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# WORKING PAPER
## ALFRED P. SLOAN SCHOOL OF MANAGEMENT

Planning Change from

Centralized to Decentralized

Management Information Systems

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Abstract

   The literature dealing with the issue of distributed management information systems concentrates mainly on one aspect of the problem: the centralization/ decentralization decision. For almost two decades, the issue of centralization versus decentralization of information systems has been widely discussed and hotly debated, but very few attention has devoted to a related issue: the planning of change from centralized to decentralized information systems. This paper argues that distributed processing has become a significant alternative to the previous trend toward centralized systems. But, to be fully beneficial, distributed systems should be carefully planned. This aspect is critical since a lack of planning is usually one of the factors that lead to a failure of information systems. In the second part of this paper, we investigate to what extent a theory of planned change can facilitate the planning of change from centralized to decentralized systems. Our approach looks at the issue of decentralization as one type of planned change. A model of planned change is described and applied to the case of change from centralized to decentralized information systems.

## I.   INTRODUCTION

### Toward Distributed Management Information Systems (DMIS)

For almost two decades, people have argued the comparative merits of
centralizing or decentralizing data processing activities.  There are several
good reasons why this has been a subject of perpetual concern.  Certainly, one
of the primary reasons is the large and increasing investment and operation
budget alloted to EDP, as shown in Figure 1.

Distribution of Spending

| Item | $ Billions | | % Of Total | |
|---|---|---|---|---|
| | 1973 | 1976 | 1973 | 1976 |
| Personnel | 7.07 | 9.99 | 32.6 | 29.3 |
| Computer Hardware and Maintenance | 7.53 | 11.88 | 34.7 | 34.8 |
| Purchased Computing and Other Services | 2.46 | 4.35 | 11.3 | 12.8 |
| Data Communications | 1.22 | 2.55 | 5.6 | 7.5 |
| Supplies | .82 | 1.23 | 3.8 | 3.6 |
| Total Direct Costs | 19.1 | 30.0 | 88.0 | 88.0 |
| Indirect Costs | 2.6 | 4.1 | 12.0 | 12.0 |
| Total Data Processing Spending in the US | 21.7 | 34.1 | 100.0 | 100.0 |

Average Annual Increase      16.5%

Figure 1.   Total Annual Spending on Data Processing
in the United States in Current 1973 and
1976 Dollars.  Adapted from (6).

This has drawn management attention to the need to make full use of this resource. Also the increasingly wide spread use of data processing systems has caused substantial dependence of any organizational units on their information systems. Because of this dependence, many authorities (2) perceive control of information systems to be synonomous with political power in the organization. While discussions of the advantages and disadvantages of both structures continue, the fact that a great many data processing operations are simply not performning up to expectations becomes alarmingly clear (18).

Since the early 1950's the trend in EDP installations has been toward centralization. There were several reasons for this trend, primarily economically motivated. Usually, three major arguments were used in favor of centralized systems: economy of scale, sophistication of applications and quality of systems development.

### 1. Economy of Scale

Organizations have been told that bigger is cheaper . In other words, a large computer is more cost effective than a small computer. This conclusion was derived from Grosch's law (4) which states that "the performance of a computer increases as the square of its cost."

There were several reasons which justified the economy of scale. First of all, decentralized small computer may have unused capacity. Centralization on a large computer could eliminate such costs. In addition, individual small computers may be overloaded, generating pressure for upgrading equipment or purchasing expensive bureau time. Centralization on a large computer could absorb this overload. While the arguments above can be valid for a particular centralized system, many researchers and practitioners have questionned the validity of

Grosch's Law.  They argue  that Grosch's Law was valid during the 1950's and the 1960's when the CPU Cluster was the dominant element in a computer.  Today a dramatic change has occurred in the sense that the cost of the CPU is less than 40% of the total cost.  Another argument used against Grosch's Law is the fact that the latter assumes that the power of a computer is proportional to its price.  This is a very simplistic assumption, especially when one considers the structure of a machine, the variety of channel and their speeds, and the characteristics of secondary storages.  Studies which invalid Grosch's Law can be found in Littrel (15), Reynolds and Lussato et al.(16).  All the recent studies point out to the same conclusion:  Grosch's Law, no longer seems to hold.  Although Grosch recently published a paper maintaining the validity of his law, most people do not believe it is true any more.  With the continuous reduction of hardware costs (20% yearly), the economy of scale is becoming less and less important and, in some cases, disappearing.  The increasing amount of data being transferred between the central node and the dispersed users joined to the remarkable stability of communication costs are changing the shape of the economies of scale curve.  Finally, the overhead associated with very large computers and the potential for underutilizing the capacity of a large centralized computer combine to diminish the validity of Grosch's Law.

An argument related to the concept of economies of scale and used in favor centralized systems is the one stating that in terms of floor space, electricity, air conditioning and other facility costs, a single large installation is less costly than multiple smaller installations.  Although this argument may still be valid, the changing technology of minicomputers and the intrusion of micro-computers can lead to a less important economies of scale.  In fact, some mini-

computers when used in distributed systems and most of the microcomputers do not need important facilities and can use only very limited floor space, electricity, and other facilities. An additional argument related to the economy of scale and used to justify centralization is the following: "The number of support personnel is lower for a large installation than for multiple small installations." This argument is true if one assumes that the complexity of minicomputers and microcomputers is as big as the complexity of large systems. In fact, mini- and microcomputers are fairly easy to operate. Besides, the development of new concepts like decision support systems (12), where systems are being tailored to the particular requirements of managers, favors the re- duction of support and specialized personnel.

In summary, the advances in the computer technology and the development of new concepts make the concept of economy of scale almost obsolete, therefore clearing the way for distributed systems.


## 2. Sophistication of Applications

To justify the centralization of information systems, other arguments besides the economy of scale have been used. An important one is related to the sophisti- cation of applications. In other words, there may exist certain applications which need high internal speed, great storage capacity and specialized personnel. These kinds of applications are not feasible in small installations. Some ex- amples may include scientific computation, database management systems, and the access to hierarchically structured files for manufacturing systems. In such cases, the application would justify the larger computer, which would in turn justify the elimination of smaller computers in the organization in order to

utilize the excess capacity of the large machine. The logic behind this type of argument is that decentralized systems are incapable of providing this service. A careful investigation of the capabilities of microcomputers leads to this surprising conclusion: "The capacity of a microcomputer can be bigger than the one of a maxicomputer but at a least cost" (16). The argument about database systems and hierarchical files is not valid anymore since the concepts of distributed files and distributed database systems has shown to be viable and efficient (5). In fact, the degree of sophistication of applications does not depend on the equipment used.

### 3. Quality of Systems Development

This is the third major argument used to justify centralized systems. The latter are said to establish and enforce systems documentation standards, to regulate standards for user documentation, to avoid redundant development of similar systems for different divisions of the organization and to allow an evaluation of projects from an overall organization perspective.

Although from a theoretical point of view, these advantages can be achieved, in reality, the huge centralized systems lead to an enormous complexity. This complexity is due to the necessity of handling large volumes of batch work. The resulting consequence is a system failure and difficulties to maintain a coherent system standard.

Besides, small dispersed systems allow local management and analysts to be more attuned to local needs. This enables them to establish requirement specifications and to design systems that are suitable for the local needs. As a consequence, small systems can lead to a limitation of complexity, as shown in Figure 2.

| Systems | Power | McClure's Law Number of Instructions for the software | Patrick's Complexity Index |
|---------|-------|----------------|----------|
| IBM 704 | 1 | 1,000 | 1 |
| IBM 709 | 2 | 10,000 | 2.5 |
| IBM 360 Small Systems | 4 | 100,000 | 8 |
| IBM 360 Big Systems | 8 | 1,000,000 | 20 |
| IBM 370 Virtual Memory | 16 | 10,000,000 | 200 |

Figure 2.  Complexity Indexes in Different
Computer Systems.  Adapted from (10).

A related factor which has been argued in favor of centralization is the
substantial differences between the abilities of large and small installations
to attract and retain highly qualified technical personnel.  It is argued that
the smaller installation will frequently suffer a higher turnover rate as talented
individuals outgrow the opportunities available.  The retention of highly quali-
fied personnel provided the centralized group with the capability to apply a
higher level of expertise to the solution of problems.  This personnel can then
provide a greater range of alternative solutions to the problems for evaluation
by management.

The literature about centralization versus decentralization of information systems does not provide any evidence to support the above arguments. On the contrary, behaviorial scientists such as Herzberg (11) and Maslow (17) support the opposite argument. They argue that the real factor that can contribute to attract high qualified personnel is motivation rather than the size of the companies in decentralized systems, the possibility of being associated to the decision-making process can be a real factor to motivate skilled personnel. Proponents of centralization have argued their case on additional grounds ranging from the benefits of company-wide consolidation of operating results to the ease of control by corporate executives. Many of these arguments, however, boil down to matters of management style. This adds additional confusion to the issue because styles change as the pendulum of management philosophy swings to and fro. All these and other such arguments have contributed to make a per-suasive case for centralization. Indeed centralization has been the major trend in EDP systems architecture for the last twenty years. Lately, however, a new and innovative approach to systems architecture has appeared. Distributed processing has bloomed into major prominence as a technqiue for increasing the efficiency of EDP operations. Several important factors have contributed to this surge of interest. The advent of cost efficient mini- and microcomputers as well as recent breakthroughs in network technology have clearly added credence to the realities of distributed processing. The recent literature abounds in cases of managers claiming substantial cost savings as well as increased effectiveness after implementation of distributed systems.

There are several other important reasons why distributed processing is gaining such rapid acceptance in the EDP industry. The economy of scale consideration which argues in favor of centralization is based

on Grosch's Law. However, Grosch's Law has been repealed, and the relation between total computer configuration cost and performance is much less of an argument for centralization.

Another important factor which favors distributed processing is system complexity. Two or three years ago progress in many big shops stopped when system complexity equaled the ability of the staffs to cope with it. Clearly almost any EDP manager would admit that a system with two or more connected CPU's with four or more megabytes, 100 communication lines (connected to anything), and 40 or more spindles of disc is indeed complex. They could prove this by displaying the million or so lines of software that go make up the operating system, the data base management system, the communication front-end, and the raft of compilers, utility programs, restart packages, and accounting systems required to run a single factory. With that much software, complexity is there even if only one application is being run. The complexity of the entire system of hardware, software, and personnel, rises much more rapidly than computer power or cost. When that complexity rises to a point where it taxes management's abilities to manage, it strongly argues against centralization inspite of possible economies of scale.

Not only is system complexity increased, but centralization forces divisions into a common mold that may be inappropriate for their needs. The specific hardware required for any one user may be different than that required by another. These different needs could be satisfied far more simply and less costly by more but smaller installations.

The centralized system also creates a contention for machine time between users. Several jobs running concurrently on a single machine may delay response

time to all users and, invariably, create competition for priority of service.

These and other factors combine to make a convincing argument for distributed processing. This is not meant to assert that distributed processing optimally satisfied every organization's EDP needs. As with most technologies certain tradeoffs must be considered between efficiency and effectiveness. All the arguments developed above and the reality of data processing point out to the following conclusion: distributed systems are here and offer the potential of being a new generation in EDP. It is considered as the fourth generation, as summarized in Figure 3.

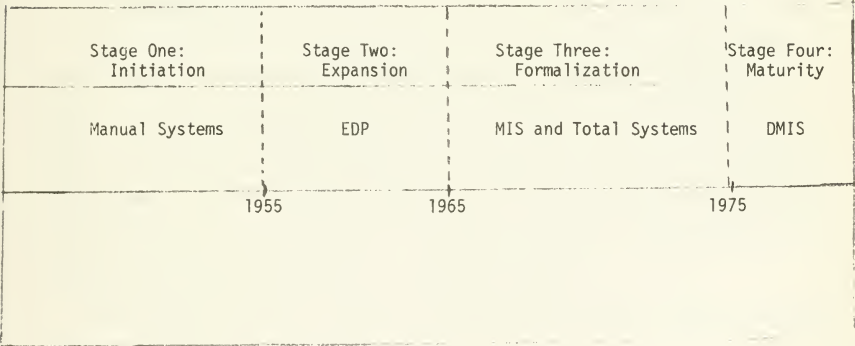| Stage One: Initiation | Stage Two: Expansion | Stage Three: Formalization | Stage Four: Maturity |
|---|---|---|---|
| Manual Systems | EDP | MIS and Total Systems | DMIS |
| 1955 | 1965 | 1975 | |

Figure 3.    Evolution of Information Systems

Within this framework we can add to the Gibson-Nolan (7) growth stage scheme, a fourth area of hardware growth. In the initiation, there is very little computer hardware. In the expansion stage there are several small computers within the organization each being seen by the user department with enough capacity to satisfy that department's need. In the formalization stage there is a centralization of hardware with a move to larger machines and high capacity to

meet the expected needs of all departments. Finally, in the maturity stage there is a movement to distributed processing order to service user needs most effect- ively.

There can be little doubt that distributed processing has become a signifi- cant and realistic system alternative. Distributed processing has come to be regarded as beneficial. Therefore, a careful planning process should be developed when organizations have to change from centralized to decentralized systems.

## II. Planning Change from Centralized to Decentralized Information Systems

### 1. Introduction

In the first section of this paper, we have shown that the trend in today's data processing is toward decentralizated systems. Therefore, an important question that to our knowledge was never been addressed, once the decision to decentralize has been achieved, how to plan change from centralized to decentral- ized systems? This is a critical issue since a lack of planning is usually among the factors that lead to a failure of information systems. It is our opinion that decentralizing systems should be carefully planned.

In all previous work, no author has addressed the issue of change from the viewpoint of the theory of planned change.

The aim of this section is to investigate to what extent a theory of planned change can facilitate the planning of change from centralized to decentralized information systesm. Our approach looks at the issue of decentralization as one type of planned change. We first describe possible models of planned change, and choose Beckhard's Action-Research model. Then we applied it to the case of change from centralized to decentralized systems.

2.  Possible Models of Planned Change

The theoretical base most frequently suggested in planned change is the LEWIN/SCHEIN theory of change (12). This theory states that any change effort can be viewed as including three distinct phases: Unfreezing, Moving, and Freezing.

Unfreezing is the process of alteration of the forces acting on the individual such that his stable equilibrium is disturbed sufficiently to motivate him and make him ready to change. Changing is related to the process of learning new attitudes.

Finally, the refreezing phase is achieved when the individual integrates the new attitudes. This model is not adequate to serve as a basis for planned changes from centralized to decentralized system since it lacks detail, is very general and hardly operational.

A number of models which elaborate on this basic theory have been suggested in the planned change literature. Some of these models can provide some of the detail needed to begin defining operationally the mechanisms necessary for each phase (i.e. Unfreezing, Moving and Freezing). One possible candidate is the KOLB/FROHMAN model (13). This model divides the process into seven phases, adding more structure and detail to the basic framework provided by Lewin and Schein (see Figure 4). This model was used by Ginzberg (8) in his study of implementation and was slightly modified by Urban (16), in his study of implementation of marketing models (see Figure 5).

For the issue of planning change from centralized to decentralized information systems, we have chosen BECKHARD's Action-Research Model descirbed in Figure 6.
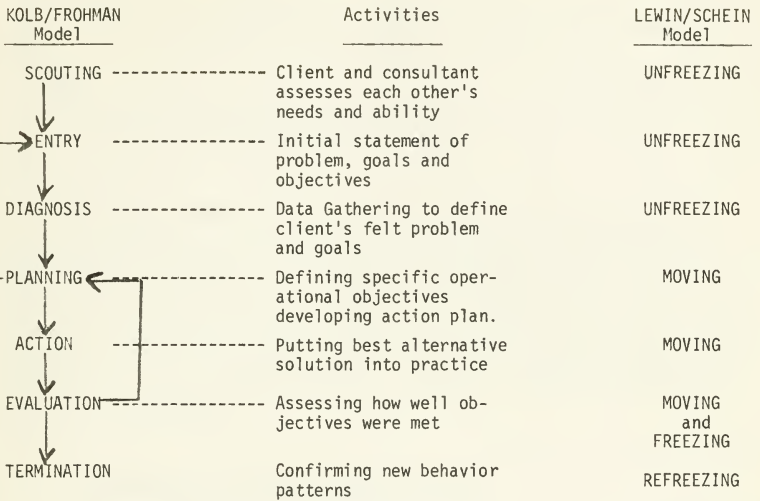
| KOLB/FROHMAN Model | Activities | LEWIN/SCHEIN Model |
|---|---|---|
| SCOUTING --------------- | Client and consultant assesses each other's needs and ability | UNFREEZING |
| ENTRY --------------- | Initial statement of problem, goals and objectives | UNFREEZING |
| DIAGNOSIS --------------- | Data Gathering to define client's felt problem and goals | UNFREEZING |
| PLANNING ------------- | Defining specific operational objectives developing action plan. | MOVING |
| ACTION ------------- | Putting best alternative solution into practice | MOVING |
| EVALUATION ------------- | Assessing how well objectives were met | MOVING and FREEZING |
| TERMINATION | Confirming new behavior patterns | REFREEZING |

Figure 4. The Kolb-Frohman Model of Change

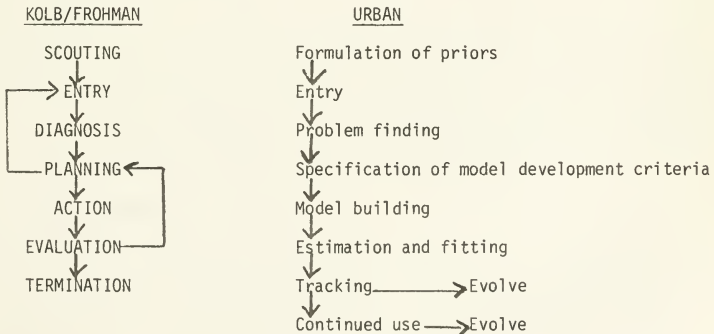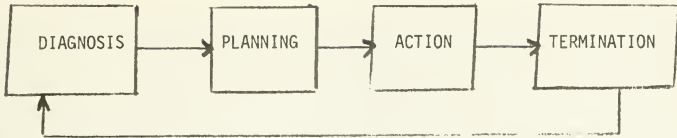| KOLB/FROHMAN | URBAN |
|---|---|
| SCOUTING | Formulation of priors |
| ENTRY | Entry |
| DIAGNOSIS | Problem finding |
| PLANNING | Specification of model development criteria |
| ACTION | Model building |
| EVALUATION | Estimation and fitting |
| TERMINATION | Tracking ———→Evolve |
| | Continued use ——→Evolve |

Figure 5. Urban's Model

Figure 6. Beckhard's Model of Change

The reason for this choice is that we do not need the Scouting-Entry Phases since we assume that the decision to decentralize the information systems has been made already. In fact, in this paper, we are focussing on the issue of planning of change and not on the issue of centralization versus decentralization of information systems. Therefore, BECKHARD's model seemed to be more appropriate.

### 3. Application of the Action-Research Model

Let us apply BECKHARD's change model as a tool to facilitate the planning of change of information systems.

#### (a) Diagnosis

This stage allows us to define the client's felt problems. The origins of the problems that a centralized information system may have come from the following factors: the changing environment, the information system itself, the behavior of the individuals involved and the situation of the organization.

#### (i) The environment

One significant change in the environment of computers is the advent of mini- and microcomputers. Minicomputers appear to have very attractive cost performance ratios. They can be afforded by many organizational units since their costs are very low. Another change is the development of the concept of

distributed systems based on availability of minicomputers. Distributed systems are now seen by many as viable and attractive alternative to the previous trends toward larger computers. A final change in the environment is due to the relatively low costs of communication lines. This allows organizations geographically distributed to be fully connected.

(ii) <u>The information system</u>

A centralized information system has several disadvantages that have been described in Chapter II. Let us mention some important one. It has a very high risk of failure and is very rigid. It requires costly controls. A centralized system is more vulnerable to corporate overhead reduction.

(iii) <u>The behavior of individuals involved</u>

According to Beckhard (4), individuals wish to develop. In a centralized system it is generally accepted that the opportunity to develop is very low. In a very centralized system, stresses, straints and conflicts may develop easily. Finally, since most hierarchical organizations have norms of relatively low openess due to low levels of trust, a change of the centralized system may be interpreted as signs of trust in the individuals and their capabilities.

(iv) <u>The situation of the organizaton</u>

Most organizational activity is centered around the acquisition, production or transfer of information in various forms. The information is viewed as a resource. Without information, long-range organizational functions cannot be carried out. Centralized information systems are rarely responsive to the special needs of the corporate executive. They lack essential element of an intelligence system required to support top management. Most of the centralized systems are more supportive of operating level activities than corporate decision making.

Besides these arguments, the goal of an organization is to maintain a competitive position. In order to do so, it relies on the full capabilities of its information system. Every change in information systems technology has to be taken into account. In a growing and diversified company, centralization of the information system may be of disastrous consequences.

(b) Planning

This stage is related to the following activities: formal goal-setting, evaluation of alternative plans and their impact on the organization.

We feel that the key aspect of this phase is the direct involvement of the people who will be held responsible for implementing the new operation. Another aspect that is very fundamental is the involvement of the user, and the top management. This is essential to assure the success of the decentralization process. An approach to describing the overall planning activities is described below (see Figure 7).

A detailed explanation of the different steps involved in Figure 7 is given in Rockart et al. (20).


(c) Action

The action phase can be seen as the implementation stage. It is the task related to the ability of the designer to deliver the decentralized system that meets the user's real needs and that is on time. ACKOFF's conventional wisdom on implementation (1) suffers from a lack of a perspective. ARGYRIS argues that management scientists dealing with the implementation aspects, must develop interpersonal competence and play down, even avoid, the threatening use of power. GINZBERG (18), in his study of fourteen companies suggests that implementation
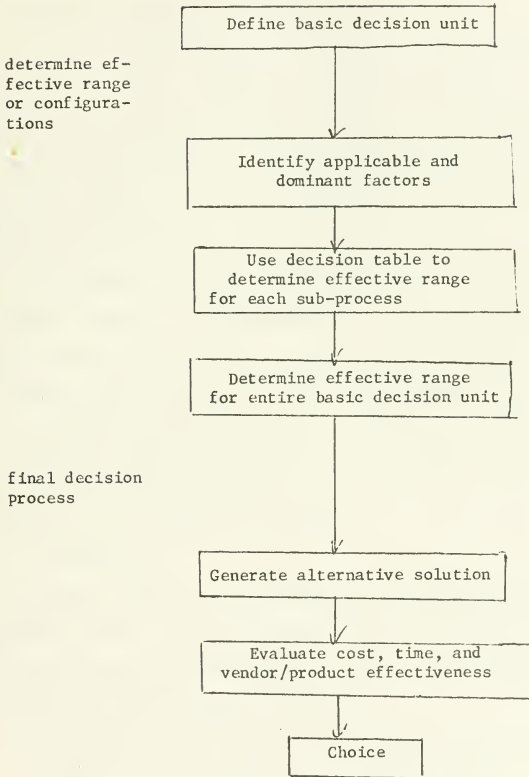
Figure 7. Overall Model

Adapted from (20)

is a contingent process, meaning that the characteristics of the situation
most determine the approach the implementor should take.

In our view, implementation of a new decentralized system must be seen
as a process of change. Therefore, the related questions of resistence to
change have to be adequately tackled. Besides, and as stated by SCHEIN (21),
an effective implementation (of decentralized information systems) is deter-
mined by the number, distribution and position with respect to authority
structures of professionals in the organization.

At this point, a practical question should be answered. When to operate
the decentralization?   Our experience leads us to believe that a global
decentralization at one time is very risky. Sequential decentralization of
each basic unit may lead to an acceptable decentralized system. Besides, some
time is needed to change the attitudes and the behavior of the DP staff. If
some resistance appears during the decentralization of a unit, a slowdown in
the decentralization process is desirable.

4. Termination

This stage focusses on the assessment of organizational mechanisms for
maintaining change:  the institutionalization of the new system. BECKHARD (4)
indicates some ways of maintaining the change. Other factors that are particu-
larly relevant to decentralized systems are:

(i) Structural reinforcements: The design of administrative
policies and procedures to reinforce the change.

(ii) Top level support: The top managers must model the be-
haviors that are consistent with the goal of the change.

(iii) Pocket of resistance: A particular attention has to be
given to the pockets of resistance to insure further
cooperation.

(iv)  Personal counselling:  Managers may need personal attention
      to help them work out new problems created by the new change.


CONCLUSION

Over the past decade, the trend toward decentralized systems has been rapid.
When they were planning change from centralized to decentralized information
systems, most organizations tended to focus on the technical areas.  Yet there
are still major questions to be answered about an effective planning of change.
Much of the inability to address this question can be traced by inadequately
assessed organizational impacts.  There is, however, a rich source of expertise
in the theory of planned change available to organizations seeking to deal with
the issue of planning the change from centralized to decentralized systems.
This paper shows that some models of the theory of planned change can be very
useful to facilitate this change.

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