Clues in the search for ever more valuable separations of concern

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SEEKING OPPORTUNITIES TO PROVIDE VALUE TO OUR CUSTOMERS

We are particularly interested in finding *more valuable* criteria for separating concerns in information systems development.

Two strongly related areas in which we are trying to make valuable contributions are:

- providing ever more adaptable information technology in support of adaptive enterprises
- bridging conceptual and other gaps between practices of management consultants doing organization design and software engineers building information systems.

Since we are driven by this view of what we believe to be of value, we take a somewhat broader view than the traditional bounds of software engineering. We seek a conceptual synthesis that allows us to better situate engineering practices for building information systems within a larger constellation of communities [12] including both communities that conduct business using those information systems, and communities that reason about the conduct of business.

SEPARATION OF CONCERNS TO ENCOURAGE CONSTRUCTION IN SHEARING LAYERS

In his book *Adaptive Enterprise* [5], Haeckel points to the effect on the strategies of business enterprises of the increasingly frequent unpredictable, discontinuous changes that occur in the environments in which they operate. How many enterprises predicted the rise of the World Wide Web and e-commerce? How many *software* companies made this prediction?

Frequent and disruptive technological, social, regulatory, political or competitive changes render traditional "predict and plan" approaches to business and information technology strategy not only inadequate, but downright dangerous to the long term health of an enterprise. The only possible alternative, in Haeckel's opinion, is to focus strategic thinking on the design of an adaptive, learning organization.

But while enterprises and their people may seek to become ever more adaptive, software is at best adaptable. The required engineering approaches and organizations able to build and adapt adaptable software are still missing.

Our source of inspiration for this dilemma is Stewart Brand's observation that successful buildings are constructed to support qualitatively different rates and scales of change [2]. That is, they are constructed in *shearing layers*, with a clear separation of concerns between parts that may and should change at different rates and on different scales.

Brand describes six shearing layers of change in a building. A site, especially when bordered by other buildings and roads in an urban setting, may constrain generations of buildings; a load-bearing structure may last for 30 to 300 years; the skin (exterior surfaces) typically changes every 20 years due to changes in fashion or technology or for wholesale repair; services (heating, ventilation, wiring, elevators, communications, and so on) "wear out or obsolesce every 7 to 15 years;" space plans in "turbulent commercial space can change every 3 years or so"; and stuff ("chairs, desks, phones, ...") "twitch around daily to monthly".

Brand's model corresponds closely to our own intuitions about the kinds of changes that are made to information systems. Some features change very slowly: credit card processing, or posting systems in banks. Others change very frequently, such as advertising features of web sites. Moreover, some engineering techniques and technologies exist to overcome cases where appropriate shearing was not initially supported. For example, the technique of screen scraping allows composite business functions and more modern user interfaces to be assembled on top of the unfashionable and obsolete character-based user interfaces of valuable, long-lasting systems built in earlier eras. Such techniques are the equivalent, in Brand's terms, of changing skin and space plan while leaving valued, reliable structure and site unchanged.

Brand states that buildings are deliberately constructed in shearing layers, with each layer having associated materials, practices and costs appropriate for its scales and rates of change. Thus, changes are differentiated in terms

of their associated costs, durations and disruption, with relatively many cheap, rapid, inobtrusive changes, and relatively few large, costly, long duration, disruptive projects. Shearing layers provides a language and metaphor enabling such a view of information systems development.

We are seeking a similar separation of concerns by scale and cost of deployment for information system function. In evaluations of the cost of deploying function, money to change, time to change and level of disruption must all be considered. Financial costs to change include: purchase, licensing and upgrade costs of raw software technologies; costs of employing, developing, retaining and renting the human skills necessary to deploy and maintain the technology in support of selected conversations; and costs associated with the purchase, leasing, maintenance and operation of supporting hardware, including bandwidth, storage media and processors. Deployment costs apply both to deployment of individual classes of conversation and of interactions between conversations that may have been deployed to different technologies.

The wide variety of information technologies, whether proposed by academia or available on the market, are a response to the highly differentiated needs of different applications. That there is such a wide variety of needs, and a corresponding variety of solutions is natural in any technological market and is an empirical validation of the shearing layers model.

Suppliers of materials, practices and human resources, whether aimed at buildings or information systems, seek to differentiate and diversify their offerings in terms of the differing needs of their users. So far as we are concerned, a key criteria for differentiating these technologies is in terms of their deployment costs. Moreover, deployment costs should be appropriate for the scale and rate of change of the shearing layer(s) at which the technology is targeted.

The shearing layers intuition is to focus thought on two things. Firstly, both suppliers of and investors in infrastructure require an appropriately richly differentiated set of deployment capabilities, including corresponding skills, hardware and software. Secondly, they need techniques for separating required function into pieces each of which can be separately deployed to a single appropriate shearing layer and thus targeted to appropriate deployment capabilities.

This separation of concerns in terms of rates and scales of change, with a diversity of costs of implementation technique and scales of system development effort, will we believe lead to adaptable information systems.

ROLLING THE WISDOM OF COMPUTER SUPPORTED COOPERATIVE WORK INTO INFORMATION SYSTEM DEVELOPMENT

Our goal here is to raise the level of discourse for IT design away from technology and towards how the IT supports the organization. In doing so we can better match what we believe to be natural boundaries and practices within organizations. Moreover, we become able to enlist the help of users and other subject matter experts in achieving a shearing layers separation of functional concerns.

Sociological accounts of work are full of discussions of boundaries and boundary practices. Star talks about artifacts specifically developed to support exchanges between different communities of practice [9]. Wenger talks about boundary practices including legitimate peripheral participation which we can interpret as specially demarcated conversations on the boundaries of a community [12]. Many authors talk about the advantages and disadvantages of keeping one group's work invisible to others (e.g., [6]). Clement and Wagner talk about the value of not articulating something [3]. And Bannon and Bødker build upon Strauss's notion of articulation work to point out that maintaining a common information space requires extra work on behalf of its contributors [1].

Lucy Suchman applied the insights of Harold Garfinkel [4] to propose a view of human action as improvised within each given situation, and in so doing successfully disposed of then-prevailing procedural views of work [10]. While she did not deny that people did, indeed, produce and make use of plans and procedures, she explained that when they are produced they are used as "resources for situated action" rather than as accurate accounts of what has taken or should take place.

Our focus in designing both organizations and software is on carefully identifying and designing situations and key resources available to people within those situations, leaving people free (empowered) to choose how to act within those situations [5,7].

In other words, we seek to focus detailed organization design on identifying and designing the separate concerns (situations) of business, and exploit insights from computer supported cooperative work to design systems as lots of small applications, each focused on a separate concern of the business.

VALUABLE CRITERIA FOR THE SEPARATION OF CONCERNS

Truex, Baskerville and Klein recommend that information system developers embrace and even foster change within both the organization that they support and the information systems that they maintain and evolve [11]. As such, they propose an alternative goal set for information systems professionals that optimizes on high rather than low maintenance. In their words:

> Emergent IT organizations value continuous analysis, negotiated requirements, and a large portfolio of continuous maintenance activities.

But how can engineers optimize for change rather than stability, do that efficiently, effectively and safely, and thus build and adapt the adaptable information systems needed

by an adaptive enterprise? Engineering wisdom seems to suggest that certain forms of change just cannot and should not occur quickly. Goals of high throughput and reliability, or a need to interface to a wide variety of other systems, are all believed to be incompatible with many forms of change.

We propose to use scales and rates of change, and a corresponding richly differentiated set of materials and practices, as primary criteria for the separation of concerns not only in information systems development, but for three related areas of design:

- the design of organizations: with an emphasis on design that promotes organizational adaptiveness and learning;
- the functional design of information systems: that is, design of how information systems will support the organization;
- the implementation of information systems: that is, design of how required function is made available to users using enabling information technologies.

We bridge the gap between the first two by exploiting the insights from computer-supported cooperative work that we pointed to above.

While this may seem like a broad focus for study, any large information systems services organization must not only cover this range of practices, but do so in an increasingly seamless manner. Moreover, if it is itself to be a learning, adaptive organization it must apply these three forms of design to itself, not only to its customers.

Beyond the above synthesis, which we believe to be a valuable research result in its own right, we are making concrete proposals for how to go about the three forms of design. An approach for functional design that meets these requirements is described in [8].

Note

This position paper is essentially an extended abstract for [8], focussing on motivation and sources of inspiration, but omitting any discussion of how we apply that inspiration in solving the identified problems.

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