Group dynamics meet cognition: combining socio-technical concepts and usability engineering in the design of information systems

Andrew Dillon

in: E. Coakes,. (et al) (Eds.) The New Socio Tech: Graffitti on the Long Wall. London: Springer-Verlag, 2000, pp119-126.

Chapter overview

Socio-Technical Systems Theory (STST) has been widely mentioned and applied in the domain of information systems implementation (see e.g. Eason [1], Mumford [2]). Dillon and Morris [3] argue that the term STST is now generally applied to many user-centered orientations to design and implementation. Unlike the pragmatism of usability engineering which aims to support the design of technologies that are compatible with users' abilities and needs [4], STST posits underlying drives and motivations to use tools that supersede concerns with effectiveness and efficiency alone.

In the present chapter, STST is re-examined for relevance to contemporary software design practices. Specifically, the unconscious drives to gain control and enhancement through one's work are seemingly at odds with a strictly cognitive approach to interaction that dominates studies of human-computer interaction. STST is here critically assessed in the light of what is now known about user acceptance of new information technologies. Emerging ISO-backed usability standards are in turn critically evaluated in the light of STST's richer analysis to identify weaknesses in the current usability engineering approach to design and implementation. Reconciling the psychodynamic and the cognitive in a manner that enables pragmatic application of STST in design is gained through the formulation of operationalised measures of the forces shaping acceptance.

Introduction

In a review of the theories of models that seek the predict user acceptance of new information technology, Dillon and Morris [3] noted that the term 'socio-technical' has become widely applied to a mix of theoretical positions that do not all share the original psychodynamic views of socio-technical thinkers. In current usage, STST is interpreted as referring to almost any view of user acceptance or resistance that emphasizes the role of the organizational context in shaping technology use, thus blurring the historical distinctions between structuralist, human relations and open systems approaches. As such, STST stands in contrast to the user or tool-based models that seek to explain user reactions in terms of individual dispositions (e.g., cognitive style or personality) or tool quality (e.g., ease of use).

Currently, broad based socio-technical approaches tend to deal with issues at one level of abstraction (the group, the organization) while usability professionals deal with another (the user, the interface). The result, in my view, is a joint limitation of these perspectives, which if coupled appropriately, could offer richer insights and practices for all systems design and implementation projects. The present chapter extends this by examining the nature of both approaches and the practical means of utilizing both appropriately in context.

Usability engineering

Current software design practices place great emphasis on interfacing the tool to the intended users. While the origins of this work are classic ergonomic or human factors concerns with control panels, user-centered design methods have evolved over the last two decades to the extent that usability is now seen as a crucial component of the software engineering lifecycle even by mainstream software engineering theorists [4].

Usability engineering (UE) is a term that has come to describe a pragmatic approach to interface design which emphasizes empirical methods and operational definitions of user requirements for tools. Extending as far as International Standards Organization-approved definitions (see e.g., 1S0 9241 part 11) usability is considered a context-dependent agreement of the effectiveness, efficiency and satisfaction with which specific users should be able to perform tasks. Advocates of this approach engage in task analysis, then prototype interface designs and conduct usability tests. On the basis of such tests, the technology is (ideally) re-designed or (occasionally) the operational targets for user performance are revised.

Usability engineering has been an extremely influential approach to technology design. Conferences, academic articles, job advertisements, professional groups etc. all make reference to the approach and one could be forgiven for thinking that the adoption of this operational perspective is the panacea for information technology design. Its philosophy of specify-design-test-redesign etc. is both action oriented and pragmatic. UE espouses empirical data collection from real users as the only yardstick by which success can be measured. As such, this approach has won many adherents in the literature on human-computer interaction (HCI) and an ability to operationalise and test usability is a de facto core competency of any budding interface or interaction design specialist.

Socio-Technical Systems Theory's impact on information technology design

STST shares the UE concern with understanding users and their tasks, but in contrast to UE, STST can appear to outsiders as cumbersome and ill-defined. Rather than specifying empirical methods to be iteratively applied throughout the design process, the socio-technical approach places greater emphasis on the participation of stakeholders, and the evolution of a planned implementation strategy. Derived from STST's focus on the fundamentally unconscious drives of all organizational members, practitioners seek ways of enhancing the users' working lives through technology. Such concerns are not immediately translatable into interface design guidelines or testing methods. Faced with a

group of designers who demand answers to questions such as "what size would the window be?" or "which icons are most meaningful?", a socio-technical theorists can appear vague or irrelevant. In my experience, advocating anything other than a quick usability test in these circumstances is frequently a recipe for communication breakdown.

One should not be too surprised by the apparent negative reaction here. Software design is a costly and ill-structured process and the search for clear answers motivates anyone seeking to design a usable system. More importantly, STST offers no clear advice on interface design. This is hardly damning, STST makes no claims to unique insights on this matter and relegates it to a second-order concern in conceptualizing the users' response to technology. However, the danger is of STST seeming irrelevant at worst or vague at best in the face of increasing expectations of designers for clear answers to such questions from social scientists. And it is not just the expectation of designers - the lack of specific interface design guidance is a frequent criticism made of many social science approaches to technology [6].

Aside from the practical concerns of addressing software design appropriately, STST needs to address the theoretical slide that reduces the term to a catch-all, a convenient dustbin into which we all throw the soft, social stuff that we know we ought to consider but somehow is not amenable to testing in our prototypes. Yet it is precisely this form of fossilization that STST faces as the empirical methods of usability engineering gain greater foothold, and as all classes of organizational perspective get lumped together. Can STST regain its practical import? I think so but we may need to do socio-technical analysis under a different name!

Developing humanly acceptable information systems

All social scientists and HCI professionals engaged in the production and implementation of software know the importance of being involved from the outset. However we continually face the problem of being seen as 'testers' or evaluators who of necessity cannot be employed until there is 'something' there for us to test, and this 'something' must be built first by the 'real' designers.

Over the last 20 years there has been a growing movement towards what is known universally as a "user-centered" design process. In this process emphasis is placed on iterative design-test loops and the desire to 'know the user'. This is contrasted with the more traditional waterfall models of design that used to impose fixed stages and milestones for development that made re-visiting earlier decisions costly. The beauty of the user-centered approach from an HCI or STST perspective is the opening it provides to engage in design at the earliest stages, rather than at the end. Some have argued in fact that the movement towards a user-centered approach is a direct result of STST and related movements [7]. However, powerful as user-centeredness might be, it is clear that UE and STST are not equally served by this approach.

The UE community has perhaps more naturally found a niche in this process. Encouraging testing from the outset, the setting of operational criteria for efficiency,

effectiveness and satisfaction, the development of prototyping etc., UE makes a case that seems to immediately support the better development of systems: feedback is quickly gained, design alternatives can be empirically selected and long-term targets can be seen to be attainable. This is positive and renders it easier to engage design at the conceptual stage, but is it sufficient? More importantly, should this be the extent of social scientists involvement in active design? In my experience it is not, and there are two inter-related shortcomings with the UE approach which can be at least partly overcome by employing STST. It is worth exploring these in turn to consider the options for STST in HCI. Let us call these the problem of involvement and the problem of measurement.

The problem of involvement

To design for usability, one normally runs candidate designs by representative users until the emerging interface can be shown to support agreed upon levels of performance. In a systematic UE approach this generally entails well-controlled usability studies, often in a laboratory-environment, with any user errors or problems noted and analyzed for their causes and potential implications. Re-design recommendations normally are made by the testers, designs are then tweaked, and testing is performed again until acceptable performance scores are found. Obviously the tests could vary in form (expert, heuristic, user-based etc.) and location (lab or field) depending on the context.

In itself, UE guarantees some measure of data that is directly pertinent to the job in hand. However, underlying this approach is a rather simple idea that user involvement in the design is primarily as a test subject. While mention is made of participation in standard UE texts such as Nielsen's [4] this is highly simplified and no mention is made of the importance of psychological rather than just physical participation in the process [8]. Users in the UE method answer questions, give reactions, highlight problems and are 'called-upon' - they are not active generators of designs. Indeed, part of the UE literature calls attention to the problems with asking users for design ideas since they demonstrate seemingly very poor ability to estimate the impact of any design on their own behavior [9].

Involving users in a process that is costly, politicized and management-driven is always going to have problems. While UE has found a natural niche in the philosophy of user-centered design, it has done so largely through ignoring the messy issues of really centering efforts on users or for users. This is less a criticism of UE which stands as a pragmatic improvement over once-off testing at the end of the development chain but more a recognition of the need to determine just what involvement or true participation in design processes entails.

Similarly, UE places no emphasis on the key socio-technical concepts of designing for human values such as the provision of work that is reasonably demanding, that supports user learning and incorporates an element of decision making [10]. Lack of appropriate task structures leads to alienation in the long term, but most directly it affects the user's perception of control. Such concerns are difficult if not impossible to articulate in UE terms and thus are cast out of the user-centered design paradigm that rests on usability

alone. In this way, participation is limited by the very language we use to conceptualize the human response. The very concepts that drive acceptance from an STST perspective are too easily by-passed in an analysis of effectiveness, efficiency and satisfaction of individual users.

The problem of measurement

Measures of effectiveness, efficiency and satisfaction certainly have value, but they tell only part of the story. That I can use a system is in many ways of little interest if you want to estimate whether or not I will use the system once it is implemented. Efficiency or satisfaction measures alone are not likely to be powerful enough to determine this. STST has long emphasized the psychodynamic forces shaping our behavior and the search for control and enhancement of one's position are considered natural phenomena of existence. Such forces are far deeper and more difficult to measure than efficiency etc. yet they are ultimately more powerful in determining our behavior. A highly usable system is always likely to be rejected if users perceive it as increasing others control over their working lives or leading to a de-skilling or reduction in autonomy.

UE offers no insight on these issues which is fine if one understands what usability testing is all about - measuring if people *can* use a tool, not if people *will* use it- but the term usability is now taken synonymously with anything positive about a technology that enhances its attraction to users. Everyone recognizes usability as important, every designer is user-centered, but somehow, we end up with systems that people will not use. In short, this is natural result of relying totally on a set of measures that reflect only part of the complex determination of use.

Other models of user response, such as the Technology Acceptance Model (TAM) [11] raise the value of usefulness or utility of a new tool but even the best evidence for this model suggests it accounts for only half the variance in user acceptance. Innovation diffusion models [12] posit characteristics of users and tools that influence adoption but the constructs themselves such as 'relative advantage' or 'observability of outcome' are open to more than one interpretation. Furthermore, neither perspective seeks to go as deeply into the core forces that shape human responses. STST strongly suggests that the frequently unconscious aspects of human motivation are more responsible for user behaviour than objective reports of utility. STST has an important role to play here in articulating and, ideally, operationalising the variables shaping acceptance at the human level which could be used to extend the UE measures now so dominant.

Reconciliation?

Obviously, STST does not offer a ready made set of alternative methods of involvement or of measurement. Enhancement or personal control are intuitively appealing as theoretical constructs, and allow for plausible explanations of resistance to new technology, but they are difficult to clearly measure. Compared to counting user errors in a usability test, they are more difficult to operationalise and harder to observe! Furthermore, it would be foolhardy to ignore the power of UE properly applied. What I

would advocate is some degree of reconciliation between the two approaches that might allow STST to display its value in a manner that will allow its application through UE-style practice.

The best way to do this, in my view, is to remind ourselves of some of the basic principles of STST and how they are overlooked in current usability-based approaches. Thus, in reminding system designers to re-address these core issues, we might be able to build further on the work accomplished by UE professionals to date in impacting design processes. Specifically, some of the main principles of STST as outlined by Trist [13] emphasize the work system as the basic design unit and the need for technology to support a work group rather than just a single user/single task. This places STST in sharp relief to UE which advocates the primacy of task level analyses and evaluations. Coupling this with the advocacy of increased variety, multiskilling and group-level regulation of work activities, it is conceivable that we can propose a richer form of analysis and evaluation than a strict usability approach.

This does not mean, as is frequently assumed, that one must be either STST or UE in outlook. A user is both an individual and a group member; cognition is both internal and distributed and we need to break down the limited barriers of analysis level to understand interaction with technology in its true socio-cognitive form. I propose UE as offering a way of grounding some concerns with users in a measurable form, but that effectiveness, efficiency and satisfaction are insufficient to explain and predict user responses fully. STST affords a perspective that emphasizes establishing the value of these measures in group-relevant terms so, for example, establishing faster performance on a given task is not seen as the end of the design, but the point at which we can start to establish the implications of this for the group or socio-technical unit.

The reverse also holds. STST can be employed at the very outset to offer insights into the setting of operational criteria for effectiveness, efficiency and satisfaction so that they reflect better the needs of the real work context in which the technology will be employed e.g., satisfaction criteria can be determined for all stakeholders, not just the direct users etc. Not only would this allow us to exploit the gains made by UE, it would serve to orient UE into a truer representation and measurement of the variables STST has long advocated as crucial.

Lessons for learning:

- Usability is necessary but insufficient condition of technology acceptance.
- Criteria for effectiveness, efficiency and satisfaction must be derived from the social not the individual context of use.
- User-centered design must engage real users as more than test participants
- STST must address the operational measurement of control and enhancement factors.

Clearly these lessons are not simple to learn, but they represent a means for socio-technical perspectives to impact design practices in the immediate term.

Practical hints and tips

- Derive participation through clear stakeholder analysis
- Expose designers to the context of use for the tools they are developing
- Continually revise criteria for acceptance through user involvement.

Bibliography

[1] Eason, K. *Information Technology and Organizational Change*. Taylor and Francis, London, 1988

[2] Mimbford, E. *Designing Participatively*, Manchester: Manchester Business School

[3] Dillon, A. and Morris, M.) User acceptance of new information technology - theories and models. In M. Williams (ed.) *Annual Review of Information Science and Technology*, Vol. 31, 3-32 Medford NJ: Information Today. 1996

[4] Nielsen, J. *Usability Engineering*, Academic Press, Cambridge MA. 1993

[5] Boehm, B. A spiral model of software development and enhancement, *IEEE Computer* (1988) 21(2) 61-72.

[6] Landauer, T., *The Trouble with Computers*, MIT Press, Cambridge MA. 1995.

[7] Baecker, R., Grudin, J. Buxton, W. and Greenberg, S. (eds.*) Readings in Human-Computer Interaction, Toward the Year 2000* Morgan-Kaufman, New York, 1995.

[8] Hartwick, Jon; Barki, Henri. 1994. Explaining the Role of User Participation in Information System Use. *Management Science*. 1994 April; 40(4): 440-465.

[9] Bailey, R. Performance vs. Preference. *Proc. of the Hum Fac Soc*. HFES, New York, 316-320, 1995.

[10] Cherns, A. Principles of Socio-Technical Design. *Human Relations*, 1976; 29, 783-792.

[11] Davis, Fred D. User Acceptance of Information Technology: Systems Characteristics, User Perceptions and Behavioral Impacts. *International Journal of Man-Machine Studies*. 1993 March; 38(3): 475-487

[12] Rogers, Everett, M. *Diffusion of Innovations*. 4th edition.: The Free Press, New York, NY; 1995.

[13] Trist, E. A socio-technical critique of scientific managment. In E. Trist, and H. Murray (eds.) *The Social Engagement of Social Science: A Tavistock Anthology. Vol II:*

The Socio-Technical Perspective, 580-598. University of Pennsylvania Press, Philadelphia. 1993.