-Fall of 1994) and occur in very similar sequences, in the three environments. In particular all of them begin with a relatively long and intensive period of planning, which lasts from two to four months. The completion of such redesign plan is followed by few months, spent on the implementation of various preliminary changes, mostly aimed to prepare the organization for the shift from individual to team work.

Each of the three patterns includes a pilot project. Such project consists in a small scale experiment, involving one or, at most, two teams, and is aimed to test the effectiveness of the redesign policies, on the job, for a few months (three to six months.)

In parallel to the pilot project, other changes take place: decisions about team location, staffing and so forth, are made, and eventual construction works are planned on and started. Finally, a few months after the completion of the pilot project, the actual teams start their job, in the respective areas of competence.

The team roll out process occurs in separate stages: one or two teams at a time. This process, already completed in the Custodial Service, is ongoing in the Maintenance/Repair Service and has just started in the Mail Service.

If we look at the sequences of innovations that took place in each of these three environments at the aggregate level, or, in other words, from the perspective of the whole redesign process, we notice that the resulting pattern of adaptive effort is definitely episodic: isolated

spurts of adaptive activities, can be observed before the beginning of the pilot project. Towards the end of the pilot project, further changes occur in lumpy batches: overlapping spurts of adaptive effort are interspersed with particularly short periods of routine operations.

This lumpiness persists if we observe changes at the level of groups of related activities, within the main redesign process. As an example, if we look at the team roll out process, following the completion of the pilot project, we can again observe relatively lumpy patterns.

Some interesting differences in timing of changes across the three environments, lead to the identification of the forces underlying the resulting patterns.

The Custodial Service, as an example (see fig. 4.3), started the redesign phase later than the others, but finished the team roll out earlier. A relatively long pilot project and an equally long period of uninterrupted routine operations, after the completion of the pilot project, are followed by a particularly fast team roll out process.

These observations highlight a combination of underlying forces which alternate in the role of dominant drivers, during different phases of the whole redesign project, as to achieve an optimal compromise. "Slow Learning Leads to Fast Improvement" and "Management of Human Attention over Time" account for the length of the pilot project and especially for that of the following period of routine operations. "Production Pressure", here intended as need for having the whole service fully operative as quickly as possible, accounts for the speed of the subsequent team roll out phase, characterized by frequent spurts of adaptive effort (roll out of new teams), hardly interspersed with very short periods of routine operations. This means that the leading ideas during and immediately after the pilot project, were that of maximizing initial problem solving and that of optimizing learning outcomes, whereas, right after such phases the leading idea was that of rapidly and effectively putting to use the just gained knowledge and experience. These considerations are strongly supported by the data and information gathered during the interviews. Apparently, most of the initial problems were confronted and solved during the pilot project, thus exploiting the "windows of opportunities" offered by the period of first implementation of the re-engineering plan.

As an example, one of the most important issues that arose as soon as the pilot project started, was the inefficiency of the preliminary procedures, which all the employees had to go through, before they could start their daily work: they actually had to stand in a line

Figure 4.1 : Intensity of Adaptive Effort over Time in the Mail Service

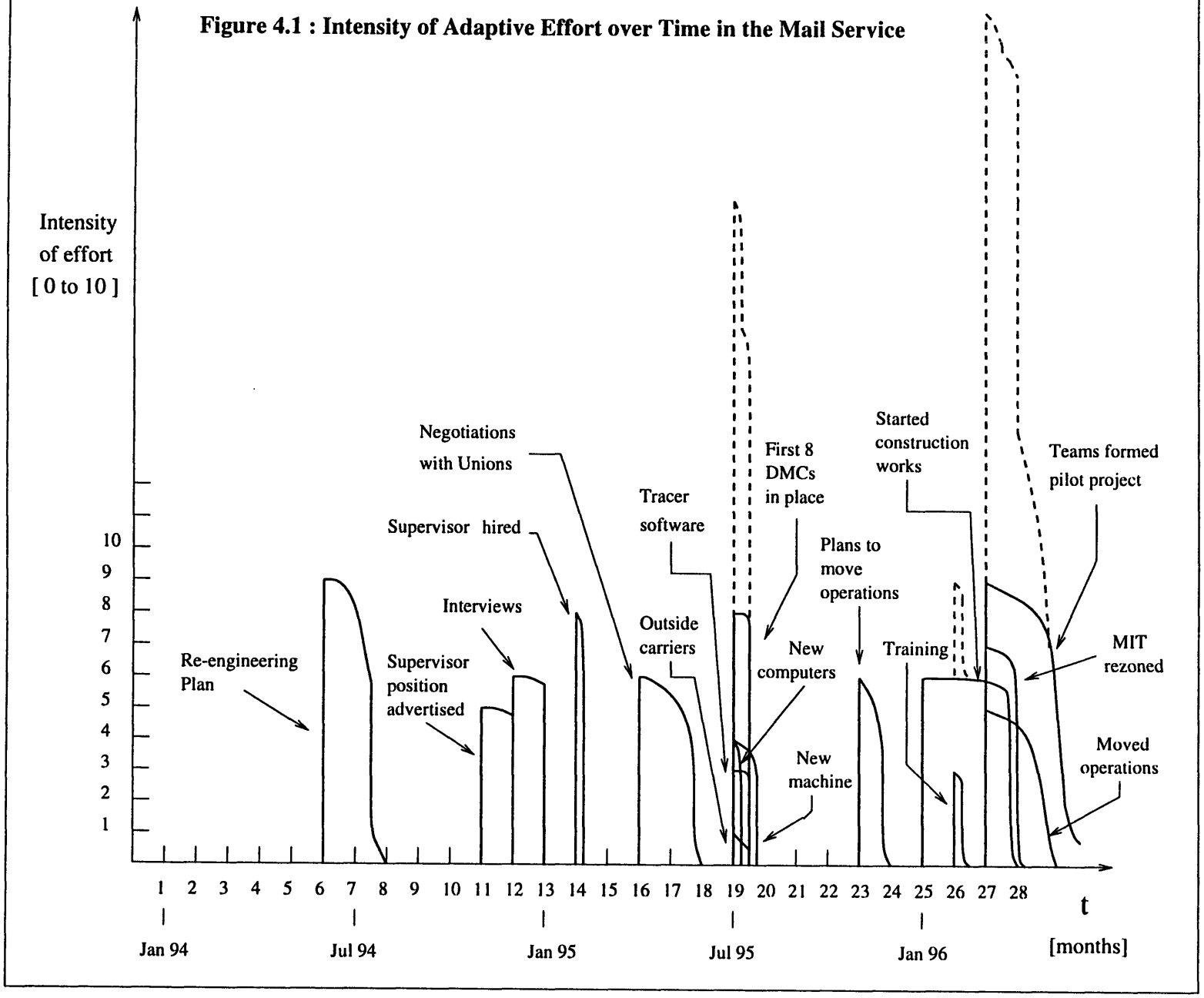


Figure 4.2 : Intensity of Adaptive Effort over Time in the Maintenance/Repair Service

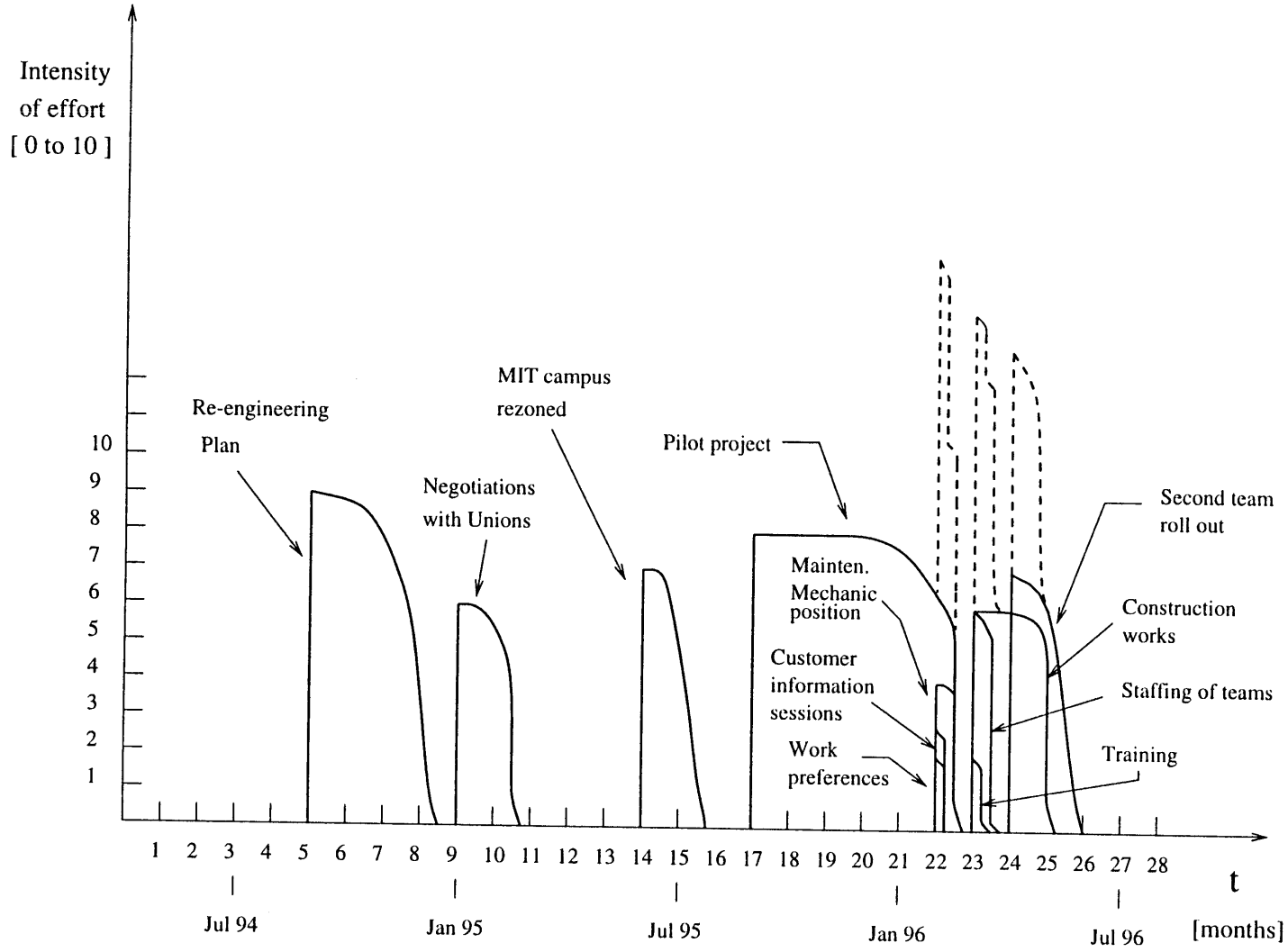
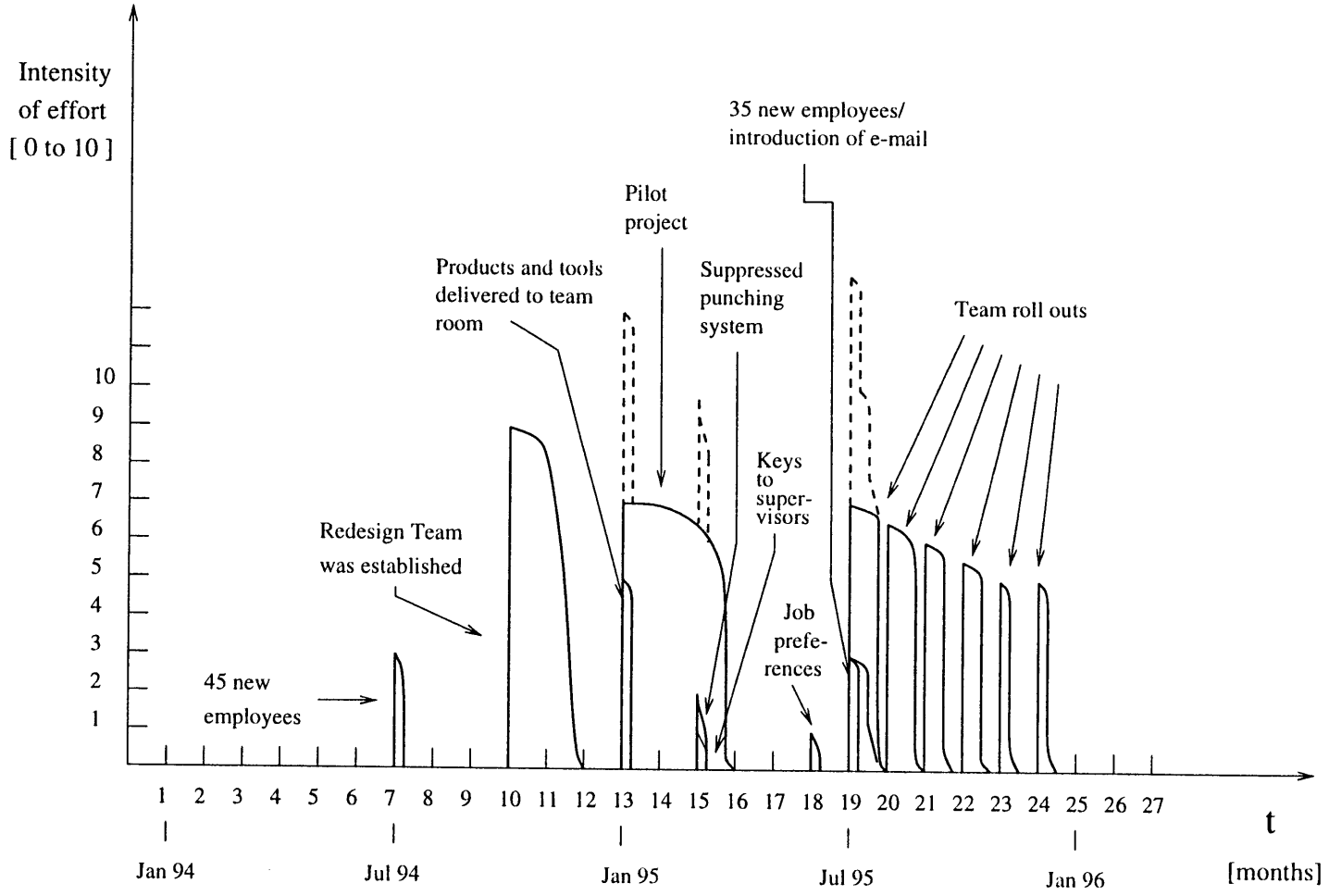


Figure 4.3 : Intensity of Adaptive Effort over Time in the Custodial Service



for punching in and they had to pick up the keys to the buildings of competence, at the beginning of their working shift.

As a result, towards the end of the pilot project the punching system was suppressed and the keys to the buildings were directly assigned to the teams' supervisors: this allowed the employees to dedicate more time to the actual work, without inefficient waits and trips from the central offices to their respective working areas.

The period of routine operations, immediately following the pilot project allowed for observation and learning: one of the major issues that came up in such period was that of communication: apparently, the decentralization of the teams (team rooms were conveniently located near or within the teams' working areas), made it difficult for both customers and central managers to promptly reach and communicate with team members. Therefore, the plan was made of installing computers provided with e-mail systems in each team room. Such a plan was actually implemented during the next period of adaptive activities.

This approach highlights how "Management of Human Attention over Time" and "Slow Learning Leads to Fast Improvement" are major driving forces in the early stages of implementation of the re-engineering plan.

Later on, however, "Production Pressure", here intended as need for having the whole service fully operative as quickly as possible, becomes the major driver, and accounts for the pattern of adaptation observed during the team roll out phase. The team roll out process, as observed in figure 4.3, took place very quickly and smoothly, partly due to the fact that the most significant problems were solved during the pilot project and soon after, but mainly due to production pressure, as defined above. Production pressure, in fact, explains why the periods of routine operations between the roll out of a team and that of the next are almost negligible: spurts of adaptive effort at this stage of the project seem to be compressed within a short period of time, determining an "almost continuous" sequence of spurts.

Finally, by looking at the pattern, we can identify an underlying learning experience: the roll out of each team benefits from both the experience and the knowledge gained through the pilot project and through previous team roll outs: in fact, each team roll out required lower intensity of effort, and took a shorter period of time to reach completion, than any of the previous ones. This consideration, again, shows how "Slow Learning" in the initial

phases "Leads to Fast Improvement" in the following ones: if initial learning is optimized, further learning is easier and faster: in this way we can think that the exploitation of a well planned pilot project, together with the subsequent phase of routine operations, may account for significant learning outcomes during the following, and much shorter, periods of routine operations, which the actual team roll outs are interspersed with.

The Mail Service (see fig. 4.1), started the planning phase earlier than the other two, but, at date, has just undertaken the team roll out phase, which in this case coincides with the pilot project itself. This delay in the completion of the redesign plan is mostly due to difficulties faced in the preliminary stages of the redesign process: strong customer opposition to the redesign plan, long lasting negotiations with the Unions, heavy load of construction works are example of such difficulties, which called for problem solving effort and entailed a shift of attention from the redesign project to other activities. Therefore, the resulting pattern of adaptive effort reflects lack of "Economies of Scale in Problem Solving" (problems are dealt with as soon as they arise) which, in turn, shrinks the opportunities for properly "Managing Human Attention over Time".

Once preliminary problems are solved, a set of activities significant to the redesign plan are immediately undertaken, almost at the same time: MIT campus is completely rezoned, teams are formed and assigned to the respective zones, and operations are moved to the new location. These overlapping spurts of adaptive effort are simultaneously caused by three driving forces: "Economies of Scale in Problem Solving", "Production Pressure"and "Lumpiness Inherent in the Project". Again, production pressure is intended as need for having the whole service fully operative as quickly as possible. The concept of "Inherent Lumpiness" in this case refers to the fact that such changes are not only interdependent in the project, but also relatively indivisible.

The Maintenance/Repair Service implemented its changes most smoothly (see fig. 4.2): in particular it had a very intensive and long lasting pilot project and no unrelated changes interspersed with those concerning the redesign process. Most probably, in analogy with what observed in the Custodial Service, this means that opportunities for initial problem solving were exploited during the pilot project, and periods of routine operations between changes could actually be devoted to learning activities, such as analyzing the effects of pre-

viously implemented changes and identifying opportunities for improvement. Consequently we can see how both "Management of Human Attention over Time" and "Slow Learning Leads to Fast Improvement" play a dominant role in driving the pattern of adaptation in the first stages of the redesign process. After the completion of the pilot project, changes tend to accumulate, as observed in the Mail Service, and again the driving forces can be recognized to be "Economies of Scale in Problem Solving", "Production Pressure" and "Inherent Lumpiness", with the same meaning as above.

4.3 Computer Services

If we look at the pattern of adaptive effort, observed in the Sloan Computer Service, (see fig. 4.4) we can notice that not many changes were implemented in the period between January 1994 and September 1995, whereas a significant number of changes occurred after the Summer of 1995. Moreover, such changes appear very scattered and episodic first, and take place in a lumpy fashion after (many at the same time.)

Two major reasons help explaining this pattern: the first one is related to the organization of the Sloan Computer Service itself, the second one concerns the particular nature of the changes, that were going on at the end of 1995.

Until the Fall of 1995, all the employees were relatively interchangible and worked on both support activities and new projects. As the manager pointed out during the interview process, there used to be a permanent conflict between the two kinds of activities: frequent interruptions of project work, due to customer calls and daily problem solving, were disruptive in terms of progress in project related activities.

This observation seems to highlight an issue of "Management of Human Attention over Time". As discussed in Chapter 1, in fact, interruptions are useful if they are interspersed with longer periods of routine operations, and if they help focusing on problems related to the ongoing activities. In this case, neither of such two conditions were satisfied: first the interruptions were too frequent, second they shifted attention from project work to support activities. Such situation, apparently, would not only delay any progress in current projects, but also hamper any attempt to undertake new ones.

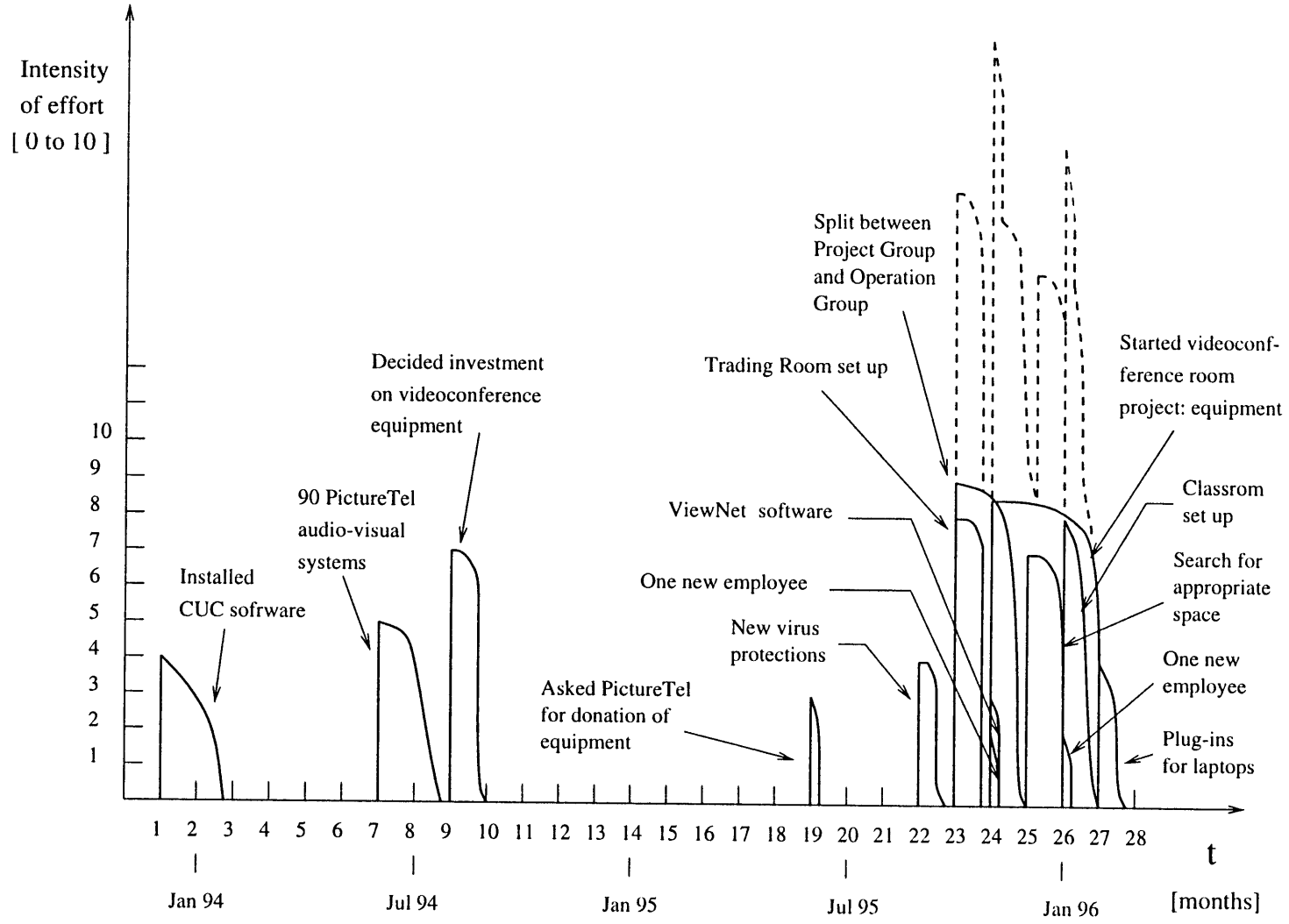
Innovation activities started to intensify in October 1995, when the split between Operation Group and Project Group took place. The split seems to have occurred primarily because of the size and nature of ongoing projects. Both the "Trading Room" and the "Videoconference Room" were particularly demanding projects in terms of time, resources and effort: apparently, management felt that they could not be completed on time, unless a team was specifically dedicated to such projects, on a full time basis. Thus, the decision of forming two separate groups, respectively dedicated to support activities and new projects, reflects a strong need of properly "Managing human Attention over Time". It is important to notice that after the split, at the aggregate level (see cumulative intensity of adaptive effort fig. 4.4) adaptive activities take place almost continuously, for the next few months, and individual spurts of adaptive activity are strongly overlapping. This particular pattern can be explained by the split itself, as it dramatically changed the way "Human attention was Managed over Time". In fact, at such stage, the newly formed Project Group started working on project tasks full time, without further unrelated interruptions.

Another consideration makes us recognize "Management of Human Attention over Time" as a major driving force. Most of the changes occurred since the Fall of 1995, concerned one single project: the introduction of videoconference equipment in the Sloan School of Management. Changes related to such project look seldom interspersed with minor changes, occurred at different levels, such as the introduction of new virus protections and the installment of plug-ins for laptops in the Tang Building. Moreover only one relatively demanding project was undertaken during the same period of time: the set up of the Trading Room.

Changes towards the introduction of videoconference systems started slowly in the beginning, when new audio-visual systems were explored and tested. However, once the decision was made of investing in a fully equipped videoconference room and the deadline for it to be operative was set, activities intensified not only due to "Production Pressure", here intended as pressure of meeting the given deadline, but also due to "Inherent Lumpiness", or, in other words due to the indivisible nature of some of the changes required for the completion of the videoconference project. These two forces again contribute to explaining the increased intensity of adaptive effort towards the end of 1995.

In fact, the pattern of adaptive effort, in the period between the end of 1995 and

Figure 4.4 : Intensity of Adaptive Effort over Time in the Sloan Computer Service



the beginning of 1996, looks distinctly continuous, but not gradual, at the aggregate level (see cumulative intensity of adaptive effort, fig. 4.4, dashed line). This means that, over a relatively short period of time, many adaptive activities, partly overlapping with one another, were undertaken: as a result, a basic level of adaptive activity, whose intensity is always greater than zero, can be observed, and occasional spurts, very close in time to one another, add up to such basic level of activity. This behavior can be explained as follows. Most of the activities undertaken in this period were timewise related to each other: for example, the installation of the videoconference equipment could not start until an appropriate room was found and set up. However, "Production Pressure", here intended as need for meeting the given deadline, forced the beginning of one activity to take place when the preliminary ones had not been totally completed yet. This explains why activities, that under regular circumstances would have been undertaken and carried out sequentially, partly took place in parallel, and produced a continuous cumulative pattern of adaptive effort.

Moreover, delays in the installation of the equipment were caused both by the difficulties encountered in finding an appropriate location for the videoconference room and by long negotiations with PictureTel, the company which partly sponsored the project with donations of equipment. Such delays, forced the team to squeeze all the necessary activities at the end of 1995, as the deadline, February 1996, was getting closer and closer.

This again highlights the presence of a driving force, which, in analogy with "Economies of Scale in Problem Solving", can be labelled as "Economies of Time in Problem Solving".

4.4 Food Services

The three food service environments, chosen for the purposes of this study, although operating in the same kind of business area, are significantly different in both size and ways of providing their services. As observed in Chapter 3, the Refresher Course is a small dining facility, serving a limited group of MIT students, faculty and staff members, mainly focused on providing quick meals and snacks, in the morning and at lunch time. Lobdell is one of the largest dining facilities on MIT campus, it serves thousands of customers every day and offers a wide variety of full meals and snacks, at breakfast, lunch and dinner time. The

Faculty Club is a relatively large facility currently used for catered events only.

Relatively different organizations were chosen, within the same area of business, in order to verify whether dissimilarities in purposes and ways of providing the same type service would lead to different patterns of adaptive effort, or, instead, the interaction of common driving forces would maintain the same pattern across environments.

There is no doubt, just by looking at the respective patterns of the adaptive effort (see fig. 4.5, 4.6, 4.7), that the implementation of changes, in the three food service environments and the following adaptive efforts occur in a discrete and episodic fashion. Moreover, such activities, in each of the three environments, are definitely undertaken, and most likely completed, during Summer or Winter breaks.

These similarities of patterns can be explained by four major underlying forces, common to the three environments:

1. Entrainment
2. Management of Human Attention over Time
3. Economies of Scale in Problem Solving
4. Slow Learning Leads to Fast Improvement

The concept of entrainment, borrowed from the natural sciences, is here applied to organizational behavior. Entrainment as Ancona and Chong (1996) define it, is the adjustment of the pace or cycle of an activity, to match or synchronize with that of another activity. The adjustment could be in phase, periodicity or magnitude. Thus, pace entrainment examines the change and alignment of speed, whereas phase entrainment examines the synchronization of cycles.

The term entrainment in biology refers to the process whereby an endogenous biological rhythm is modified in its phase and periodicity by powerful exogenous influences called external pacers.

The fundamental idea behind entrainment in organizational theory is that endogenous cycles exist within individuals, groups, organizations and environments. These endogenous

Figure 4.5 : Intensity of Adaptive Effort over Time at the Faculty Club

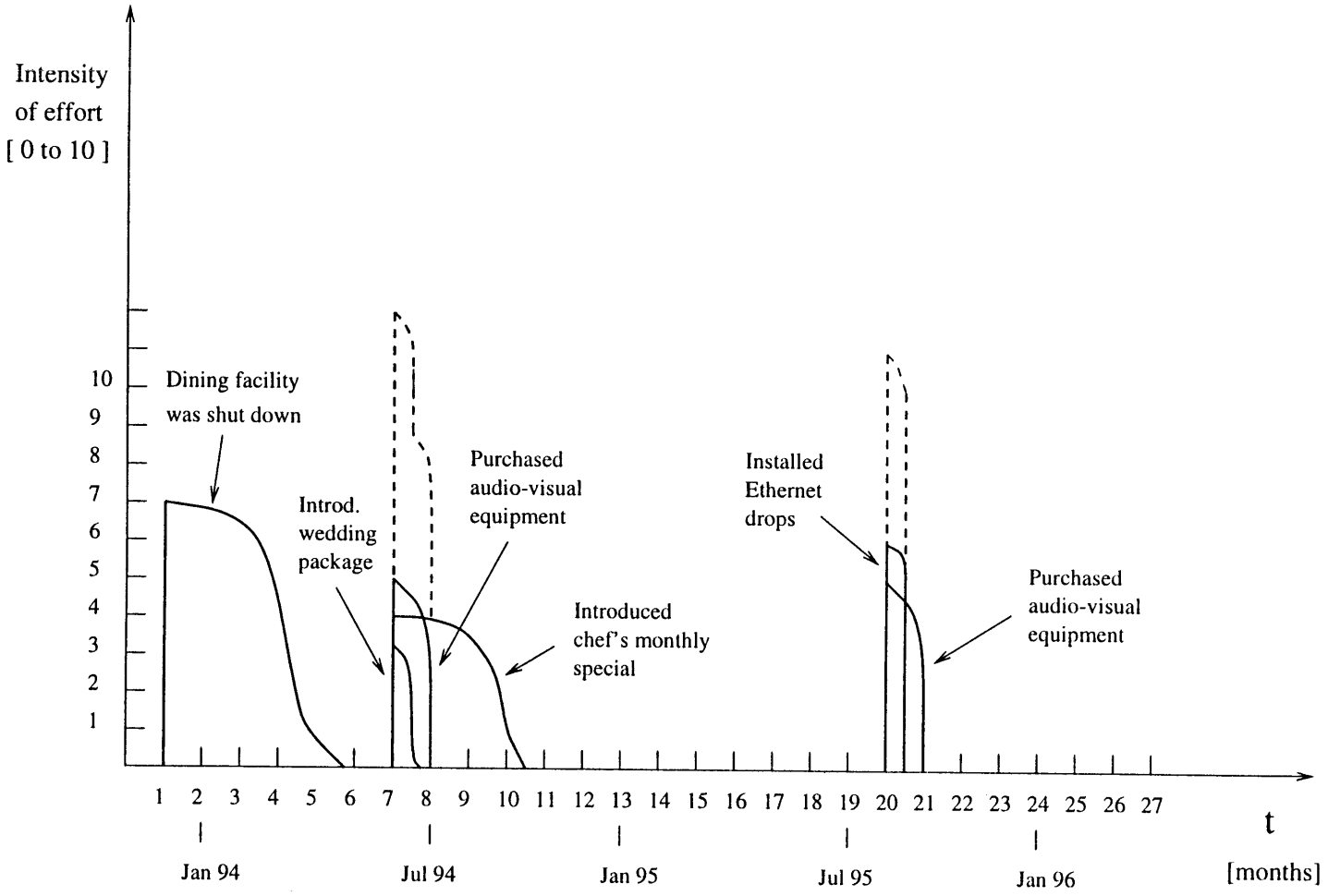


Figure 4.6 : Intensity of Adaptive Effort over Time at Lobdell

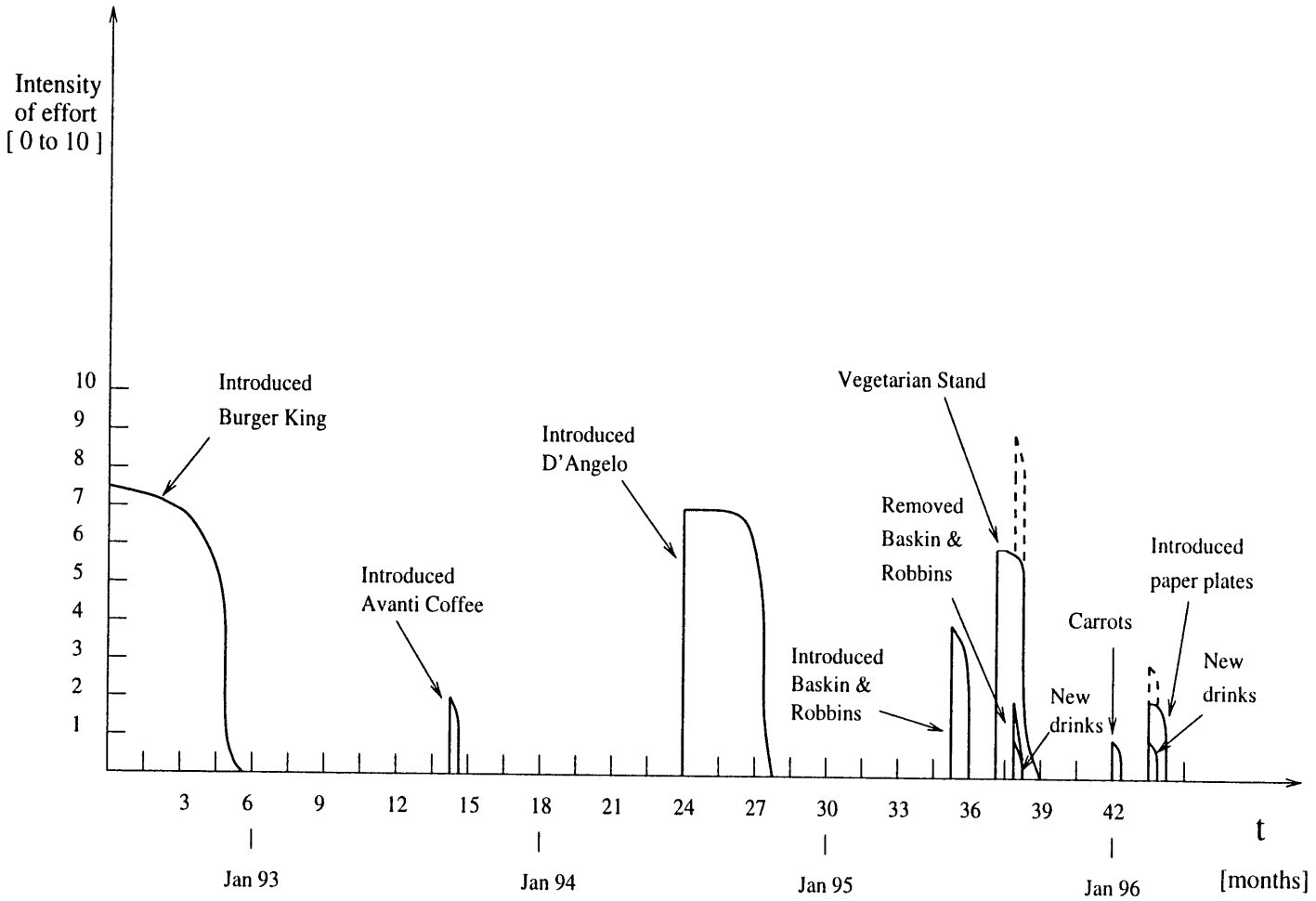
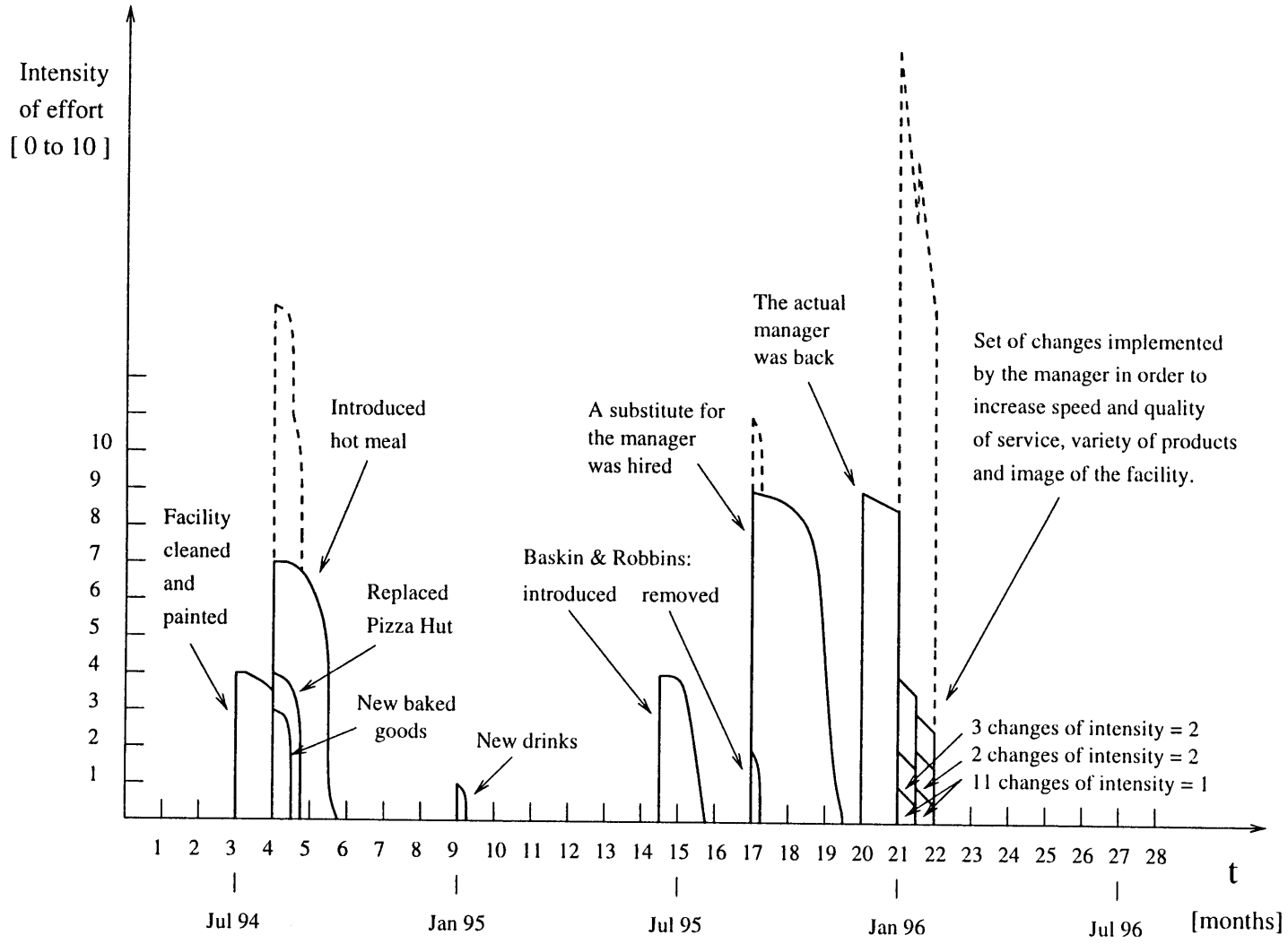


Figure 4.7 : Intensity of Adaptive Effort over Time at the Sloan Refresher Course



cycles are often influenced by other cycles within the system or outside the system, so as to occur in synchrony; in entrainment language the cycles are "captured" by an external pacer so as to have the same phase, periodicity, or magnitude. The "captured" cycles establish an entrained rhythm that then pulls many other cycles into synchrony. The fiscal year in public firms and the semester in academic institutions are two examples of pacers that create entrained organizational rhythms, which dominate and capture many organizational activities.[4]

Observing the patterns of adaptive effort in the three service environments analyzed in this section, we notice that the correspondent activities are strongly entrained both in phase and peridicity to match the endogenous rhythm of the major organization they belong to.

Naturally the dominant pacer, in this case is the academic calendar, consisting of semesters, Summer and Winter breaks. Cycles of innovations and adaptive activities are undertaken with the same periodicity as all other academic activities, but with opposite phase: changes systematically occur during Summer and Winter breaks when most of the academic activities are either suspended or slowed down. Therefore, in such environments we observe periodicity and asynchronic phase entrainment. Periodicity entrainment can be observed directly from the patterns, because adaptive activities systematically take place during given periods of the academic year, respectively Summer and Winter breaks. Asynchronic phase entrainment can be observed because during the semesters, when academic activities reach their highest levels, food services run routine operations and do not attempt to introduce any innovations, whereas, during the breaks, when academic activities are either slowed down or suspended, food services undertake adaptive activities and do implement changes.

If we examine the services as part of the whole academic environment, we recognize that the academic calendar is an internal pacer. However, if we observe such environments as separate and independent organizations, the academic calendar becomes an external pacer.

Management of human attention over time is another force which partly accounts for the observed patterns of adaptive effort. Such force is active at two levels, respectively customer level and staff level.

As pointed out in the outlines presented in Chapter 3, these food services put an effort in

introducing changes at the beginning of each semester, in order to give customers something to look forward to when they go back to school, maintain old customers and gain new ones. This goal is achieved by improving the quality and variety of products, the efficiency of service, or the image of the facility itself. The important issue is that of bringing something new. In this regard we can talk about management of customers' attention over time: changes introduced at the beginning of each semester are most likely to be noticed and appreciated, because they come after an interruption of routine habits, and thus in a period when the level of customers' attention is particularly high.

The same concept, management of human attention over time, applies to staff members as well: in fact, it would be hard for them, or at least harder, to switch from routine operations to adaptive activities during the course of the semester, when business is demanding and other priorities have to be taken into account. If the switch is made when business is slow, or, even better, when the facility is shut down, difficult compromises in terms of human attention can be avoided.

Another force, which accounts for the observed patterns is "Economies of Scale in Problem Solving". It is apparent that shutting down the facility, during the semester, for problem solving and improvement purposes, would be disruptive both in terms of image and customer satisfaction, and in terms of business profits. Therefore, it seems preferable to accumulate ideas for change during the semester and save their implementation for the following break.

Finally, we can observe that relatively long periods, in this case academic semesters, of smooth, routine operations, interspersed with shorter periods of adaptive activities, lead to interesting learning outcomes. Such periods of routine operations, as discussed in Chapter 1, not only constitute valuable test-beds for changes previously implemented, but also provide opportunities for identifying unforeseen problems and developing new ideas for further improvement.

During each academic semester, in fact, these food services obtain both formal (surveys) and informal (occasional comments) input from their customers, concerning what they particularly like or dislike, and would add to, or change about, the service. Such information, together with the internal records, and financial statements, of the operating units themselves, constitutes the basis for decisions and plans, concerning the changes to be im-

plemented during the next academic break.

These considerations show how "Slow learning Leads to Fast improvement" plays a significant role, as driving force, in such environments.

Chapter 5

Conclusions

"With a few exceptions", as Ancona and Chong (1996) observe, "time and timing have not played a significant nor explicit role in organizational behavior research. Moreover, while time plays a key role in identifying many organizational phenomena and concepts, it has seldom been isolated as a key variable, compared across theoretical frames, or included into general organizational theory. Most of the work that has been done on time and timing results from a recent surge in interest among organizational researchers. The issues of how long, how fast, and when activities do and should occur within organizations have recently gained prominence as competitive pressures grow and speed and timing are seen as prerequisites for corporate success.

Rather than viewing time as an objective entity, research on time and timing suggest that time may be subjectively determined through a temporal reference framework that provides organizational members with a sense of time. Therefore rather than simply consider the levers of success in organizational change to be what is changed and how change is implemented, it is important to understand that when change takes place is critical to its success." [4]

As pointed out in Chapter 1, an apparent conflict has been identified in the existing literature over the timing of technological adaptation in organizations. "While innovation research describes a gradual, continuous process of modification, behavioral theory indicates that the process may be much more discontinuous" (Tyre and Orlikowski, 1994.)[1]

The results of this study reveal patterns of adaptation which are distinctly discontinuous,

or episodic, in all the environments, with the exception of the Sloan Computer Service, where the split between the Operation Group and the Project Group created the conditions for rather continuous problem solving and improvement activities, as observed in Chapter 4.

"In general, while full integration of a new technology may take several years, in most cases, adaptation attention and effort are not applied consistently over that period , and they do not decrease gradually. Rather, they are concentrated in short spurts during the period" (Tyre and Orlikowski, 1994.)[1]

During the course of this project, strong dissimilarities of patterns were observed across categories of operating units, respectively Physical Plants, Computer Services and Food Services; the reasons for such dissimilarities are the inherent differences in strategies, purposes and situations, as thoroughly described in the beginning of Chapter 4 (see Section 4.1), which in turn cause different sets of organizational forces to dominate and shape the respective patterns of adaptation.

As discussed in Chapter 4, the major driving forces in the Physical Plant group are: "Slow Learning Leads to Fast improvement", "Management of Human Attention over Time", "Production Pressure", intended as need to have the service fully operative as soon as possible, and "Inherent Lumpiness" of projects. In this case, it is hard to provide an unique ranking of such forces, in terms of their importance as drivers, because they alternate in playing dominant roles, over time.

However, it can be noticed that, "Slow Learning Leads to Fast improvement" and "Management of Human Attention over Time", tend to dominate in the early stages of each project (see Chapter 3, Sections 3.2 to 3.4 for project descriptions), whereas "Production Pressure" becomes the leading driver towards the end, when deadlines need to be met and project's milestones need to be achieved.

These findings fit the behavioral theories by Tyre and Orlikowski (1993, 1994), presented in Chapter 1, about discrete patterns of technological improvement. Such theories, in fact, based on experimental results, predict initially high levels of effort in active problem solving and learning experiences, which decrease afterwards, together with focus and attention, due to production priorities and objectives.

Again, based on the considerations presented in Chapter 4 (Section 4.3), "Management

of Human Attention over Time", appears to be the most important driver in the Sloan Computer Service, and, as observed above, regarding the Physical Plant group, "Production Pressure" and "Inherent Lumpiness" strongly contribute in shaping the pattern of adaptation, when the the Videoconference Project gets close to completion, or, better, needs to be completed. In this regard, we can think of a similarity between the patterns observed in the Physical Plant Services and the one observed in the Sloan Computer Services.

The driving forces identified in the three food services included in this study are, in order of importance: "Entrainment", "Management of Human Attention over Time", here referred to both customers' and employees' attention, "Economies of Scale in Problem Solving" and "Slow learning Leads to Fast improvement" (see Chapter 4, Section 4.4).

Patterns are, in general consistent within a given category. Minor differences, at the level of either individual changes or groups of changes can be observed among the three areas of Physical Plant. Both exogenous and endogenous factors account for slight differences in time and timing of adaptive effort across the three areas, in fact the re-engineering plan, undertaken by each of them, has different impacts both within the service itself and in its operative environment: customers' responses, internal acceptance by employees, beaurocratic issues, pre-existing structures, routines and frames of mind, may actually either delay or favor the implementation of certain changes, either stretch or reduce the transition phase following the implementation of changes. In other words, situations particular to the operating units set different equilibria among the same driving forces, thus determining minor differences, across similarly shaped patterns.

Analogous considerations hold true for the Food Services: minor dissimilarities can be observed across the three operating units. However, in this case, different situations, faced by the operating units, do not produce differences in time and timing of changes; such parameters, in fact are mostly the same in the three organizations due to entrainment phenomena (see Chapter 4, Section 4.4). Instead, they determine relatively strong differences in the number of changes introduced over a given period of time, and in the values assumed by the cumulative intensity of adaptive effort over time.

As shown in Chapter 4, important conclusions, in terms of driving forces, can be drawn by observing the patterns of adaptive effort in a given environment over a significantly long

period of time. The identification of driving forces and the understanding of their interactions over time, validly contribute to the explanation of many aspects of organizational behavior and constitute a basis for both planning and scheduling further changes.

"Managers have learned that, to exploit the advantages of new technologies, they must adapt those technologies to fit the organization and its strategy, and thus exploit the episodic pattern of adaptation around a given technology. However, exactly how and when to make those changes is not well understood" (Tyre and Orlikowski, 1993.)[2]

Further and more extensive research in this area, conducted on a larger variety of environments, may actually lead to the formulation of exhaustive theories about the forces underlying patterns of adaptive improvement and their impact in given environments. Based on such theories, it will then be possible to optimize the timing of implementation of desired changes, according to management's priorities, in different phases of the organizational history.

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4. D. Ancona and C. Chong, "Entrainment: Pace, Cycle, and Rhythm in Organizational Behavior," *Research in Organizational Behavior 18* (1996): 251-284.