WHY DO I HAVE TO LEARN ABOUT ORGANIZATIONS? I AM A SOFTWARE ENGINEER/COMPUTER SCIENTIST!

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Abstract. Most systems fail for organizational reasons, not for technical ones. Many of our solutions are technically adequate, but they cause organizational problems or do not take into account organizational issues, and that is why so much technology is not implemented, adopted, or deployed. Knowing how organizations work greatly improves the chances that our technical solutions are appropriate and will actually be used. Besides, big work, significant work, is done by organizations for organizations.

This presentation chronicles the journey of the author from his role as technical solution provider to a person who understands organizations. He now uses a process of mutual adaptation to develop systems and transition them to actual practice. In this process, the technology is adapted to the organization and the organization to the technology.

While learning about organizations has been beyond the normal education of us technologists, today there are a number of resources available to engineers to learn about organizations with the objective of developing appropriate systems and having them successfully achieve their usage goals. This talk introduces those resources and gives field examples of their application to technical problems.

This is not a pop psychology pep talk. In fact, it's not about psychology at all. It's about the pervasive influence of organizations on our work and how to use knowledge of organizational systems to be successful with technical systems.

Keywords. Organizations, planned change, social systems.

Sometime in your career you will be asked or you have been asked to estimate how long it will take to accomplish some important task, such as writing a computer program. Hopefully you have learned a formula and can consult it, such as:

$$\text{Effort} = \left[\frac{\sqrt[3]{\text{Functionality} \times B}}{\text{Productivity Parameter}} \right]^3 \times \left(1/\text{Duration}^4\right)$$

$$\text{Effort} \propto K / \text{Duration}^4$$

from (Putnam & Myers, *Measures for Excellence: Reliable Software on Time, Within Budget*, 1992). One observation can be made immediately: effort and duration are independent of each other, and, in fact, if one squeezes duration then effort increases as a fourth power! Also, one has to ask what is being requested: the duration or effort, and is it for a plan, to win business, as a target, or other purpose.

Figure 1 illustrates the relationship between effort and duration. All of the dots are estimates for the same constants: functionality (61,800 source lines of code), productivity (15 on the Putnam & Myers scale, which value is low for a business application today), and rate at which people are added (manpower buildup index of 3, which is brisk but achievable). One can see that the effort (in man months) depends upon how compressed the development time (schedule, duration) is. And that the relationship between effort and duration is not linear: 15 months ÷ 11.7 months = 1.3, that is, 15 months is 30% longer than 11.7 months; 4 people at peak ÷ 14.5 peak staff = 0.3, which means that if the duration could be extended 30%, then effort (= labor costs) could be reduced to 30% of the previous total, a 70% savings.

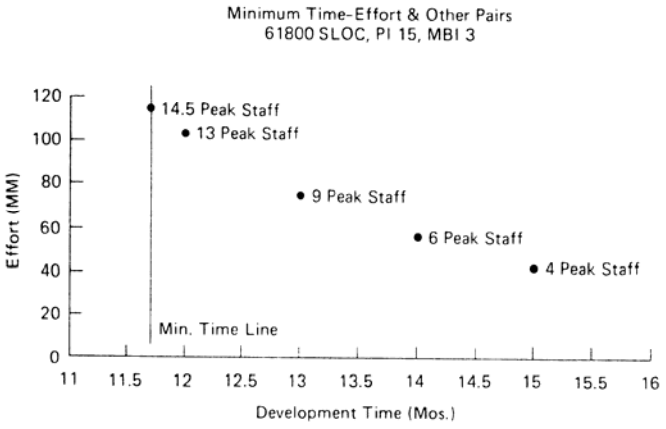
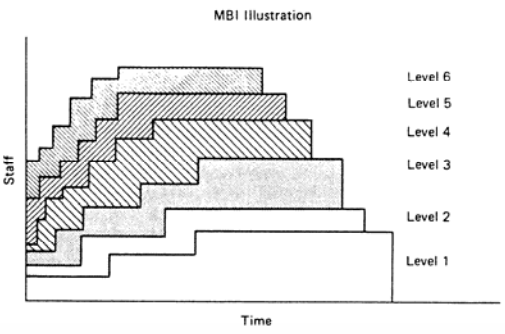


Figure 1. Relationship between programming effort and duration. (Putnam, Lawrence H. and Myers, Ware, *Measures for Excellence: Reliable Software on Time, Within Budget*, 1992)

1. THERE IS A MINIMUM DEVELOPMENT DURATION

The figure also illustrates another important fact: there is a duration such that there is no recorded industry data showing the project being considered could be accomplished sooner. Now, it is possible that your team can, in fact, beat all other industry records, but it seems worth knowing that your team is actually attempting such a feat, that there are risks in estimating below all recorded history.

The existence of a minimum development time is evidence that durations cannot be compressed without bound. While we all hear the joke about nine women not being able to make a baby on one month, for some that is the extent of the knowledge. So, what is the relationship between compression and effort?



The Level 1 Manpower Buildup Index indicates that the buildup is slow and takes longer. As the index numbers increase, the buildup becomes steeper and more rapid.

The decision to speed up the staffing of a project has a small effect on the development time but a major effect on the effort.

MBI	Dev. Time (Months)	Effort (Manmonths)	Cost	PI
1	16	55	$458,800	11
2	14	80	666,700	11
3	13	120	1,000,000	11
4	12	180	1,500,000	11
5	11	235	1,958,000	11

Figure 2. The effect of schedule compression on effort. (Putnam, Lawrence H. and Myers, Ware, *Measures for Excellence: Reliable Software on Time, Within Budget*, 1992)

Here is one more illustration, again from Putnam & Myers.

2. ESTIMATING EFFORT

If effort is being estimated -- and is much better than trying to estimate duration, for the reasons stated above -- then in accordance with the formulæ above, in order to estimate one needs to know the functionality being sought and the potential productivity. In addition, a number of other things need to be known, but will be elided for the sake of example (e.g., software life cycle phases being covered, maximum team size, constraints such as quality targets, standards being applied, and non-functional requirements).

With your effort estimate in hand you may approach the requester with your figure, only to hear "Wrong answer!" Those who know about organizations would ask at that moment (actually, much sooner), "What is the commitment process? What is the process by which this organization commits resources and its good name, to a given scope or project?" If the requester hesitates or stumbles, then there is likely no way any estimate is going to be accepted because there is no step-by-step, rational procedure by which estimates are integrated into a promise that the organization will make to a client, the marketplace, or investors.

3. KEYS TO MAKING AND MEETING COMMITMENTS

The important phrases are "rational," and "step-by-step." Some years ago I investigated what the secrets might be to consistently meeting commitments, so I interviewed chief executive officers of organizations that had long track records and well-deserved peer recognition that they met their commitments over and over again. They told me that commitments are based on three things:

1. Voluntariness
2. Rational basis
3. Management is in the same boat as the doers

By voluntariness they meant that each person involved had to agree to the commitments without resort to coercion. After all, they reasoned, people are going to work really hard to make good on promises that they themselves made, and not work hard on promises someone else made.

By rational basis, they meant that they would not accept, "Yes" to the question of whether one could meet the commitment, not without a reasoned and step-by-step process of evaluating the work to be done and an agreed description of e-x-ac-t-l-y what the organization was going to do to execute. And that rational basis had to have a foundation in actual recorded history, not in recalled or remembered history (so-called expert judgment or experience, which I term "aerial extraction").

And by management being in the same boat they meant that there was not a tension in which management was pushing for shorter durations and less effort, as though management got compensated on a different basis than the doers. No, in organizations known for keeping their commitments management often pushes back and asks, "What evidence do you have that we can actually meet these estimates? Aren't they too aggressive?"

4. WHAT EXPERIENCED MANAGERS KNOW ABOUT ESTIMATES

Imagine the requester of the estimates asking you, in effect, if your estimates should be padded! But, as stated above, that conversation is what happens in organizations that consistently meet their commitments. How can the typical (pointy-haired) boss have such a different view of the world than those in organizations that consistently meet their commitments?

First, managers in organizations that meet their commitments know not to trust quantitative measures too much (Rechtin, *Systems Architecting of Organizations: Why Eagles Can't Swim*, 2000). Certainly quantitative measures are the best we have, but there are so many variables and uncertainties, particularly as every software project unfolds, that the best rational/quantitative estimates are indicative and not definitive. That some of the important variables are too elusive.

Here is an example of one such inquiry by a software boss who understands the ephemeral nature of real projects.

Figure 3 illustrates that the usual project management tools listed next to Intrinsic management power are offset by Project adversity, to yield the residual power that management has left to accomplish what was promised. That is, project adversity subtracts from and negates the tools we normally apply. And where in our estimation models is project adversity?! Worse, as most people with experience note, project adversity evolves, emerges, so

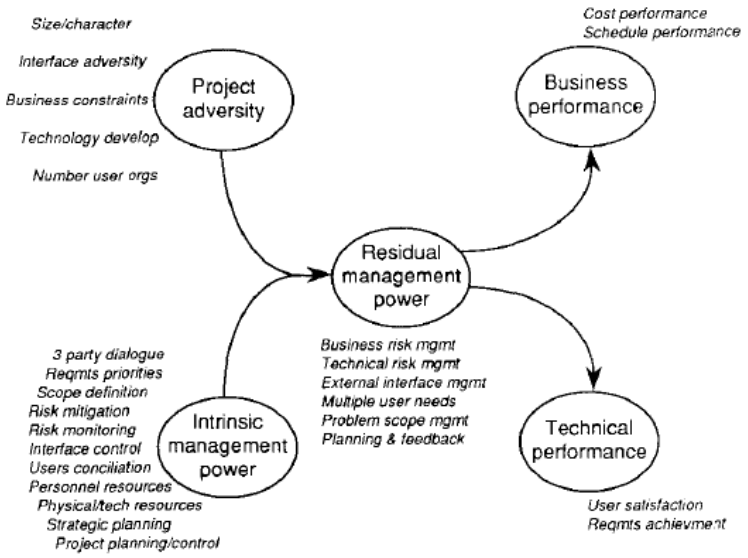


Figure 3. Project adversity as a driver of project success. (Deutsch, *An Exploratory Analysis Relating the Software Project Management Process to Project Success*, 1991)

we are not always good at estimating it anyway. And what does not show in this figure is that some project adversity arises from the delivering organization itself, it is not all extrinsic.

5. THE PLACE OF WORLD VIEW

One of the changes that permits a person to go from a hard science and mathematics background to a field that can reason about people is a shift in *world view*, all of the assumptions we make about the nature of the world and the people who live in it. Table 1 depicts some world views and indicates what a/the shift might involve. The shift to which I refer is from Normal Science to two columns to the right, where reality is viewed as a contextual field of information.

For me, the compelling insight was that people are not like billiard balls, we cannot predict their behavior precisely, the way we can predict physical phenomena. The reason people are not as easily predictable is that they are interpreters, not necessarily (accurate) responders (Daft & Weick, *Toward a Model of Organizations As Interpretation Systems*, 1984). They/we process information and then decide to react or not, while billiard balls always have to react and always in the same way. So, even when we do decide to react, we can absorb energy or reflect it, analogically speaking. Again, billiard balls can only absorb a small amount of energy and must reflect most of it.

While it sounds like we are heading down an infinite regress, we are not. Though individuals are interpreters, collectively we are much more predictable. In fact, it is well known that even if I knew or could know everything about each individual in a group, that information would not help me to predict how the group would act collectively! The simplest example of this in our realm is that most of us in computing are introverts. But what happens when you get a group of introverts together to act collectively? At least one of them emerges with behavior that we associate with extroversion!

6. PREDICTING HOW ORGANIZATIONS WILL ACT

Whilst individuals may not be predictable, their collective actions are more easily foreseeable when they combine into groups, teams, and organizations. This area of work is informed by sociology, the study in

particular of social systems. One of the most prolific thinkers on the subject was Talcott Parsons, perhaps the best-known American sociologist in the 20th century. He modeled collective action according to Figure 4.

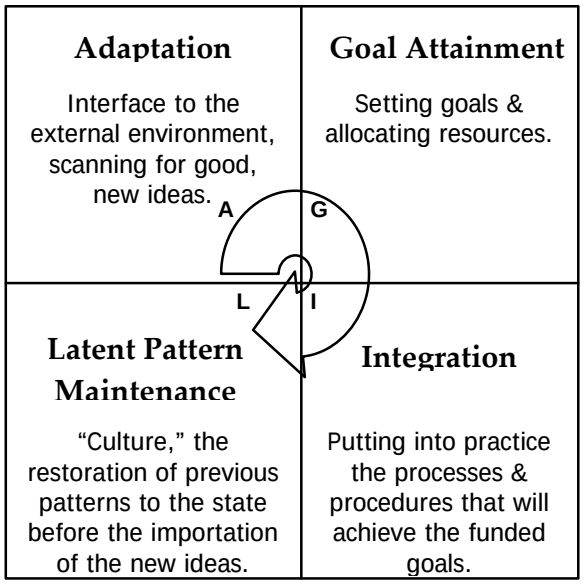


Figure 4. Parsons' theory of organizational action.
(Bluth, *Parsons' General Theory of Action: A Summary of the Basic Theory*, 1982; Lackey, *Invitation to Talcott Parsons' Theory*, 1987)

The arrow in the middle shows the predominant flow of energy (e.g., information) entering an organization. The energy enters through the Adaptation function, which scans the environment for news and good ideas. Some of the good ideas are passed on to the Goal Attainment function, which sets goals and allocates resources accordingly. Some of the ideas that enter the organization are about setting new, different goals, such as becoming "agile." Some are about how to allocate resources, such as the estimation process suggested at the beginning of this paper.

Once goals are set and resources allocated, then the work of the organization is addressed by establishing a set of processes that are integrated in the service of the goals and constrained by the resources allocated. The integration of the workaday processes into the organization has an impact on how things are usually done and so that integration comes up against norms, history, and culture. The Latent Pattern Maintenance role is to counteract any change to how things are usually done; its job is to maintain the previous patterns of what is valued, what is rewarded.

How might our estimation example play in this model? Consider that parametric estimation is new to the organization but not new to you; you have studied it in a course, read a book or article, learned it somewhere else, or been introduced to it by a consultant. So, you have this new idea: let's compute the effort required based on the estimated size and potential productivity. And let's consider this a problem of trying to minimize duration subject to certain constraints, such as team size, delivered quality, etc.

But we must consider something before we even try this method. With an eye on Goal Attainment function, we realize that are mid-course in the current budget cycle so there are no reserved funds for this new way of estimating, and no funds with which to acquire a tool, training, even to research this method and prepare a description. No problem, we request funds for the next budget cycle.

We will we have to compete to get resources allocated, so we try to align our objectives of the estimation process with higher level goals, such as improved client satisfaction by meeting our promised delivery date. In the process of trying to convince our management that parametric estimation is worthwhile, we come to learn that today commitments are made by the sales staff and the sales staff is nervous that an evidence-based, quantitative estimation method will give us programmers an excuse to drag out delivery duration, so Sales is against using a rational basis. And when our

technical management hears those objections it, too, becomes nervous that with a quantitative basis for calculating estimates it will be more difficult to talk us out of our duration estimates, there will be fewer contests of wills, our strength of evidence will be greater than their strength of authority.

And so our proposal fails. Because we do not understand how organizations work. There was never any question of how estimates work, but rather the question became how would this estimation process impact the organization from a non-technical perspective, from a world view that few of us in the computing field have.

7. HOW ORGANIZATIONS CHANGE

Now we are energetic to champion change. We all have ideas about how to do this, such as convince executive management by learning how to talk about finances. This, unfortunately is completely uninformed. There are better models.

Perhaps the best-known and most widely applied framework for organizational change is depicted in Figure 5, which is really four models. We might adopt most easily Teleology, where our dissatisfaction is the engine that powers our motive force for change. We take the rational steps of searching for solutions (though we already have a strong candidate in our formulæ) and then selling it internally as we learn and modify our approach. Then we help to set estimation process and outcome goals. Next we learn how to implement these new goals and execute based on that learning.

In the end, the Teleology approach looks like a control loop that attempts to close a gap by increasing performance. But one phrase should catch our attention, "Social construction." It also appears in the spectrum of world views, but further to the right than we might feel comfortable moving. Besides, that would be a big step for us.

8. HOW WE CAN CHANGE BEFORE WE ASK OUR ORGANIZATIONS TO

Fortunately for us, scientists and technologists have come before us and will help us to transform our world views. One early path leader was Abraham Kaplan (Kaplan, *The Conduct of Inquiry: Methodology for Behavioral Science*, 1964), a "recovering physicist," who observed that there is as much dogma and faith in physics as there is in the softer sciences. After all, he reasoned, when we write *F=Ma*, we know full well that there is no force, no mass, and no acceleration, that those are constructs that we have created out of our imaginations to try to explain the external world.

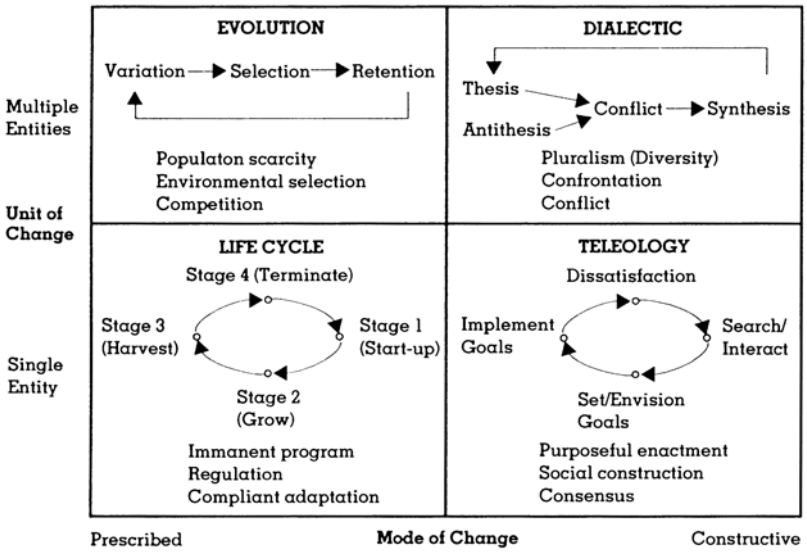


Figure 5. Process theories of organizational development and change. (Van de Ven & Poole, *Explaining Development and Change in Organizations*, 1995)

Constructs? Construction? It is the nature of scientific evolution (and revolution) that knowledge advances by destroying one framework and replacing it with another (Kuhn, *The Structure of Scientific Revolutions*, 1970). The

march of science is nothing more than the march of the evolution of the mental constructs we use to describe the world around us. No matter what our mental constructions are, we agree to use them for awhile. That is, there is some social agreement to accept the current explanation. While a factual basis for that agreement is helpful, it is by no means required; just look at all of the religious wars! And, besides, the facts change.

Accordingly, the key to changing organizations is to change how we look at them. Physics and pure mathematics will fail us here because organizations are not like billiard balls. But theories of how organizations act and change will aid us, and there is a new development: more and more is being framed for us scientists and engineers.

There is an emerging field of computational and mathematical organization theory, so learning about organizations from our vantage point is greatly facilitated (Carley & Prietula, *Computational Organization Theory*, 1994; Ilgen & Hulin, *Computational Modeling of Behavior in Organizations: the Third Scientific Discipline*, 2000; Jin & Levitt, *The Virtual Design Team: a Computational Model of Project Organizations*, 1996). One reference is particularly germane, as it includes a CD with an expert system on it that can be used to evaluate, diagnose, and design organizations, which had hitherto been an art (Burton & Obel, *Strategic Organizational Diagnosis and Design: The Dynamics of Fit, 3rd Ed.*, 2004).

In the end there is hope for us engineer-types that we can learn to shift our world view towards the rich phenomena of human organizations, so that we can accomplish big things, the ones that can only be achieved in organizations.

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Table 1. Mapping alternative world views.

	"Normal Science"					"Pure Subjectivism"
Core Ontological Assumption	reality as a concrete structure	reality as a concrete process	reality as contextual field of information	reality as realm of symbolic disclosure	reality as social construct	reality as projection of human imagination
Metaphors	machine	organism	hologram, brain	theater, drama	sense-making	transcendental
Human Nature Assumption	people are responders	people are adaptors	people are information processors	people are actors, symbol users	people are symbol creators	people are spirit, being
Epistemological Stance	construct a rational objective science, emphasizing networks of causal laws and rule-governed relations	study systems, process and change	map contexts to understand how actions and contexts mutually evolve over time	understand patterns of symbolic discourse; symbolic actions used to shape and make meaningful social reality	understand processes by which social reality is created and sustained	obtain phenomenol-ogical insights; get/receive revelations
Knowledge Generated	systematic laws to explain and predict	understanding the impact of context on organization	understanding mutual causality; causal loops	identification of typologies of symbolic actions	understanding of processes used to create org. reality	understanding of the contents of consciousness
Research Approaches	lab experiments, surveys	historical analysis	contextual analysis	symbolic interactions	semiotics, ethno-methodology	explore pure subjectivity

Source: Hunt on leadership, exact citation being researched.

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