STS THEORY – FROM THE INDUSTRIAL TO THE KNOWLEDGE AGE

Socio-Technical Systems (STS) theory is rooted in principles that have their origin in action research field projects undertaken by the Tavistock Institute of Human Relations in British coal mines during postwar reconstruction of industry (Trist, 1950). This was a time when mine productivity was failing to increase despite major investments in increased mechanization, while labor turnover and absenteeism were on a rapid rise. In the course of this research (supported by the Rockefeller Foundation and the British government), Tavistock social scientists discovered work practice and organization innovations made by local coal mine management and workers who had evolved a way of working at a high level of mechanization, which recovered the work group cohesion and self-regulation that had existed in the pre-mechanized era (Trist et al., 1963).

It was an alternative work organization for coalfields that were using the new technology, demonstrating that "the technological imperative could be disobeyed" (Trist & Murray, 1993). Results of this "organizational choice" were positive in economic as well as human terms. Accordingly, Tavistock social scientists proposed a conceptual reframing of work organization. No longer would separate approaches to the social and technical dimensions of an organization suffice. Although the social and technical arrangements are the substantive factors, the economic performance and human outcomes depend upon the "goodness of fit" between these factors within a work organization as an open "socio-technical system" (Emery, 1959; 1972).

This "new paradigm" of work organization was subsequently applied in the Indian textile industry (Rice, 1953). Major experimentation continued in Norway during the mid-1960's, where action research further applied and refined socio-technical systems (STS) theory and methodology in manufacturing and chemical process industries (Emery & Thorsrud, 1969). From this work arose concepts of technical "variance analysis" and "psychological job requirements". From the late 1960's to mid-1990's, STS design methodology was then utilized successfully in many companies within North America, Europe, Scandinavia, and Australia to achieve high performance and quality in working life (Davis & Cherns, 1975; Kolodny & van Beinum, 1983). American and European collaboration led to the articulation of a set of STS design principles (Cherns, 1976), while in Australia and Scandinavia, new processes were developed for "participative design" (Emery, 1982; 1989) and collaboration through "democratic dialogue" (Gustavsen, 1985; 1989).

However, in the midst of this industrial era, the growth of service industries and "office technology" inspired efforts to adapt socio-technical systems theory and methodology for a changed context and nature of work in an emergent information society. Methods of work analysis for single linear conversion processes were extended to meet the demands of concurrent nonlinear conversion processes typical of non-routine office and professional work (Pava, 1983; Taylor et al., 1986). A new conceptual language entered STS thinking, a "second-generation" of STS theory that focused on "deliberations" in technical analysis and "discretionary coalitions" in social analysis.

Pava (1983) defined deliberations as "equivocality reducing events" or "choice points" that are not simply the equivalent of decisions or meetings; rather, they are sense-making exchanges (Weick, 1994), communications and reflections dealing with "problematic issues", the resolution of which propels the technical conversion process of nonroutine work. Deliberations are identified by the existence of an equivocal topic, which is explored in different types of forums, involving a particular group of interested parties. A focus on deliberations constitutes a "middle ground for analysis," providing a method for examining nonobvious and counterintuitive patterns of work that would normally be invisible to approaches that limit their focus to formal organization, technical system features, or the efficacy of various IT solutions. In summary, deliberation analysis provides a more complex and rich description of the socio-technical dynamics involved in nonroutine work.

During the 1990's, this updated STS perspective was applied in a variety of settings such as new product development in software engineering, R&D in the chemical industry, a teaching hospital, and in advanced manufacturing systems, (Purser, 1990; Purser et al., 1992; Pasmore & Gurley, 1991; Shani et al., 1992; Stebbins & Shani, 1998). The new concepts and methods to accommodate nonlinear throughput and knowledge work were combined with attention to the high involvement of knowledge workers in the design process (Pasmore & Purser, 1993). Nevertheless, by the end of the 20th century, this version of STS was superceded in the white-collar world by "reengineering" of work processes in conjunction with information technology (Hammer & Champy, 1993).

STS thinking did survive prior to and after the turn of the century, in traditional manufacturing applications, but more particularly, in three new streams of development. One of the strongest applications has been in social principles for design of information technology. Illustrative of this approach have been concepts of "human computer interaction" (HCI), or those aspects of information science dealing with the social impacts of computerization, i.e. "social informatics" (Kling, 2000); and, closer to the original STS thinking has been "ethical computer use" and the "ETHICS" method of system design (Mumford, 1995, 1996; Porra & Hirscheim, 2007). The focus on technology is also implied in an oft-quoted definition of sociotechnical systems as "technical works involving significant social participation, interests, and concerns" (Maier & Rechtin, 2000). Also, in social computing, sociotechnical systems are defined as "systems of people communicating with people that arise through interactions mediated by technology" (Whitworth, 2009).

At the same time, there is growing understanding that information technology, though integral, is insufficient for development of knowledge work and knowledge management (McDermott, 1999; Shani & Sena, 2000). This conclusion is based upon a distinction between "information", and the discretionary and social dimensions of "knowing". Information systems enable a knowledge economy, and yet, it takes human systems to achieve it. Experience in design of such systems like "communities of practice" to leverage knowledge across disciplines or business units has revealed that this process involves technical, social, and socio-technical challenges (McDermott et al., 2002).

Finally, these two developments, information/communication technology (ICT), and an economy based on knowledge and innovation, have spawned a third effect, the emergence of "network organizations" (Van Alystne, 1997) that span the boundaries of individual teams and organizations. The need for societies and single organizations to develop an "inter-organizational capability" was anticipated very early in socio-technical system literature that built upon von Bertalanffy's (1950) theory of "open systems", and profiled the "causal texture of organizational environments" (Emery & Trist, 1965). The increasing "turbulence" in the real world of organizational environments and the emergence of issues "too extensive and too many-sided to be coped with by any single organization" has led to new theory for "referent organizations and development of the inter-organizational domain" (Trist, 1983). Thus, socio-technical systems theory and its "socio-ecological" perspective (Trist et al., 1997) provide foundational understanding for "institution-building" and design of networks and their virtual form with cyber-infrastructure.

This historical and future-oriented perspective on socio-technical systems theory is also background for an STS "Discovery" initiative ("Using Action Research To Promote New STS Theory and Practice") now being undertaken by an international network of academics and STS practitioners, The STS Roundtable (http://stsroundtable.com/wiki/STS_Roundtable). The objective is to discover a next, "third" generation of STS concepts and methodologies for the 21st century.

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