Quality Drives Efficiency

Designing Quality Management Systems for the Digital Age

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Productive Systems (PS) comprise four elements: the mechanisms of production (hardware and software system), the human component in design and execution of the system, the information that defines the knowledge base by which the system operates, and the data that is collected to define the means by which the system operates. Richard M. Young describes how a PS operates as a cognitive system: it is "a collection of if-then rules that together form an information-processing, computer simulation model of some cognitive task, or range of tasks. A production system operates by means of a recognize-act cycle, in which the rule whose condition part is satisfied is identified, and its actions taken." Thus PS working mechanisms include integrated acts of cognition and learning in order to function effectively – this is the same integration of things and people that is characterized by the initiative that is called Industry 4.0 and it requires development of a new understanding of the workplace that is based on a systems approach to this knowledge which integrates the four PS elements into a new framework that integrates situational awareness and sensemaking into constantly evolving production experiments that adapt to the shifts in dynamic capability of the production system to operate within the bounds of required performance.

A fundamental requirement for an Industry 4.0 system to operate is the optimization of the Internet of Things (IoT) to avoid both systemic and human errors in operational performance. As observed by the "lean thinkers" of Japan: humans characteristically will make inadvertent mistakes so systems solutions need to be devised that "mistake-proof" operations and inhibit human errors. However, quality in the specification of systems occurs through the human process of design which is also subject to inadvertent human error. Thus, to understand how future PS designs must be developed, it is essential to master all of the four elements that combine into a PS. The nature of humanity must be comprehended within the cognitive systems that serve as the brains of Industry 4.0 and an adaptive learning process must be set to steer the improvement activities through adaptive learning about the variations in input signals that are negatively influencing the results of the dynamic system. This quest for automated improvement of the system requires master of many components that are current topics of discussion: the IoT, Industry 4.0 systems, "Big Data" inquiry, artificial intelligence, and adaptive learning.

Achievement of PS mastery in evolving environment will require new means to develop situational awareness of both externalities and internalities of the system (e.g., noticing, registering, recording, and preserving of observations) as well as a new art or science of sensemaking (e.g., reading, interpreting, deciding and acting on the observations). How does such a system become designed in practice? The development of an integrated systems approach to development of Industry 4.0 requires not only the presence of situational awareness and sensemaking, but also their application through a process that engages all

systems elements in what may be called “collaborative analytics.” What is the nature of this concept of “collaborative analytics?” This represents a convergence of: accessible, massive data bases; unlimited computing power using cloud-based resources for parallel processing and multi-tasking; highly flexible algorithms for searching and sorting data according to patterns identified through multi-variable attributes of textual meaning as well as temporal and physical analytical attributes; and a wide spectrum of diverse analytics which can be commented upon and interpreted by a distributed network of business analysts and automated machine-based inquiry. This is the analytical world that is in the process of being developed to satisfy the processing requirements of a fully integrated IoT in the emerging world of the Industry 4.0 initiative.

What benefits will organizations achieve by pursuing this approach to leadership? Some suggestions can be implied based on a series of case studies of leading corporations over the past quarter century:

- Development of improved approaches for competitiveness (e.g., case studies in the design of competitive intelligence capability to support strategic decision making based on methods that were developed at Hewlett-Packard, Xerox, and Nokia Mobile Phones).
- Creation of technology forecasting capability through imaginative use of intellectual property inquires (e.g., applications at Hewlett-Packard and Nokia Mobile phones).
- Application of strategic improvement projects to reshape business resources (e.g., case study of Compaq Computer, Nokia Mobile Phones, ExxonMobil and Toshiba).
- Focused resource development into breakthrough strategic projects (e.g., case studies drawn from Hewlett-Packard, Xerox, Nokia and Toyota).