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Causes and Effects of Rationale Clarity in the AEC Design Industry

By

John Chachere

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If you would like to contact the authors, please write to:

*c/o CIFE, Civil and Environmental Engineering Dept.,
Stanford University
The Jerry Yang & Akiko Yamazaki Environment & Energy Building
473 Via Ortega, Room 292, Mail Code: 4020
Stanford, CA 94305-4020*

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John Marvin Chachere

Center for Integrated Facility Engineering

Stanford University

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Abstract

In recent years, stakeholder concerns, building codes, and building products have become more dynamic than historically, tracking (for example) increased attention to sustainability, security, extreme weather, information technology, and globalization. The paper describes how information technologies and globalization have undermined projects' once-valid justification for professionalization, creating an opportunity for disruption by alternate methods of rational administration. In particular, bureaucratizing AEC projects becomes more compelling with the availability of methods that assess novel conceptual designs more rationally. These observations and existing theories suggest that a combination of contemporary industry challenges (such as globalizing supply-chains and competition, new information technologies that support design and analysis, new building technologies, and rapidly dynamic project goals and stakeholder preferences) will lead to a period of turbulence and the need and potential for re-organization. This paper argues that the US industry needs a systematic and transparent methodology to assess and adapt to changes in product, organization, process, and technology.

Changes in AEC Project Context

Communication Cost is Lowering

Bureaucratization includes communications routing rules and efficiency in information processing that heterogeneity of professional expectations and social ties complicate. "Routine processing of administrative communications and information is economical only when the overhead cost of specialized information-processing structures is highly productive... only if rules concerning the route of communication can be taught to clerks..." [Stinchcombe 1959 p. 176-177].

The information technology revolution has made file sharing and other forms of advisement and ordering far more economical. In each project we observed, designers, stakeholders, managers and gatekeepers used modern information technologies (including wikis and secure, proprietary applications) to share files. The availability of these tools lowers the cost of committing to specialized rules of communication and collaboration in bureaucratic organization.

Information technologies (such as the web and mobile telephones) can, do, and will destroy and enhance numerous AEC competencies. For example, the web increases access to project histories and reviews, making "arm's length" ties more trustworthy and weakening the importance of embedded ties. In addition, information technologies can increase the rate of

industry adaptation by increasing the visibility of best and worst practices, and enhancing the ability to assess organizational performance through automated analysis and simulation [Levitt et al., Burton and Obel, Lomi and Larsen, Chachere et al. (Comparing formal models of ICE at JPL)].

Lacking bureaucracy, control is administered through professional identities developed partly with training and social networks. Stinchcombe pointed out that rules do exist in the industry, such as those set by trade unions, contracts, and state licensing laws, but they rely on specialized knowledge, rather than the traditional advise-order links of formal supervision.

Failures of information flow, such as the failure to assess preferences, provide a powerful evolutionary force [Carroll and Hannan 1995].

Business is Globalizing

Features of globalization (such as increased competition for resources and greater institutional) alter the landscape of AEC competencies. In addition, globalization combines previously disjoint organizational fields including owners, designers, norms and legal systems that have co-evolved in isolation over thousands of years. In addition to increased competition for projects, raw materials, and labor, joining these fields creates new institutional conflicts [Hofstede, Orr]. Even within relatively homogeneous projects, the distance between workers matters in important and complex ways [Olsen and Olsen 2000].

Globalization lowers transaction costs to external firms, resources, projects, etc.

Variability is Lowering

Lemma 1 AEC demand and supply are becoming less variable.

Variability in the construction industry's work and product mix is greater than in manufacturing because of the former's physical ties. "The variability of the construction industry, its intimate dependence on variations in local markets, makes the development of bureaucracy uneconomical." [Stinchcombe 1959 p. 177]. Stinchcombe provides four main sources of the variability: the business cycle, changes of season, restriction to small geographic regions, and the organization of work into stages.

Globalization decreases seasonal variability in demand for large construction work by weakening three of the four main sources of cycle variability. This argument suggests that Stinchcombe's criterion of variability applies less in the current construction industry, and therefore that bureaucratization is more viable in construction and <therefore in the isomorphic> AEC industry.

Changes of season are less important to global firms because they can now access projects in both hemispheres and in many climates.

Globalization provides increasing access to markets for projects, labor, equipment, and materials once limited to a small geographic region.

Work previously organized strictly into serial stages involving different trades is increasingly organized using fast-tracked or parallel work.

Variations in business cycle persist in the global market, although they are comparable to bureaucratized industries such as manufacturing. Moreover, Stinchcombe included permanent

employment as a bureaucratic feature. In many industries (such as manufacturing), the practice and expectation of permanent employment has eroded since the mid-century.

Analytic Power is Increasing

Competence-enhancing discontinuities are changes that increase the productivity of existing business functions. These changes can strengthen companies' existing competencies and raise barriers to entry by new firms. However, existing companies can have great difficulty adopting new technologies, enabling more adaptable newcomers to develop specialized skills taking advantage of the new technologies [Tushman and Anderson 1986].

The introduction of VDC tools (such as BIM) and new building technologies (such as prefabrication and green materials) is a competence-enhancing discontinuity, because it increases the certainty and accuracy of design option analyses.

The increased returns from analysis make hiring clerks more attractive, and therefore make bureaucratic forms of information processing more productive.

Types of Change

Several fundamental changes in the AEC industry dramatically alter the competencies and dependencies of project participants.

Environmental processes include changes in resource and social alignments, changes in regulation, changes in institutional linkages, and technology cycles [Baum].

“Structural change in organizations seems less and less driven by competition or by the need for efficiency. Instead ... bureaucratization and other forms of organizational change occur as the result of processes that make organizations more similar without necessarily making them more efficient. ... Highly structured organizational fields provide a context in which individual efforts to deal rationally with uncertainty and constraint often lead, in the aggregate, to homogeneity in structure, culture, and output” [p.63-64].

How will existing firms enact the new industry environment and take advantage of the new entrepreneurial opportunities? DiMaggio and Powell [1991] provide three mechanisms of institutional isomorphic change – coercive, mimetic, and normative – and provide hypotheses linking the rate of isomorphism in fields based on attributes of the organizational field. For example, “The greater the extent to which technologies are uncertain or goals are ambiguous within a field, the greater the rate of isomorphic change” [p.77].

Mimetic Change

Mimicry will tend to base the new bureaucratization of AEC on existing industries, such as manufacturing, that bear more resemblance currently than they did historically. Some learning from those industries will surely serve efficiency, however they too are structured according to the market and socio-technical possibilities perceived at their founding. Each of the disruptive forces described above (such as globalization, information technology, and changing consumer preference) presents challenges to those industries as well. If AEC radically restructures based on the best social and technical innovations of today, AEC may provide a model for manufacturing instead.

Normative Change

Proposition 1 Building a clear design rationale improves organizational learning.

Organizations may not improve through learning, especially under conditions of ambiguity [March and Olsen Error!]. This observation underscores the importance of clarity in action and in collaboration (Chachere and Haymaker 2008.2).

Even perfectly well-intentioned project participants tend to have different information that suggests different social welfare functions. There is a need, therefore, to assess and reward for the quality of a decision, not the quality of outcome. This argues for clarity in the decision as an incentive leading to better organizational learning.

Embedded ties flow information in relatively proprietary, tacit ways [Uzzi 1997]. Without explicitly recording information, later organizations cannot learn from the experience of those embedded teams. In addition, misunderstanding is more likely because old methods of communicating don't translate to the global, multicultural organizational field. Under these working conditions, clarity becomes more important and difficult to achieve [Chachere and Haymaker 2008.2].

Organizations that have previously developed related knowledge will have an “absorptive capacity” enabling more rapid learning and exploitation of the proposed formal methods [Cohen and Levinthal 1990]. Organizations that consistently fail to invest in learning will tend to be locked out of further improvements by their limited absorptive capacities, and to overlook their dwindling effectiveness much as Kay and Ross [2003] found human agents overlook their own ineptitude.

Investing in the clear rationale contributes to the absorptive capacities of members regarding the use of formal methods in their own fields, but also to capacities regarding previously implicit relationships that contemporary changes hinge upon. This specific investment, or a similar one, is a critical element of learning that affects each member's long-term ability to maneuver effectively and survive. <Modulate the above discussion of absorptive capacity with the three project teams' specific spillover rates >

Stinchcombe observed that “[Construction firms have] no large element in the administration with the specialized task of planning technological innovation in the work process” [1959 p.182]. This observation indicates that the industry possessed low absorptive capacity at mid-century, and therefore a weak ability to track changes that, today, place companies vulnerable to disruption.

Coercive Change

Assessing dependencies between conflicting groups can enhance decision making and organizational durability.

Proposition 2 Building a clear design rationale improves organizational stability and survivability.

A basic premise of the population ecology view is that rationality as an individual firm is not the same as rationality within a market context [Hannan and Freeman Error!].

Organizations on whom each firm depend have their own inertia and dynamic market contexts. Survival of firms is a function, therefore, of knowing the existing context of current operations and operating “rationally” based on that knowledge, rather than based on an absolute concept of rationality as perceived by social norms.

Pfeffer and Salancik [Error!] argue that understanding organizational behavior follows from knowing the goals and dependencies of organizations in an interacting community. Organizations obtain resources essential to survival by exerting power over one another, and each exertion of power’s effectiveness depends on ten specific conditions [p. 44]. <review how those conditions are changing in the current market> This view sees the seemingly different AEC organizations – contractors, subs, owners, neighborhood groups, for example – as similar players in a single game of dominance.

Pfeffer and Salancik argue that understanding the organizational field –knowing ones’ dependencies, and those of other participants – is essential to survival. In this view, predicting changes based on awareness of the field reduces uncertainty, which is the fundamental attribute of the environment that determines which organizational structure provides the most efficient allocation of resources [Thompson Cite!]. To the extent that AEC firms can change intentionally, the capacity to observe the related organizational field is essential to success. As with any organizational function, team members have limited knowledge of the organizational field and must integrate the knowledge into a whole that serves pseudo-rational decisions. Pfeffer and Salancik argue that blind spots and lack of precision are common problems in the organization’s knowledge of its field, and these (institutionalized) problems lead organizations to underestimate the value of formal review. A comprehensive evaluation must consider current and also potential participants in the organizational field [Hannan and Carroll].

Pfeffer and Salancik argue for the assessment of external demands by “determining interest groups,” “weighting interest groups,” determining “the criteria of groups,” and assessing “the impact of actions on criteria.”

Inertia

Clarifying Rationale Faces Organizational Challenges

Lack of clarity on existing practices exacerbates the difficulty of assessing and affecting change because routines, like individuals’ habits, resist change. Even effectively breaking these routines can harm external procedures and decisions based on expectations (sometimes implicit) that the routine will continue. One source of organizational inertia is that routines are needed to support individual rationality- to predict the effects of action [Simon].

It is necessary to provide incentives for participants to invest in the clear rationale because of a “principal-agent problem”; not all the benefits accrue to model builders naturally. Having learned analyses or preferences implicitly, making them explicit is an investment that benefits recipients who lack that previously implicit knowledge. In this way, the clear rationale faces a commons tragedy: individual contributors benefit from the whole, but suffer for their own investment. Guarding against shirking is particularly difficult for data contributed anonymously. For example, designers must be prepared to defend their analyses, but stakeholders need not. However, assigning stakeholder representatives who depend on their constituents’ authorization presents the needed incentive.

Those implementing a clear rationale or other novel technology face considerable inertia, including challenges to legitimacy. One risk of claiming a new process is expert, as many VDC systems do, is that the perceived failure to perform expertly provides an opening for accusations of fraud [Kotter]. Even if fraud does not occur, the perceived risk of fraud triggers a wide range of adaptations.

The need to establish a formal method's legitimacy limits its range of effective application. When a method is simple, one can learn it well enough to fully understand its relationship to existing norms. When this understanding comes easily, commitment can spread rapidly through the organization. When a technology is complex or subtle enough that it takes one month, then consensus to use the method may only be achieved after the period of greatest potential benefit has passed.

For example, a project manager once remarked to us that the team was already making decisions that they needed rationale information for. This made it difficult to establish information sources, because one required a long "lead time" in which we could predict a decision, do the analysis, and convince them of its merit before the conventional method committed resources irrevocably.

Management teams routinely learn of specific changes that may help their companies improve performance, but fail to translate the learning into action [Sutton].

Rather than being able to simply reorganize around senior managers' perception of rational organization, "attempts at purposive action are instead embedded in concrete, ongoing systems of social relations" [Granovetter 1985 p. 487].

Human choices that seem to serve individuals poorly sometimes results from bounded rationality, and there is strong evidence that humans make decisions non-rationally (Cite Kahneman and Tversky). However humans also appear to make decisions non-rationally when in fact observers have failed to account for a broader context (cite selfish genes, memes), for example using previously unrecognized preferences.

Resistance to new information technologies can hinder the advancement of individual analysts yet preserve the broader functioning and balance of the project team.

The "liability of obsolescence" [Baum 1989] is based on the observation "The organizational inventions that can be made at a time in history depend on the social technology available at that time" [Stinchcombe 1965 p. 153].

Resistance to adaptations intended to address long-term change are likely to be concentrated among senior managers for several reasons. First, design professionals nearer retirement from the field, as well as political appointees with limited tenure, generally benefit more from exploiting existing methods than from exploring alternatives with longer-term returns [March 1989, March "Democratic Governance" Error!]. Too much embeddedness can make adaptation difficult because the business based on embedded ties is harmed by rationalization of the relationship [Uzzi 1997]. Design rationale "rationalizes discussion" [Fischer et al. 1996 p. 270].

Without alignment between rational controls (the basis of formal authority and structure) and normative controls (the basis of social cohesion), change in the workplace is difficult to establish (Vallas 2003).

Models' Benefits Perceived Partially

Proposition 3 Individuals and firms will overlook costs and benefits from implementing clear rationales.

People with low skill typically fail to recognize their own incompetence because they lack the skill necessary to observe their own shortcomings (Kruger and Dunning 1999).

As a result, designers, project managers, and stakeholder representatives who aren't using formal methods may not realize how poorly they currently perform, and may fail to appreciate the improvements that formal models offer.

Organizational Inertia Strongest in Organization's Core Features

Proposition 4 Efforts to clarify design rationale will meet the greatest resistance in companies with incompatible mission, authority, technology, and marketing.

Proposition 5 Companies will tend to survive bureaucratization whose mission, authority, technology, and marketing are consistent with clarity of design rationale.

Changes to “peripheral” organizational features often succeed and yields benefits; changes to “core” features are more difficult and rarely succeed [Carroll and Hannan 1995]. Carroll and Hannan identify mission, form of authority, basic technology, and marketing strategy as features that are typically “core.”

The prospect of resistance to a necessary change suggests that firms will tend to succeed when their mission, authority, technology, and strategy already .

This suggests that, to the extent that the identified industry changes persistent in applying pressure on firms' core features, few organizations will survive the increasingly turbulent period.

Common Decision Processes Have Flaws

Many simple and commonplace decision making methods have fundamental weaknesses.

For determining the relative position of alternative design options in the face of many stakeholders with differing preferences, Saari [2006] finds that a particular measure, the Borda Count [Borda 1782], best addresses Arrow's Impossibility Theorem [Arrow 1963].

In contrast to the mathematical elegance of decision theory, human processes are complex and poorly understood [cite March on ambiguity Error!]. March [1994] describes theories of choice behavior using a “general rational framework” that includes an explicit “decision rule.” Decision Rules indicate how the above three data determine the option chosen (such as formal Decision Analysis or voting in a committee).

Shortcomings in the design process can lead to shortcomings in the built product [Chachere 2007]. Assessing changes to design processes therefore involves considering how the improvement a formal method represents might exert externalities leading to defects rendering the net result counterproductive.

Commons

Free-for-all can Cause “Commons Tragedy”

Situation:

Pristine natural setting available to all developers
Developer gets all proceeds from building homes
Each home degrades land (an “externality”)

Result:

Developer gains all of the advantage
Disadvantage is shared among all developers
Rational developer action: add more and more homes
All developers act rationally
Parkland becomes overdeveloped and degrades
Rational developers will always build more

Applications: Fisheries, forests, water pollution, air conditioning

Solution: Regulation

Voting

Planning commissions and city councils are examples of the common practice of approving building designs (or requiring revision) with a simple majority vote. In the West, reverence for democratic governance is rarely tempered by knowledge of fundamental problems that have been known to political science for decades. In principle, Arrow’s Impossibility Theorem [Cite Arrow] indicates that voting and many related methods of social choice can lead to tragic behavior, such as allowing money to be pumped endlessly by presenting just three options to three stakeholders who decide using majority rule. In practice, sequential democratic choices often expend resources irrationally [Cite Error!]. These systematic problems, such as the undervaluation of long-term concerns, systematically harm constituents [Cite March Democratic Governance Error!] and shape industries such as AEC [Cite Alaska Pipeline study].

Negotiation

Negotiation methods typically apply to cases where compromise is required [Cite], because (for example) each party possesses and is willing to explicitly withhold resources the other desires. In AEC conceptual design, the owner is the only party with explicit decision making power.

The designers and stakeholders have informal power, however, over the owner. For example, designers can hold up the owner (cite) in the design process, and stakeholder representatives can withhold support that owner representatives typically require to be viewed as successful in the project.

Bureaucracy

Max Weber [1922, 1952] argued that the spirit of rationality drives organizations to form hierarchies of connected actors connected through the advising of superiors and the ordering of subordinates. “The bureaucratization of the corporation and the state have been achieved. Organizations are still becoming more homogeneous, and bureaucracy remains the common organizational form” [DiMaggio and Powell 1991 p.63].

Craft Administration

In AEC, the contracts and subcontracts used to rationalize administration use standard professional definitions of product and price, rather than task. Stinchcombe [1959] explained why the mid-century use of professionalization, rather than bureaucracy, was the means of rational administration in the construction industry.

Stinchcombe considered six criteria Weber found in manufacturing, and viewed three as carrying over to construction: stable jurisdictions, official duties, and authorities. He found, however, that three did not carry over: continuity, hierarchy, and files (files are “Stable, rule-governed communication channels among official statuses”). Stinchcombe concluded that professions, rather than bureaucracy, provided rational administration within the field of construction.

A similar view based on transaction costs indicates that craft organization results from commitment to dedicated resources [Error! and Levitt]. This argument holds most strongly for construction requiring investment in assets dedicated to a particular trade, such as cranes and bulldozers. This argument is eroding, however, for relationships between global firms that can include contractors and subs, and between design firms lacking substantial capital investments.

Dictatorship

“Dictatorship” provides one way of addressing Arrow’s Impossibility Theorem, and it is common for individuals to have unbridled decision-making authority in small projects (such as single family home construction and renovation). Simon [] observed that “if its model of reality is not to be so complex as to paralyze it, the organization must develop radical simplification of its response.”

The speed of a dictator’s decision making is a very important benefit that results, in part from having zero or negative latency in integrating multiple disciplinary and stakeholder perspectives [Cite Chachere et al. Error!]. Making high quality decisions, however, requires such vast knowledge that an individual can only compare favorably against dysfunctional organizations.

In large projects, even managers having formal decision making authority typically rely informally on the support of stakeholders and designers [Cite Power article Error!]. We have observed exceptions, such as John Arillaga at Stanford University, where a great deal of unilateral decision making authority is granted on large projects in spite of complex official channels.

This paper explains our finding that most organizations have severe shortcomings, and this can make outstanding individuals, such as John Arillaga, compelling nominees for sole design decision-maker. However, it is common for the stigma of dictators to taint the process; Even a fair outcome may fail to win back the goodwill of stakeholders who desired a fair process.

Changes Inside AEC

Inertial and Dynamic Forces Shape how Organizations respond to Changes in Industry Conditions.

Credential Standardization is Lowering

<Furthermore, operating in a broader range of regulatory environments ...>

Lemma 2 AEC credentials standards are becoming less important.

Professional credentials provide an essential form of legitimacy for subcontractors that bureaucracies establish using fixed organizational roles [Stinchcombe 1959].

Several of the disruptions identified earlier challenge this important role of professional credentials. Automatic code checkers, for example, are a VDC technology that reduces the reliance on professional reputation and training to authenticate claims of engineering compliance. The introduction of multiple standards from many countries of the global labor pool also undercuts existing monopolies on credentialing by professional and educational institutions.

New Preferences, Building Technologies, Regulations

<Explain how events like An Inconvenient Truth change preferences, then building technologies and regulations. Therefore, we need to learn about preferences, analyses, and constraints.>

Instability from Implementing VDC

According to Decision Theory, accurate information never has negative value, and has positive value when it has the potential to change a decision. In AEC design decision processes, however, there is no such guarantee. Improving the analytic ability of one portion of an organization (by implementing VDC, for example) can upset a delicate balance of power in decision processes that have evolved over many years. Until both formal processes and informal power dynamics settle into a balanced management accounting for the technology, project performance may actually suffer.

Virtual Design and Construction methods directly address the designer process only. Their expressed purpose is not to intervene in the creation or evaluation of stakeholder goals, preferences, or weights. Nevertheless, VDC methods (like other traditional or conventional processes) provide analysis results that facilitators, stakeholders, and owners all recognize as relevant. VDC methods therefore focus the team attention on those measures addressed by the formal methods, which takes attention away from measures that lack formal analytic methods.

Teams typically establish the relevance of goals that VDC methods analyze early in the project, before committing the modeling investment. Attending to VDC methods' analyses of design options is typically reasonable, therefore, because using the VDC method was appropriately motivated. As VDC methods become a part of design tradition, however, the output of VDC methods may be assumed relevant enough to warrant the model's use, even though no prior analysis of stakeholder preference exists. The tradition, therefore, may lead to a strong weighting of those goals in the decision process- even after the goal ceases to be relevant.

In addition, because attention is a scarce resource, using a VDC tool set focuses attention away from factors without corresponding VDC tools. The perceived certainty and visual clarity of VDC output may contribute to the tendency to rely on VDC-analyzed goals through a psychological phenomenon known as Error! [Kahneman and Tversky Error!]. The phenomenon of anchoring can systematically lead decision makers to believe that options ranked highly regarding VDC metrics also rank highly in other metrics. Finally, decision makers who must

defend their decisions to more senior managers will feel more comfortable with a decision supported by concrete numbers, rather than one supported by uncertain judgments, because of absorbing uncertainty is a routine function of the management hierarchy [Cite Error! – Powell?].

Virtual Design and Construction methods are becoming more prevalent in the AEC industry because they resolve uncertainties (and, therefore, mitigate risk) early in the project. However, the AEC tradition of assembling of projects from members of many diverse organizations makes reliance on convention and tradition very strong, and those conventions and traditions do not yet include VDC. Mature VDC methods now aid some projects by quantitatively analyzing many common (and tradition-established) stakeholder goals, such as cost, schedule, and energy consumption.

Each project affects a broad range of stakeholder goals that no VDC method addresses. For example, we have worked with teams having consensus on direct goals including aesthetics (GSB), Wow Factor (GD), and Sense of Ownership (SH). Because the set of goals among all projects is incalculably vast, the incompleteness of VDC tool suites seems likely to persist indefinitely. This problems described above are therefore likely to withstand all current visions for growth in VDC tools' power and generality.

Because VDC tools address only a fraction of each project's goals, traditional and conventional decision processes that were developed and perfected before the tools' introduction can render VDC modeling ineffective or even counterproductive.

Together, these results suggests the AEC design process ought to use deeply engaging methods to authentically assess stakeholder preferences (inward marketing), and rely on the authority and presence of spokespeople to assess preferences as a merely symbolic act serving public relations (outward marketing).

This suggests that achieving consensus on the use of VDC might be more effective using a simple argument with less involved managers, and a more detailed list of features and benefits with potential technology users. For example, an executive technology manager recently described VDC as principally serving to reduce uncertainty in early design stage (Schwegler Error!).

Social Networks Change

Clear Rationale Decreases Importance of Embedded Ties

Lemma 3 A clear design rationale decreases participating organizations' dependency on embedded ties.

“The more competitive advantage depends on the ability to reduce product development risk or investment uncertainty, the more organizational networks, rather than other forms of organizations, will dominate competitive processes” [Uzzi 1997 p.54]. Uzzi's theory suggests that as VDC, clear rationales and other technologies reduce the uncertainty of projects (as suggested by Schwegler Error!), these social networks will become less important in determining project formation and, therefore, its organization.

Rational search depends on embedded ties, so search relying on social ties rather than verifiable formalized information will suffer more when there are multiple teams who rarely interact, as is the case in AEC projects. Further, there is typically less investment in social ties when the project is short.

“The trust engendered by personal relations presents ... enhanced opportunity for malfeasance” [Granovetter 1985 pp. 491-492]. To the extent that rationalizing links reduces the strength of social ties, then, it also reduces the moral hazard and tendency toward illicit behavior.

Altering Information Flow Pressures the Organizational Field

Proposition 6 Efforts to clarify design rationale will meet organizational resistance.

The organization of fields depends upon definitions of what is being transacted [Leblebici 1991]. Making more clear distinctions between project team roles (so that each provides options and analyses only, or goals and preferences only, or constraints only) changes the definition of products and services rendered. Because this change applies pressure to the organizational field, efforts to clarify or change the distinctions between team roles meet resistance in the form of organizational inertia.

Organizational Change Follows Network Ties

Proposition 7 Efforts to clarify design rationale will tend to succeed in sectors with past successes.

From the viewpoint of embedded social ties, differential rates of acceptance for various information technologies will differentiate social alliances, with the potential for a divergence between projects led by technology pioneers and projects led by relative luddites.

Over time, organizations that do not change will die out as the old social ties become less reliable sources of trust. In particular, a chasm exists in each product category where it becomes better for the majority to use a given rationale map. Entrepreneurial organizations anticipating this point, in fact, may accelerate the transition and lead to a rapid transition to technology-centered industry.

The tendency will depend upon the different segments; For example, health care’s increased reliance on technology will make adopting AEC technologies easier for that segment, whereas traditional office buildings may trail the pack. However, once many segments transition, reliance on shared resources (in-house or subcontracted) will increase pressure to adopt the progressive social position, and eventually, to pressure the less progressive industry segments in their own internal operations.

Progression of Change

Development of Novel Organizations

Stinchcombe pointed out “The organizational inventions that can be made at a time in history depend on the social technology available at that time” [1965 p. 153].

Evolution by the rapid development of entirely new organization, rather than gradual adaptation, may be more prevalent. A formal rationale map may help teams resolve ambiguities and learn more from previous projects, however, thus adapting more effectively to changing conditions.

New organizations suffer a “Liability of newness” with four attributes [Stinchcombe Error!], and a formal rationale map can aid in each:

individuals learning new roles,

organizations learning new structures,

individual social relations among strangers, and

organizational relations in which actors understand one another’s services

The liability of newness hypothesis applies in cases where there is a lack of social approval, stability, and sufficient resources [Baum Error!], and can be overcome by forming attachments to community and public constituents [Baum and Oliver 1991].

Entrepreneurs, founders, and owners tend to be more personal and intuitive whereas professional managers tend to be more rational and analytical [Schein 1983]. This tendency seems at odds with the position of the entrepreneurial opportunity for rationalization of AEC projects.

The “liability of adolescence” is that initial, buffering resources are used up after an initial period of survival.

Turbulence

Organizational ecology theory indicates that a period of gradual change will soon give way to turbulence, then emergence of new standards and stability.

Existing Theory

The succession of interdependent discontinuities suggests that we may be entering an era of rapid change [Tushman and Anderson 1986], in which firms will compete vigorously to survive during a succession of organizational forms and technologies.

Whereas the contingency view indicates that structure results from current constraints, the organizational ecology view indicates that the current situation is path dependent- there are many twists and turns in organizational development, and dead ends, resulting from circumstances that no longer persist and from interactions related through a complex web of dependencies among co-evolving industries [Padgett]. In AEC, therefore, change in response to the discontinuities identified above will be neither immediate nor direct.

New Theory

New Observations

Overall, the direct effect on individual firms is a complex function of enhanced versus destroyed competence within a specific industry field. For example, the US General Services Administration has seen dramatic change in stakeholder preference for security, in security technology, and in adoption of VDC technologies [Cite BIM at GSA], but fewer global effects because the sites are domestic. These observations indicate participants in federal government projects are likely to benefit from stabilizing technologies such as the design rationale map.

In addition to direct effects, changes afoot in other industries indirectly affect the AEC organizations. As examples of destabilizing trends in the US, globalization has led to US firms' offshoring instead of building domestic manufacturing facilities, while aging of the US population has increased demand for health care facilities. As examples of stabilizing trends, the web increases firms' ability to access knowledge of these market dynamics and to communicate with stakeholders.

Each discontinuity provides an entrepreneurial opportunity. For example, New building technologies have emerged to enhance the competence of companies for addressing stakeholder preferences, such as green materials and manufactured hurricane resistant homes.

Bureaucratization

Proposition 8 Modern AEC industry conditions increase the effectiveness of bureaucratic, compared with professional, rational administration.

Bureaucratization today appears different from what Weber envisioned but the basic principle of using advise-order links to rationalize administration persists [DiMaggio and Powell].

Stinchcombe's argument relied on several attributes that distinguished construction from manufacturing in the mid and early 1900s. In modern times, those attributes no longer hold.

The discontinuities identified above effect the attributes forming Stinchcombe's groundbreaking analysis. These trends suggest the argument for professionalization vs. bureaucracy has eroded significantly, resulting in entrepreneurial opportunities to increase rationality in the organizations of AEC projects.

We observed that the current organization of AEC closely resembles the craft organization Sinchcombe described, but that the reasons for its organization no longer hold. This paper's following section assesses changes in the AEC industry, how they may cause the craft organization to change, and how the industry will resist that change.

<Cite evidence in terms of memberships, etc>

<code checkers>

Preference Clarification

Proposition 9 Contemporary changes will favor adjusting contracts, professional definitions, and closer vertical integration of projects.

Since goals are now more dynamic than previously, there are three possible adaptations:

Change the structure of contracts to incorporate diverse project-specific stakeholder goals

Change the definition of professions to include assessing and acting on diverse project-specific stakeholder goals

Bureaucratize the project (into the advise-order links of formal authority) to consolidate information (diverse project-specific stakeholder goals, constraints, and the effects of design) required for design decisions

Based on expecting diminishing returns from each of these investments, we can expect a new equilibrium will adjust expectations slightly in all three measures

Clear Rationales Complement Standardization

Proposition 10 Standards for developing consistent design rationale (such as role definitions, object names and definitions, metrics, and visualizations) improve collaboration productivity.

Design teams and regulatory gatekeepers engage in projects with many different collaborators over time. Standardization, through categorization and impersonal rules, will therefore serve those teams well [Thompson]. We observed this practice broadly, for example Figure Error! provides one structural design firm's standard report of measures deemed important [Cite]. More broadly adopted standards, such as LEED and Spear, also serve this purpose. The risk of institutionalizing these processes of generating standardized reports is their inertia in the face of rapid industry changes.

In contrast, many stakeholder groups, such as companies building headquarters or districts building schools, participate in AEC projects rarely, and standardization serves them less well. This suggests that a formal model of design rationale might include more flexible elements on the stakeholder side than on the designer side. In contemporary industry, we have found less standardization in gathering stakeholder data, and frequent reliance on unstructured interviews and focus groups (as Ulrich and Eppinger 2008 describe). These observations support the contingency theory view of design rationale generation.

The design rationale map (MACDADI) standardizes the situation's presentation, which (according to March and Simon Error) facilitates independence. This suggests that in AEC, teams familiar with the rationale map will be more able to coordinate on the subjects that map covers.

Having a standard set of goals and metrics serving designers, but flexibility in the set of goals and metrics serving stakeholders, is possible. Thompson [Error!] pointed out that employing standardization across organizational boundaries calls for developing liaison positions between the groups and the rule-making body. This indicates specific mediation requirements for the common method of maintaining two distinct sets of goals and identifying relationships between them (using simplified Boolean terms as in Ulrich and Eppinger 2008 Error!, or using a precise mathematical function). This observation from contingency theory supports the recommendation to deploy the design decision rationale map (MACDADI) using a facilitator to manage standards and using team stewards as team liaisons. <in our experience with MACDADI, we have/have not found evidence that using team stewards was effective>

Having a standard format to record and process data consistently may minimize conformance and other inertial tendencies. An institutionalized method of assessing the organizational field, either using a design rationale map or using a resource dependence map outlined below, may decrease the chance of being a casualty.

It is best to have both embedded and arm's length ties so that one accesses new, impartial, public information but also accesses the advantages of trust [Uzzi 1999]. This suggest that, to the extent that rationale maps provide public information, arm's length ties will become less important.

Measurement displays attributes more accurately, which reduces transaction costs.

Although inertia and the boundary spanning nature of these technologies makes adoption more difficult, the frequent recombination of teams in different projects increases the likely rate of standardization around a fixed set of interfaces.

<Cite Taylor on the industry's resistance to boundary spanning innovation>

Standardization Leads to Stability

Providing standards speeds coordination and the spread of new technology.

Organizational ecology theory predicts a turbulent period's end involves a wave of failures and the establishment of new standards and dominant competitors.

“When the knowledge base of an industry is both complex and expanding and the sources of expertise are widely dispersed, the locus of innovation will be found in networks of learning, rather than in individual firms” [Powell et al 1996]. Powell's observation suggests that accelerating change in AEC will lead either to industry consolidation, or to research centers and consultancies, or integrative technologies playing more pivotal roles in the turbulent period. There is evidence of both trends. The authors are affiliated with one such center, and the industry is developing integrative technologies.

Whereas the rational view of organizations presumes a closed system of known variables and the need for analysis, and the natural view presumes an open system of many organizations and social factors outside the firm, the contingency view sees organizations as needing to make rational sense of a complex and dynamic outside world [Thompson Error!]. The transformations on external stimuli needed to survive and thrive therefore determine organizational structure.

There is increased reliance on embedded ties when there is an inability to use price to provide information [Uzzi 1997].

Conclusion

Discussion

Historically, coordination among project teams was based on notions of standardized and regulated professional standard measures of work process. A complementary method is to define interfaces of responsibility (advise-order) links among project teams. These relations consist not of advising and ordering, as found in . Authentic advise-advise link use is the equivalent of lowering one's guns in a classic shootout, or and it seeks to turn away from the current trend of political and courtroom shootouts.

If bureaucratization strengthens in AEC, the strategic importance of coordination technologies increases. A trend toward bureaucratization opens the question of how information flow will differ; where Weber identified 'files'. What will the product, organization, processes, and context of AEC 'clerks' be? These questions are difficult for any industry, but there is less precedent in AEC because it has been administered primarily as a craft, rather than as a bureaucracy.

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