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Reengineering of Systems Operation; A Solution to the Challenges in the Deregulated Market Environment – I

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Abstract: - The absence of central coordination in deregulated electricity markets sets a new range of challenges to their organization and functioning. Although a lot of academic research has been done in the recent years on these topics, contributions and discussions tend to stay within a single field (economics, systems analysis, policy analysis...). The fundamental factors in the operation of electrical power systems, at a macro level, are distribution of the operation parameters over vast areas, dominance of human factors and high dimensionality of the problem.

This paper (presented in two parts) aims at providing a framework for researchers of different fields to focus on the crucial issues, in the coordination problem. Looking at the roots, the problem of economic operation of power systems is primarily that of decision management. The deregulation of electric power industry since 1992 has rendered it just more complex. As the new market environment is still in its evolution process it is time to raise fundamental and radical steps to make the system operation more manageable. Emerging information technologies (IT) can help in addressing these issues more effectively. Preliminary research with encouraging results has already been presented in a doctoral thesis recently presented in the Department of Electrical Engineering. The part – I of this paper elaborate on the fundamental concepts behind *reengineering* [9] and part – II would provide the basis of a framework where the principal entities in the diverse fields of the system operation can share information to make the economic operation more manageable in the new market environment.

Key-Words: - Reengineering, Deregulated Market, Process Map, Distributed Economic Operation

1 Introduction

Academic discussions about the opportunities and challenges associated with introducing wholesale and retail competition into the electric power sector have gone on for decades. However, serious considerations of comprehensive electricity sector restructuring and deregulation initiatives in the U.S. only began in the mid-1990s, following the first comprehensive privatization, restructuring, wholesale and retail competition program undertaken in England and Wales (E&W) in 1990 [1]. A number of other countries followed the same practice after that. However the process seems to be still in its evolution stage, even after 15 years of inception of the idea of deregulated and competitive electricity market. In the last quarter of 1999 and early 2000, the collapse of California's electricity restructuring and competition program has attracted attention around the world. Prices in California's competitive wholesale electricity market increased by 500% between the second half of 1999 and the second half of 2000. For the first four months of 2001, wholesale spot prices averaged over \$300/Mwh, ten times what they were is 1998 and 1999 [2].

Although wholesale prices began to moderate significantly during June 2001, the future of California's experiment with electricity restructuring, wholesale and retail competition program remains murky at best. This was certainly not what California planned would happen by reforming its electricity industry! And while many analysts predicted that there would be problems resulting from a variety of market design and regulatory decisions made during the new system's formation, nobody predicted that California's electricity restructuring and competition reforms would lead to such a huge mess [2].

This and other growing pains of the electric energy industry restructuring are becoming quite

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visible to the general public now. These are reflected either through undesired service interruptions and/or through highly volatile electricity prices [3].

If deregulation is to play a role in helping to improve the efficiency with which electricity is produced and used, it must be introduced as part of a long-term process that also encompasses regulatory and structural reform [4]. Electricity restructuring … is likely to involve both costs and benefits. If the restructuring is done right…the benefits … can significantly outweigh the costs [5].

There continues to be a lack of adequate communication and understanding between economists focused on the design and evaluation of alternative market mechanisms and network engineers focused on the physical complexities of electric power networks and the constraints that these physical requirements may place on market mechanisms [6].

The purpose of this and the next paper is to discuss the physiology of operation and to present a possible framework that can be effectively utilized to help alleviate this gap.

2 Background of Restructuring

Electricity sectors almost everywhere on earth evolved with (primarily) vertically integrated geographic monopolies that were either publicly owned or subject to public regulation of prices, service obligations, major investments, financing, and expansion into unregulated lines of business. That is, the primary components of electricity supply --- generation, transmission, distribution, and retail supply --- were integrated within individual electric utilities. The performance of these regulated monopolies varied widely across countries and between utilities in the US [1].

Real retail electricity prices rose significantly during 1970s and early 1980s for the first time in the history of commercial electric power. Moreover, it became clear that there were significant variations in performance across utilities, but an industry structure which provided limited opportunities for more efficient suppliers to expand and to place pressure on less efficient suppliers to improve or contract [1].

Initial interest in electricity sector reform started in the US states with the highest retail electricity prices and where the apparent gaps between wholesale and retail prices were the largest [1].

According to Joskow, the political pressures for reforms in these states, and in particular for retail competition, came from lobbying activities by industrial customers, independent power producers, and would-be electricity marketers with experience in the natural gas industry [7].

The primary selling point to state regulators and legislators was that by introducing competition, retail prices would fall significantly to reflect the lower priced power available in the wholesale market. *How retail prices could both fall dramatically to reflect lower wholesale prices and utilities could recover their stranded costs was a bit of questionable arithmetic that was largely glossed over* [1].

While, the political debates at the state level focused on retail price reductions, the creation of opportunities for incumbents and hungry new entrants, *the intellectual debates focused on a broader set of public interest goals and implementation strategies*. Although there was fairly wide agreement about the goals that electricity sector reforms should achieve and even on the basic architecture of a model (See Fig.1) for creating competitive wholesale and retail markets to achieve these goals, *it is less clear that there was broad understanding of what would have to be done to achieve these goals and how long it would take to achieve them* [1].

3 The Problem Revisited

Present day electrical power systems are very large, comprising of thousands of buses, hundreds of generation units, using diverse kinds of fuel types as well as hydro resources, and thousands of kilometers of transmission lines, etc. Operation of such a huge system in a most economic way is indeed very complex. The complexity of the problem does not lie in the complexity of mathematical models; rather it lies in the complexity of the management of the system. It is a problem that requires *decision management* as a dominant factor [8]. To be able to reach at the right decision, the right information is to be made available at the right place, and at the right time. The complexity of the power system operation is farfetched by the fact that it is *a dynamic system*. Almost every principal part of the system is continuously generating data.

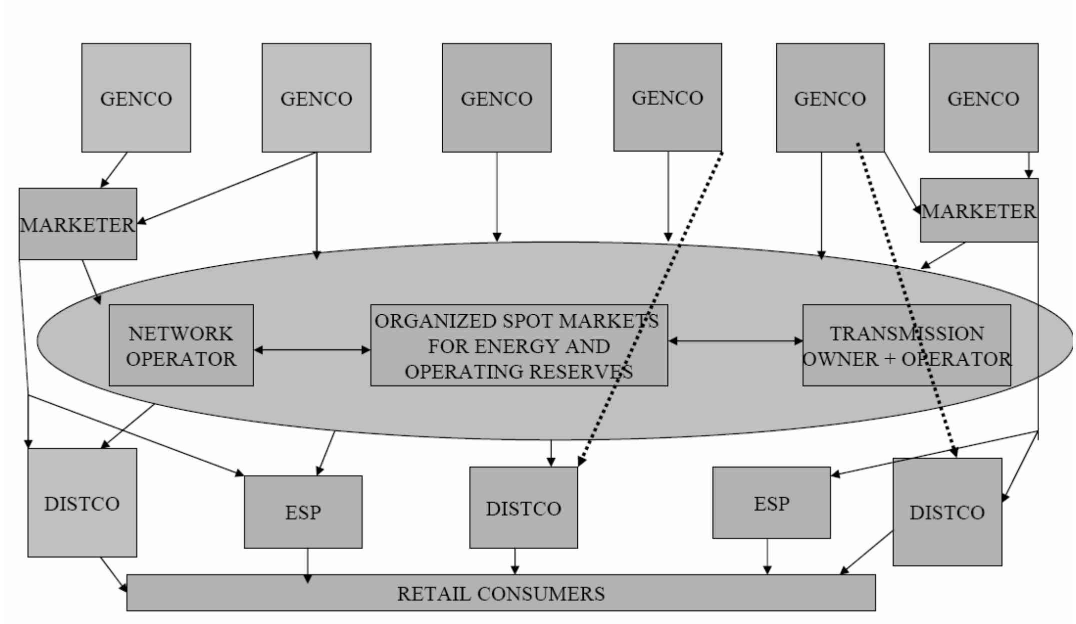

Fig. 1: Comprehensive Reform Vision of the Restructured Electric Market, adapted from [1]

Obviously, to run the system economically, it is imperative to capture this data in a well-organized fashion, transform it into information, produce it in a form that is most suitable for its immediate usage and make it available where it is required [8].

3.1 Fundamental Factors

The fundamental factors in the operation of electrical power systems, at a macro level, are distribution of the operation parameters over vast areas, dominance of human factors and high dimensionality of the problem. Contemporary power system operation in vertically integrated utilities is based on the idea of a central dispatch office (CDO) relying heavily on SCADA for transportation of data to the CDO. The data arriving in the CDO is although useful for system stability, is of little value for the short term economic operation. Interconnection of units has increased the state space to the level of combinatorial explosiveness. Recent development of multiple fuel plants as well as deregulation of electricity market has added to the dominance of the human factor [8].

3.2 Areas of System Operation

The operation of an electrical power system has two aspects: economic and stability. Fig. 2 displays these two aspects of system operation [8]. These two areas of system operation are disjoint from each other. The requirements of data for successful operation in these two disjoint areas are also different [8].

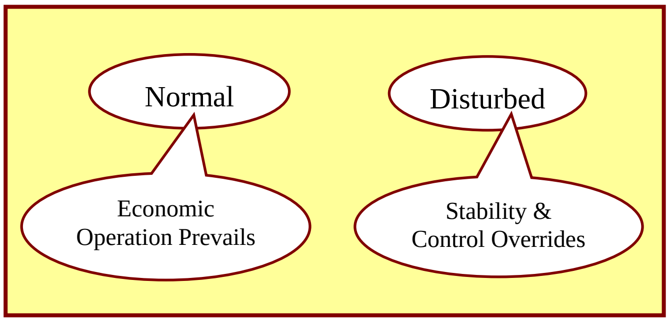

Fig. 2: Disjoint States of System Operation

Because main emphasis is laid on stability, only the parameters crucial for a stable operation usually find their way to the CDO. However there is a lot more data that is generated at almost all principal parts of a large power system that is important for economic operation, but is lying dormant and cannot be utilized effectively to participate in the short term operation [8, 9].

3.3 Physiology of Organizations

The form of control and the way in which present day power systems are operated is not the result of some accident. The time when such power systems were built is the same when the present day technology was still in its infancy. It is understandable that power systems also benefit from the technological advancements in other areas and as such adapted the technique of work as well as the rules of bureaucracy that were laid down for other areas.

It has been elaborated that the problem of system operation is indeed a problem of management. Distribution of information and the human factors are directly related to the management of the system from economic point of view. Therefore in an effort to restructuring, it seems mandatory to look at how the organizations evolved to present-day management structures.

3.3.1 Organizational Roots

Most companies today can trace their work styles and organizational roots back to the prototypical pin factory that Adam Smith described in 1776 [9]. Since the inception of these ideas, various heads of large industrial organizations raised a series of evolutionary steps. These ideas were later on accepted as the foundations of present day management structures.

3.3.2 Foundations of Management

To get an idea of how organizations work, these fundamental ideas are briefly touched in the following paragraphs.

3.3.3 Division of Labor

Mr. Adam Smith first presented this idea in 1776. Smith's principle embodied his observation that some number of specialized workers, each performing a single step in the manufacture of a paper pin, could make far more pins in a day than the same number of generalists, each engaged in making whole pins [9]. Today's airlines, steel mills, accounts departments, computer chip makers as well as electrical power companies have all been built around Smith's central idea – the division or specialization of labor and the consequent fragmentation of work. *The larger the organization, the more specialized is the worker and the more separate steps into which the work is fragmented.*

3.3.4 Division of Management

The final large evolutionary steps in the development of today's business organization came early in the twentieth century, from Henry Ford and Alfred Sloan. The organizational model that was developed in the United States spread rapidly into other parts of the world [9].

The fundamental concepts are summarized as following.

- Ford improved on Smith's concept of dividing work into tiny repeatable tasks. *He made the jobs themselves infinitely simpler, but* at the same time *made the process of coordinating the people far more complex.*
- *Sloan created, smaller decentralized divisions* that managers could oversee from a small corporate headquarter simply by monitoring production and financial numbers.
- Sloan applied Smith's principle of the division of labor to management just as Ford had applied it to production. In Sloan's view, *corporate executives did not need specific expertise in engineering. Instead, executives needed financial expertise*. They had only to look at "numbers" – sales, profit and loss, inventory levels, market share, and so forth – generated by the company's various divisions to see if those divisions were performing well.
- Large staffs of corporate controllers, planners, and auditors acted as the executive's eyes and ears, searching out data about divisional performance, and intervening to adjust the plans and activities of operating managers.
- In the 1950's and 1960's, *the chief operational concern of company executives was capacity* – that is being able to keep up with the ever-increasing demand. To solve these problems, companies developed ever more complex systems for budgeting, planning and control.

3.3.5 The Outcome

These concepts affected the performance of organizations in a very drastic manner. Some barometric effects can be reflected as under.

- The standard, pyramidal organizational structure of most organizations was well suited to a high growth environment because it was scalable.
- As the number of tasks grew, however, the overall processes of producing a product or delivering a service inevitably became increasingly complicated.
- The growing number of middle managers – was one of the prices companies paid for the benefits of fragmenting their work into simple, repetitive steps and organizing themselves hierarchically.
- Because of the increasing distance between senior management and users of their product or service, the customers and their responses to the

company's strategy became a set of faceless numbers that bubbled up through layers.

- Another drawback of spreading tasks throughout an organization is that management can not react quickly enough because input bubbles up and down large management structures. It also limits the professional growth and skills of engineers. Also the managers could not plan particularly well and certainly couldn't be creative in problem solving.
- In a task – oriented approach, it is very difficult to improve quality. On the other hand, if a group is held responsible for an entire process, the members of the group can test the process, improve it, and build quality into that process.

4 Reengineering

Management of human factors and utilizing unused distributed information require a "Reengineering" of the present system operation. Reengineering is the *fundamental* rethinking and *radical* redesign of engineering *processes* to achieve *dramatic* improvements in critical, contemporary measures of performance, such as cost, quality, service, and speed [8,10].

Reengineering of an organization like a large power system utility is not a trivial task. One obvious requirement is the understanding of how a power system operates. *But another less obvious requirement is the understanding of the "Reengineering" itself* [8].

Reengineering means "Starting Over". It doesn't mean tinkering with what already exists or making incremental changes that leave basic structures intact [9]. The concepts basic to the understanding of reengineering are summarized below.

4.1 Fundamental

In doing reengineering, the people must ask the two basic questions: *Why do we do what we do?* And *Why do we do it the way we do?*. Reengineering begins with no assumptions and no givens; *it first determines what a company must do, then how to do it* [9].

4.2 Radical

In reengineering, radical redesign means disregarding all existing structures and procedures and inventing completely new ways of accomplishing work, it is about reinvention – not improvement, enhancement or modification [9].

4.3 Dramatic

Reengineering isn't about making marginal or incremental improvements but about achieving quantum leaps in performance. Marginal improvement requires fine – tuning; dramatic improvement demands blowing up the old and replacing it with something new [9].

4.4 Process

The fourth key concept is the *process* that gives most corporate managers the greatest difficulty in understanding. *Most people are not "Process Oriented"; they are focused on tasks, on jobs, on people, on structures, but not on processes* [9].

A process is defined *"as a collection of activities that takes one or more kinds of input and creates an output that is of value to a customer"*, where the customer is the end user of that process [9].

5 What Reengineering is Not?

Sometimes it is useful to look at the other side of the coin while trying to understand a new concept [8, 10].

1. Reengineering is not the same as automation. Automation simply provides more efficient ways of doing the wrong kinds of things.
2. *Also it is not similar to software reengineering, which means rebuilding obsolete information systems with more modern technology*. Software reengineering often produces nothing more than sophisticated computerized systems that automate obsolete processes.
3. *Reengineering is not restructuring or downsizing*. These are just fancy terms for reducing capacity to meet current, lower demands. Reengineering, by contrast, means doing more with less.
4. *Reengineering also is not the same as reorganizing, de-layering or flattening an organization*, although reengineering may, in fact produces a flatter organization. *Overlaying a new organization on top of an old process is pouring rotten juice into new bottles* [9]
5. And lastly, *reengineering is not the same as quality improvement, total quality management (TQM), or any other manifestation of the contemporary quality movement*. They both

recognize the importance of processes. However the two differ fundamentally.

6 Objects of Reengineering

Processes, not organizations, are the object of reengineering. Companies don't reengineer their departments; they reengineer the work that people in those departments do [8]. The confusion between organizational units and processes as objects of reengineering arises because departments, divisions, and groups, are familiar to people in business, while processes are not; organizational lines are visible, plainly drawn on organization charts, and processes are not; organizational units have names, and processes most often do not [9].

Processes in a company correspond to natural business activity, but they are often fragmented and obscured by the organizational structures. *Processes are invisible and unnamed because people think about the individual departments, not about the processes with which all of them are involved*. Processes also tend to be unmanaged because people are put in charge of the departments or work units, but no one is given the responsibility for getting the whole job ---the process ---done [9].

7 Processes Map

One way to get a better handle on the processes that make up a company is to give them names that express their beginning and end states [9]. Just like organization charts, a *process map* can be prepared that give a picture of *how work flows* through the organization. Some interesting features of a process map are outlined below [8, 10].

1. Simple: A process map is much simpler as compared to an organization chart of the same company. Hardly any company contains more than ten or so principal processes.
2. Process Owners: A process map includes *process owners*; something that is almost never displayed on a company's organization chart.
3. End Users: A process map also includes *end users* in its view of processes.
4. Sub Processes: A process is seen in terms of key concepts to interact with others. This indicates *how a system appreciates it's owners work and how it can contribute to that work.*

8 Conclusion

Since 1992 economists and engineers trying to implement the new architecture are both facing challenges. It seems that restructuring is being pursued on the wrong foot. If the restructuring has to succeed in the near future, then the foremost responsibility lies on the engineers who are in a better position to understand and identify fundamental "processes". The second part of this paper would suggest ways for possible ways for reengineering of the system operation.

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