How do I know if I can learn from your experience?

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Abstract. The Software Engineering Process Group (SEPG) Conference is, at its core, a sharing of practical software process improvement experience. When we hear the experience of others how do we know if it will apply to our situation? How do we know what variables control the applicability of another organization's experience to our particular situation? Comparing organizations, it turns out, is a settled question in organizational studies.

This presentation introduces SEPG members to a free, well-documented tool that helps to address what we need to know about another organization to recognize if its lessons may be applicable to mine. You may be surprised by how few variables there are that really make a difference, that we do not need to know "everything" in order to make reasonable inferences.

The principal tool operationally defines "misfit" as a serious difference in the values of the variables that have to match in order for one organization to learn from another. Therefore, as we listen to SEPG Conference presentations this tool is so easy to use that we can answer for ourselves whether the lessons we are hearing are a misfit for us.

Whether two organizations are different is a settled question in the field of organizational studies. Hundreds of field studies have been conducted that compare different factors in order to answer the question of whether the differences in factors makes a difference in performance. For example, two organizations might be quite different in size: one very large and the other very small. When looking at the speed of communication, the large one might be much slower than the smaller one. Therefore, if we rated performance in terms of speed of communication, then the distinction in size would make a difference.

We are interested in the factors that influence organizational performance because they are potentially the drivers that <u>cause</u> that difference in perform-

ance.[1] Before we turn our attention to the factors for which there is evidence that distinctions make a difference, let us first ask what organizational performance is.

We shall use two organizational outcome measures: effectiveness and efficiency. An organization is effective if it realizes its purpose and accomplishes its goals. An organization is efficient if it utilizes the least amount of resources necessary to obtain its products or services.

Contingency approach

With those outcome measures in hand, we might ask, "What's the best way to achieve efficiency and effectiveness?" The correct answer is, "It depends." And our question at that point should be, "It depends on what?" The branch of organizational studies that has risen to address that question is called the contingency school of organizational design. It is called "contingency" because the best answer is contingent (that is, depends) upon the values of factors. And it is "design" because one tries to arrange structural elements in order to achieve the outcomes.

But why look at organizational design in order to find out if we can learn from other organizations? The reason is that organization design has addressed the question of what constitutes a difference in organizational performance and also on what that outcome difference depends internally, that is, on what causes the difference in outcomes.

There are three kinds of variables in this formulation: (1) those that characterize the organization's environment and context (essentially exogenous), (2) those that characterize the knobs and levers we can manipulate (endogenous) in order to achieve the outcomes, and (3) a few that we can treat as either being given or being selected.

Luckily for us, there is an encyclopedia of the relations among these three types of variables, *Strategic Organizational Diagnosis and Design: The Dynamics of Fit*, third edition, by Richard Burton and Børge Obel, 2004.[2] The rest of this section is

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[1] We (collectively, editorially) are sensitive that correlation is not necessarily causation. On the other hand, if we are looking for causes then it might pay to look (first) at factors that are correlated with the outcomes we care about.

[2] In the spirit of transparency, the author is acknowledged in the Preface to the Second Edition. Also, the text uses a different characterization of the variables: diagnostic factors and design recommendations.

a redaction of that text and application of it to the questions facing those of us trying to understand what they can take away from the experience of others.

Fit and misfits

One of the advantages of the contingency approach is that it can rate whether the organization fits with (1) the exogenous factors, and (2) all of the other choices we have made. While beyond the scope of this short paper, it is within the scope of the Burton and Obel text cited. One use of this information an SEPG might make, quite aside from addressing the question of learning from another organization's experience, is to assess the fits and misfits in the organizations it serves. Sometimes the misfits are a big part of the problem that is faced with make improvement. For example, if the organization is structured to fit with a routine technology but, in fact, it employs a non-routine one (like software development!), then the structure can present quite a barrier to the change needed to improve.
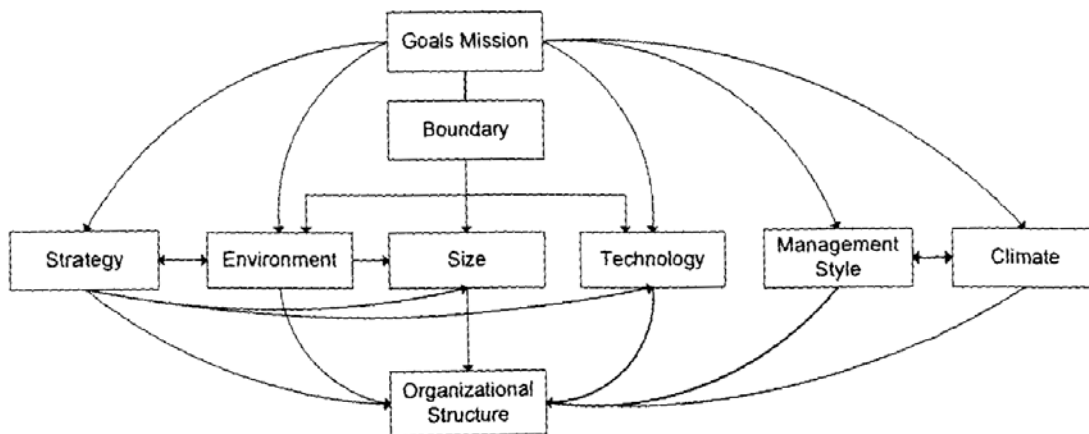

Figure 1. Organizational context. From Burton & Obel, p. 16.

Goals and mission

Goals and mission are the overarching contingency: everything else depends on them. In his SEPG 2005 keynote address, Admiral Patrick Moneymaker told of his frustration of trying to get the trust that he found in his former military position to be earned in his current commercial setting. He dramatically described his time (1989-1990) with the US Navy Blue Angels. The Blue Angels (http://www.blueangels.navy.mil/) is an aviation team that demonstrates precision aerobatics, flying F/A-18s fast and very closely together; Adm. Moneymaker had flown in the #1 position, The Boss. Adm. Moneymaker wondered aloud during his keynote presentation why the camaraderie, process focus, practice, and trust

values were so difficult to translate in a firm, when, after all, he was totally convinced and was the leader in both instances.

One reason is that the mission and goal of the Navy Blue Angels is entirely different than his commercial systems engineering firm, so the methods used to obtain their respective goals is, appropriately, entirely different. Take practice, for example. Those in the military often practice for long periods of time before entering actual battle, much like athletes. But those of us in commercial settings almost never practice. Why?

It is a matter of rewards and for what we are paid. Naval aviators are paid for all of their work, practice included. We in the commercial sector are only paid for our "production," virtually never for anything that we need as a prerequisite for production, such as training, learning, and practice. The irony that organizations such as the US Navy that pay their members for practice do not so pay their suppliers is not lost on us.

The goals and mission contingency includes how rewards are earned, including the basic financial terms. So, differences in fixed-price, performance-based, and time and materials methods of compensation make a difference that is significant among organizations, making comparison likewise difficult.

Strategy

Strategy is the reason a buyer seeks your goods or services, it's the heart of the value proposition that differentiates you from your competitors. An aligned organization operates in support of the selected strategy. There are three strategies:[3]

> *Operational excellence* – This follows Deming's logic: highest quality leads to lowest cost, which leads to lowest price, which leads to highest market share. This is the basis of the Software Engineering Institute's various Capability Maturity Models.
> *Product innovativeness* – This is the novel combination of features that is unique in the marketplace.

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[3] *The discipline of market leaders: Choose your customers, narrow your focus, dominate your market*, Michael Treacy and Fred Wiersema, Basic Books, 1995. For software examples, see "Why software process innovations are not adopted," Stan Rifkin, *IEEE Software*, vol. 10, no. 4, pp. 110-112, July/August 2001; "What makes measuring software so hard?" Stan Rifkin, *IEEE Software*, vol. 10, no. 3, pp. 41-45, May/June 2001; and "Whoosh! The sound of deployment!" Stan Rifkin, keynote address in *Proceedings* of SEPG 2000, Seattle, Washington.

Total solution – One-stop shopping, "one throat to choke," we meet all of your needs and want to earn all of your money.

The strategy contingency, like that of goals and mission, are critical and differences here make it really difficult to translate lessons in one strategy to another. One of the illustrations I often give is of medical devices. You would think that quality is the strategic driving force, but most often it is not: it's innovation, a long list of features, usually at the expense of quality. What one observes is that operators of medical devices – usually physicians – would rather acquire a system that has to be re-booted than one that is stable but has fewer features. In other words, device quality is not the competitive advantage, even in (many) medical devices.

One often hears in SEPG Conferences that quality assurance is devalued; yes, that would be <u>appropriate</u> in product innovativeness and total solution organizations! When listening to an SEPG Conference speaker we need to know what the organization being described is optimizing: quality, innovation, or a total solution.

Environment

The environment surrounding organizations selects which of them will survive and thrive. The notion is that those organizations that best adapt to their surroundings will survive longest. So, what do such organizations look at in the environment to respond to, which signals do they monitor, what do they in turn select as indicators that require attention?

The picture of the environment is itself a differentiator, let alone different environments themselves. Just as there are complexities in the environment, so are they complexities in the *descriptions* of environments! One practical framework, among many, is presented in Figure 2, below. Later work on description of the environment often adds a dimension for hostility, how aggressive and tolerant the marketplace is for missteps.

The reason environment is important is that organizations try to match the external uncertainty with internal units to address each source. In other words, if an organization finds itself in an environment of high rate of change, ignorant of cause and effect, large number of internal and external variables, and interdependence among those variables, then in order to survive it should have

organizational units devoted to each of those elements in order to sense changes in them, to explain the impact of changes in each on the organization.[4]

In order to make sense of whether we can learn from the experience of another organization that organization would have to have many elements in its environment like ours because that other organization senses and responds to a subset of all of the factors impacting it, not necessarily the way we see things. If it makes sense of its environment differently then we do there will be little to learn.
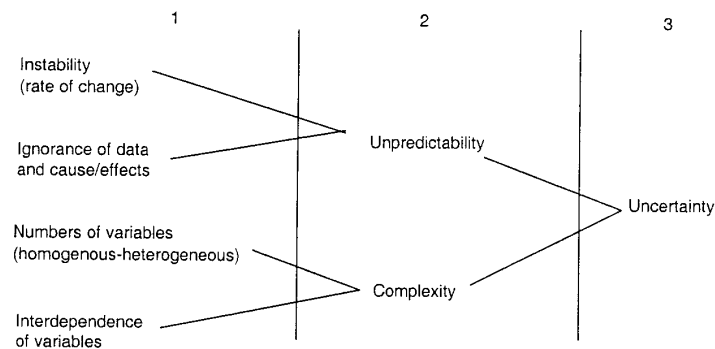

Figure 2. A description of organizational environment. From Burton & Obel, p. 190, adapted from P.R. Lawrence, "Organization and environment perspective," in Van de Ven & Joyce (Eds.), *Perspectives in Organization Design and Behavior*, 1981.

One simple example is the effect of (government) regulation. If, for example, Microsoft sees a threat from government litigation and anti-trust regulation, then it will make sense of competitive moves differently than we (not Microsoft) might. So, when we hear how Microsoft addresses a certain problem of interest, say writing secure code, then we have to filter those lessons from the standpoint that Microsoft is seeking solutions – and therefore methods to develop a solution – that do not run afoul of its regulatory environment, such as by setting de facto standards.

Size

Most contingency approaches view organizations as information processing entities: organizations take in information, arrange and re-arrange it, try to make sense of it, and then do something in response to that processing, such as give advice, make a decision, formulate a next step, etc. Size matters in that context because with greater size there is potentially greater information processing. This is good if there is a need to process more information, such as a complex and un-

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[4] Famously called "requisite variety." W.R. Ashby, *Introduction to Cybernetics*, Methuen, 1956.

predictable environment, but it is bad if much of the information is internally-generated and not in response to changes in the environment.

In smaller organizations, each person fills more roles, all things equal: "chief cook and bottle-washer." This reduces expertise and increase breadth. Which is better, depth or breadth? If we are really embracing the spirit of the contingency approach then the answer must be, "It depends." Depends on what? Depends upon the goals of the organization and its environment. If the goal is to be expert, then multiple roles dilutes achieving that.

So, for example, the best innovative firms have both experts and generalists.[5] This implies, upon deeper inspection, that an organization that wants to be innovative has to be above a certain size in order to accommodate both experts and generalists (what is sometimes called vertical and horizontal differentiation). And, because innovation is unpredictable and often operates in an unpredictable environment (never know when the next breakthrough will occur), field studies have shown that innovative organizations add resource buffers (called "slack" in management magazines) to absorb the expected but unpredictable peaks and valleys.

If someone from an innovative organization is speaking and we are wondering what we can borrow from that experience, then we have to ask ourselves whether we are of sufficient size, do we process information the way it does, do we scan our environment for changes and then have a similar process for incorporating new ideas, new energy.

Technology

In our context, technology refers to how routine the work is and to how well-defined the problem space is. Perhaps the most practical view of this is Figure 3. One other taxonomy is worth mentioning in the context of software development is:[6]

Complexity, diversity – the number of different items requiring simultaneous consideration.
Uncertainty or unpredictability – Can the work be predicted in advance?
Interdependence – Does a change in one item necessitate a change in a different one?

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[5] P.R. Lawrence & J.W. Lorsch, *Organization and environment*, Harvard Business Press, 1967.
[6] W. R. Scott, *Organizations: Rational, Natural, and Open Systems*, Prentice-Hall, 1998.

These three elements are common in that they all require more information and more information processing during task planning and performance.
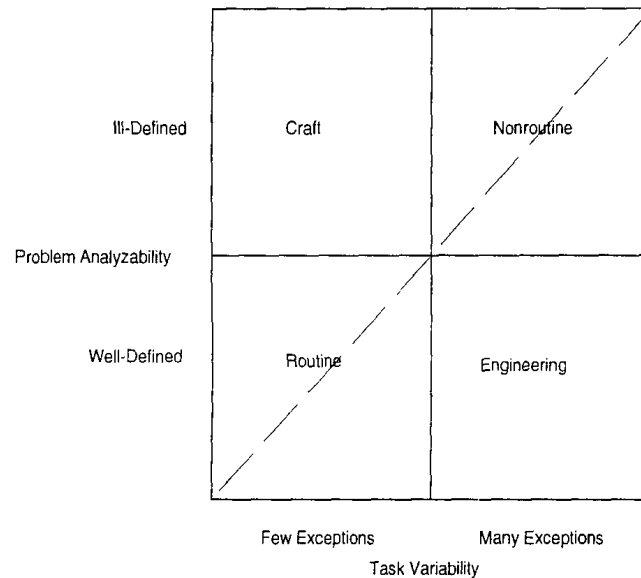

Figure 3. Technology dimension. From Burton & Obel, p. 244. Adapted from C. Perrow, "A framework for comparative analysis of organizations," *American Sociological Rev.*, 1967.

The way that technology in the sense used here is manifest is how an organization is structured. Large US defense contractors (such as Lockheed Martin, Boeing, and Northrop Grumman), for example, have a heritage of manufacturing, so they tend to organize into a "machine bureaucracy": highly routine operating tasks, much formalized rules and regulations, tasks grouped into functional departments, centralized authority, decision-making follows the chain of command, and elaborate administrative mechanisms with sharp distinctions between line and staff.[7] This is the way many data-centric organizations structure themselves internally, too, mostly for heritage reasons: Allstate Insurance, Bank of America, the IT department of Intel, most Blue Cross/Blue Shield medical insurers, and General Motors or its agent, EDS. But, as you can imagine, it's not the way so many organizations that develop a lot of software and never attend an SEPG Conference do: Oracle, Computer Associates, Hewlett Packard, Microsoft[*], the part of IBM that develops software (the out-sourcing part attends), et al.

As we listen to the experience of other organizations, we need to ask how they view the routine-ness of their software development technology. IT organiza-

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[7] Burton & Obel, p. 46.
[*] There's a small exception because a few Microsoft people have attended from time-to-time.

tions tend to view applications development as routine, to be performed according to very detailed plans and performed by interchangeable programmers. Product development organizations tend to view their activities as creative and non-routine, so they organize differently.

If, for example, I were with a federal government agency then I might find much in common with the experience of a large defense contractor (both are likely machine bureaucracies). But if the software my organization develops is for embedded applications, such as medical devices, I might have trouble locating my unease at applying the lessons; that unease could be the result of our viewing our development technology differently, that I view ours as non-routine and sometimes resorting to craft.

Structural configurations

Organizations have a great deal of latitude in how they design themselves in order to optimize their information processing capabilities. Organizations can select among a range of structures and other variables. This section briefly describes some of the choices and they impact applying lessons learned.

The first choice is the organization chart. Oddly enough, though they are entirely different on many levels, the organization chart of Microsoft and General Motors look remarkably the same. There is evidently a great deal of pressure on Fortune 500 companies to adopt the same form of organization. However, down from those lofty heights there is considerable variation in how organizations structure themselves. As we listen to experience reports we need to ask ourselves why the speaker's organization is structured the way it is and whether that would map to ours. Most organizations created a structure to optimize something about information processing and it's our job to discover it.

Formalization is the degree to which information is recorded, particularly in archivable documents. Some formalization is imposed by external regulation (e.g., medical device developers have to maintain certain records) and some by administrative policy. When an SEPG Conference experience report speaks to informality, we need to ask ourselves what drives the degree of formality in our organization and is that the same force as in the sharing one.

Centralization refers to where and how decisions are made. High centralization implies that a central authority not only makes all of the decisions, but that it also reaches down into the organization to gather and interpret data. The value of

centralization is that the view from that height is broader, more inclusive of all the factors that spell success or failure, therefore central decision-making is thought to yield decisions of high quality. The downside is that centralization consumes a lot of time and resource, so organizations have to trade-off decision quality and timeliness.

Centralization was also the topic of Watts Humphrey's SEPG 2005 keynote address. Mr. Humphrey eschewed bureaucracy, in part by focusing on what he termed the routine aspects of it. Oddly enough, bureaucracy was first seen as a boon to what up until then had been the ad hoc approach to any new situation, and yet Mr. Humphrey is identified with eschewing the ad hoc nature of software development and management! Bureaucracy, particularly machine bureaucracy with its strong centralization, it would seem is just what one would want in cases where, say, a large number of people had to be moved from one place to another, as in times of conflict or emergency. Those are hardly times for study and improvisation.

The more modern view of bureaucracy (circa 1979) is due to Karl Weick, who postulated that organizations could be tightly-coupled or loosely-coupled.[8] Tightly-coupled organizations have a strong, straight link between the executive management and the lowest levels. There are written memoranda and procedures to make sure that whatever was decided at the top is to be executed at the bottom. Again, this is especially handy when the organization is in a hurry and when it is important (life is at stake, e.g., during an evacuation) that the organization act in a uniform way with respect to some attribute (such as how it addresses injuries). It is also important when the organization does not want to reinvent repeated, standard procedures each time they are needed. Do we really want everyone to create his/her own travel request form?

Loosely-coupled organizations are driven more by values, principles, mission. The specific implementation of those is left to the operating units, which in general are not trying to optimize the time in which they respond but rather some other valuable attribute, such as the fit with local customs, the specifics of the particular environment.

An example of a tightly-coupled software development team would be one that responds to bugs where life is at stake. There is a formal, step-by-step procedure

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[8] K. E. Weick, "Educational organizations as loosely coupled systems." *Administrative Science Quarterly*, (1979).

that is followed and that has been honed by practice, by repetition. Still, this team could be faced with unprecedented events and would then have to improvise. An example of a loosely-coupled software team would be one that is creating software for a new device, one for which precedents do not readily apply. Along with the novel aspects, this team would be faced with many precedented events, such as travel and expense reimbursement requests for which it would be appropriate to have bureaucratic processes already in place.

In the end, the extent to which we desire to have centralization, formalization, and tight- or loose-coupling is very much our choice, since we are the ones who design our organizations, particularly our software development teams.

Additional factors

Leadership style can make a difference (it's called Management Style in Figure 1), but it's not clear from field studies whether leaders are drawn to organizations where the organization's style will fit or whether organizations select in leaders whose style fits the organizations. In other words, it's not clear whether leadership style is really something over which an organization has control. Because of this ambiguity in the evidence we shall skip this factor.

The last factor to be examined might be called climate, culture, or life cycle phase. Quinn developed a unification of those three seemingly disparate characterizations in his competing values framework,[9] in which he answers the question, "What are the traits or qualities of the best managers?" with "It depends." Depends on what? It depends upon the life cycle phases that are illustrated in Figure 4. Basically, the culture of an organization transits from dynamic, entrepreneurial and creative (developmental) to a friendly place to work where human resources are valued (group culture) to a formalized and structured place (internal process focus) to a place that looks towards its future by creating a strategy and executing on it (rational goal), often by starting the development phase again. Almost everything is different in the different life cycle phases: what is valued, what is rewarded, what is needed, what is antithetical to progress, etc.

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[9] Robert E. Quinn, *Beyond Rational Management : Mastering the Paradoxes and Competing Demands of High Performance*, Jossey-Bass, 1991.
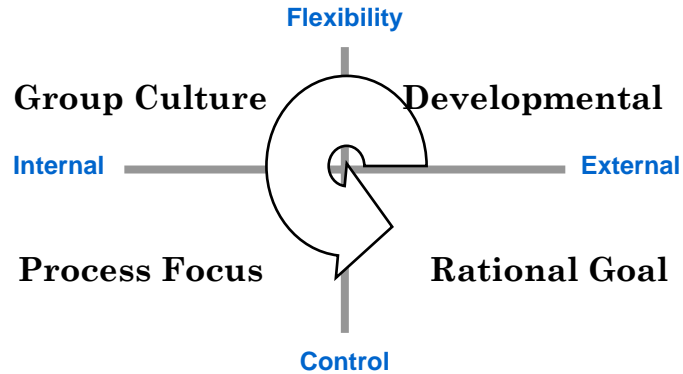
Figure 4. Competing values framework.

So, when we hear about an organization that is successfully process-focused, we can be assured that it's in the internal process focus stage. Are we? If not, then it is going to be very difficult to translate that experience to ours.

Summary of the contingency approach

Two organizations are similar if they are the same along a few axes: goals and mission, strategy, environment, leadership and management style, organizational climate, and technology. If they are similar then similar organizational designs will achieve similar organizational outcomes.

> *So, as we listen to SEPG Conference speakers we should be asking ourselves whether the turbulence in our environments is similar, and if so then are our goals and mission similar, and is our organizational boundary similar. If so, then is our strategy similar and if it is, then have we adopted a similar size and approach to technology. If we get this far in our inquiry, then we would ask whether we are in the same phase of organizational life cycle.*