Advanced Process Architectures

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Instructor's Background

- B.Sc. in Sociology and East Asian Studies (U. Kansas)
  - Not an Engineer, but Social Science background
- Ph.D. in Sociology / Philosophy of Science (London U.)
  - Spent eight years doing research into structure of theoretical systems
- Thirteen years Software Industrial Experience
  - Systems Analyst, Software Engineer, Technologist
- Five years Process Improvement Experience
  - SEPG chair and member
- Research in Practice (Action Research) Approach
  - Process improvement is a form of *sociological practice*
  - Process improvement has its own intellectual challenges
  - It is possible to do research and practice together effectively

Questions and Answers

- There is a lot of material to get through
- Questions need to be limited to clarifications
  - If you do not understand, please speak up
  - If clarifications begin to take too much time, we will have to continue them off line.
- Questions that call for expansion on points should be withheld
  - Note the part of the briefing, number of slide and question
  - Subscribe to tutorial Email List
    - Send the message "SUB TUTORIAL" to listserv@think.net
    - Post your question to the list
- Systems Engineering and Software Engineering lists exist there
    - Send the message HELP to listserv@think.net to get more information

Expectations

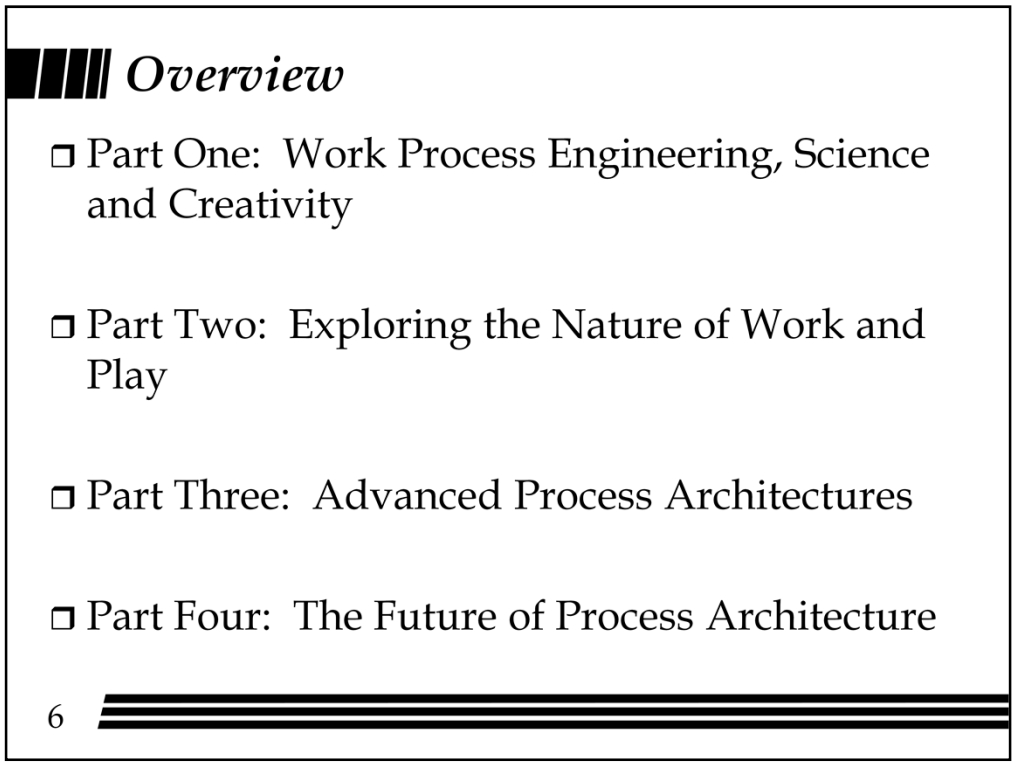
- This course contains Advanced Material; it is not Basic
  - A graduate level course
  - Targeted at experienced Process Improvement practitioners
- Theoretical, not Practical
  - No practical solutions will be offered
  - Instead this course will seek to expand the audience's horizons
  - Will consider alternative viewpoints on Process
- Pushing the state of the art
  - Will attempt to look into the future of the application of Processes to work organization
  - Will bring to bear advanced concepts from other disciplines
- Wild ideas
  - Meant to suggest new ways of thinking
  - Meant to be a starting point for your own explorations of these issues
- Architecting; not a history of architectures
  - Presents fundamental principles that form a basis for designing a process architectonic; not a survey of existing architectures

Schedule

- Section One:
  - Part One
  - Part Two
- Break:
- Section Two:
  - Part Three
  - Part Four

Symbol for extra slides not to be presented

This briefing is dedicated to my father, Alfred L. Palmer, who did Office Systems Analysis as a profession for many years and was twice President of the Kansas City Chapter of the Systems and Procedures Association circa 1965. Who would have guessed I would end up studying work also.



In the first part we will establish a framework for understanding processes and their descriptions.

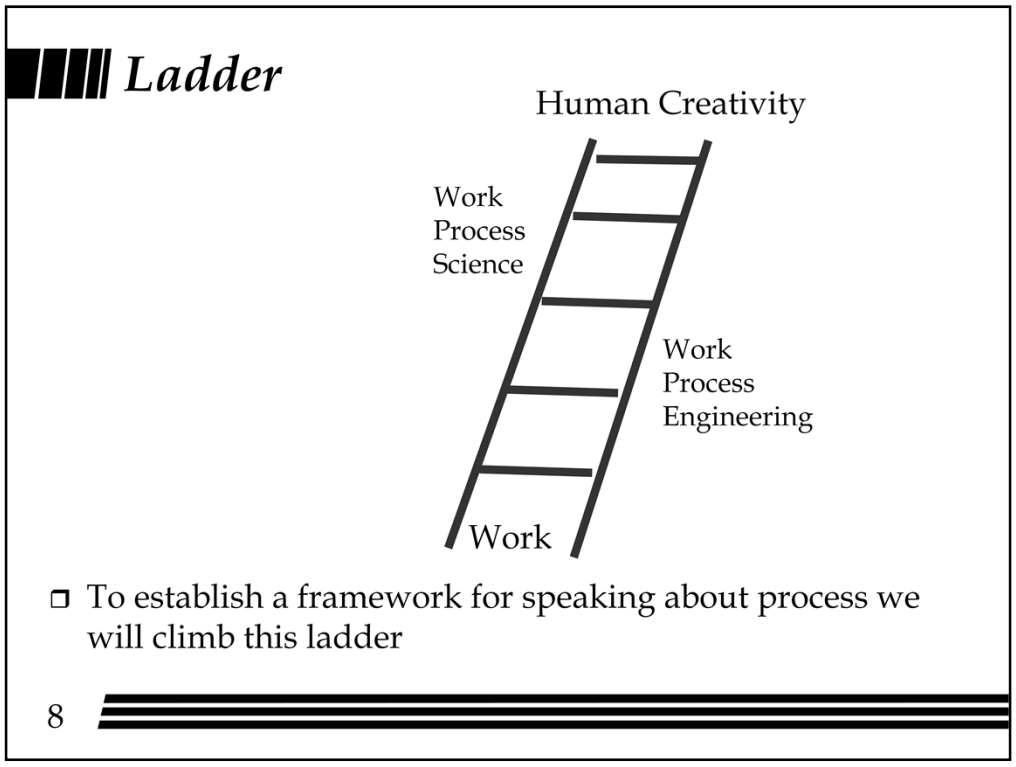
In the second part we will look closely at the meaning of work and attempt to better understand what we are trying to improve. We will especially look at the different kinds of work and their relation to non-work. A special emphasis will be placed on the relation between work and play, and between routine and non-routine work.

In the third part we will look at different process architectures for describing different kinds of work. Advanced architectures are those that can deal with non-routine work.

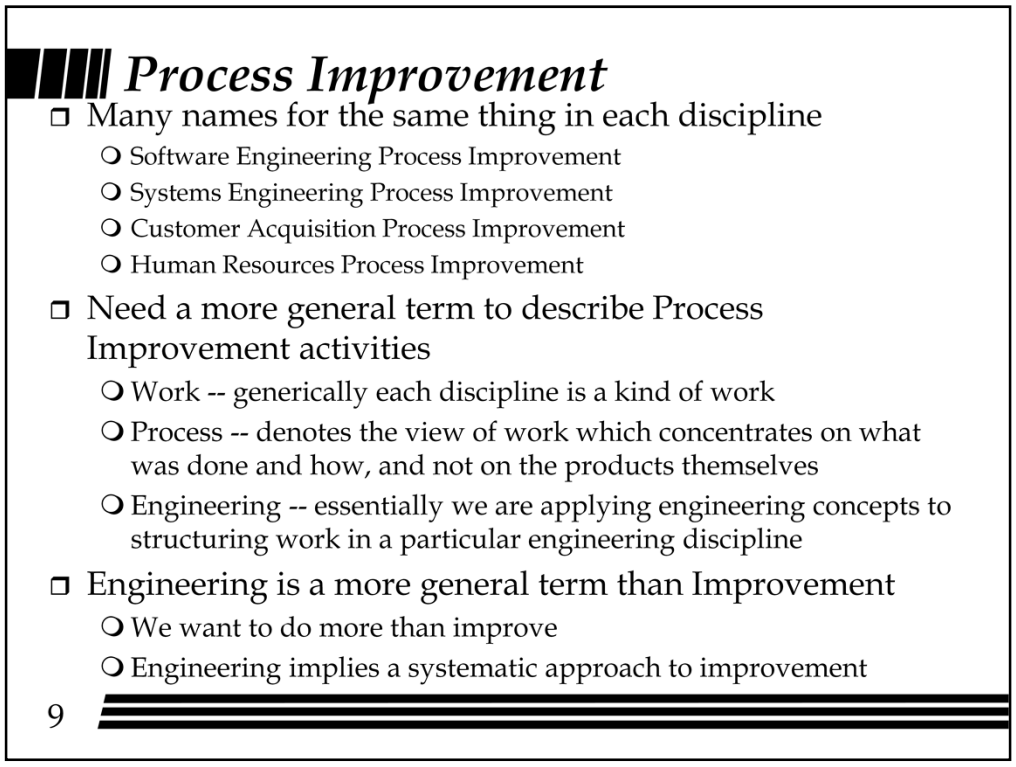
In the fourth part we will look at models of self-organizing processes.

PART ONE

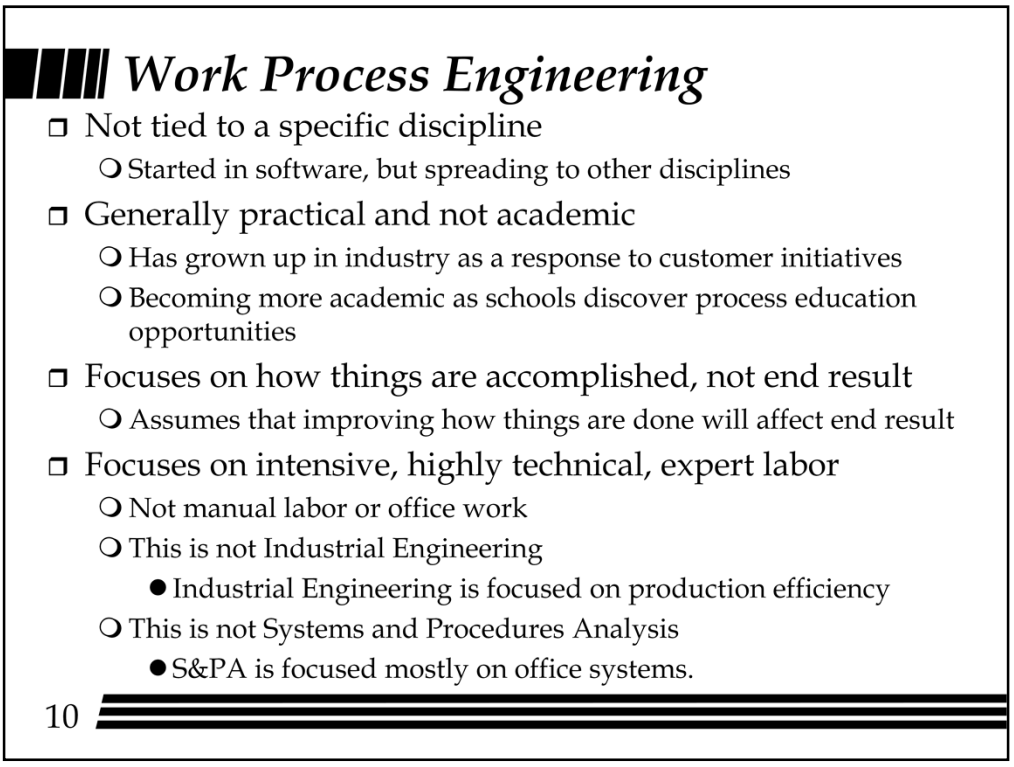
Work Process Engineering, Science and Creativity



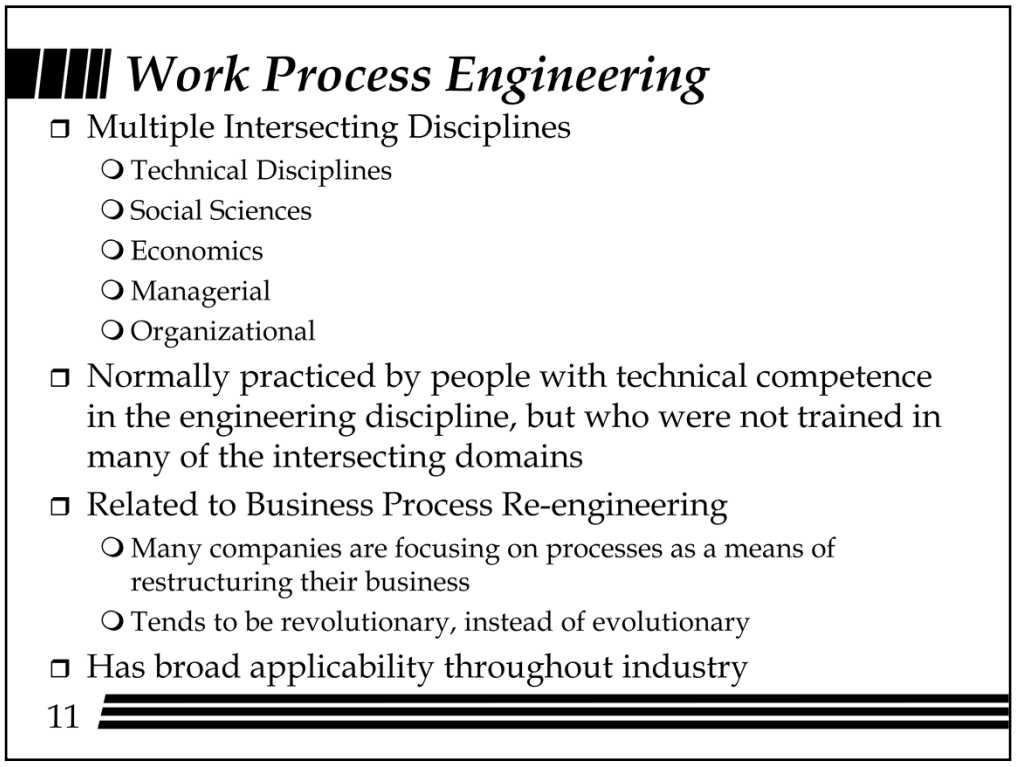
In this part we are going to establish a framework for thinking about processes. This involves building a ladder from work, through work process engineering and work process science on to the frontiers of human creativity. The framework will allow us to understand the complete context of process engineering.



Process improvement applies to many disciplines. It started off in software engineering, and has now spread to a few other disciplines such as systems engineering. It is applicable to all technical work disciplines. Instead of process improvement, we coin the term **work process engineering**. In this case we mean particularly technical work, but the discipline can apply to all kinds of work. We use the word process because it applies to what and how the work is done, not the end results. And we call it engineering because the training of most of the people engaged in this work is an engineering background, so the approach most likely for them to apply will be engineering rigor. We want to do more than just improve the work; we want to design it to meet multiple intersecting constraints as we do for any engineered system.

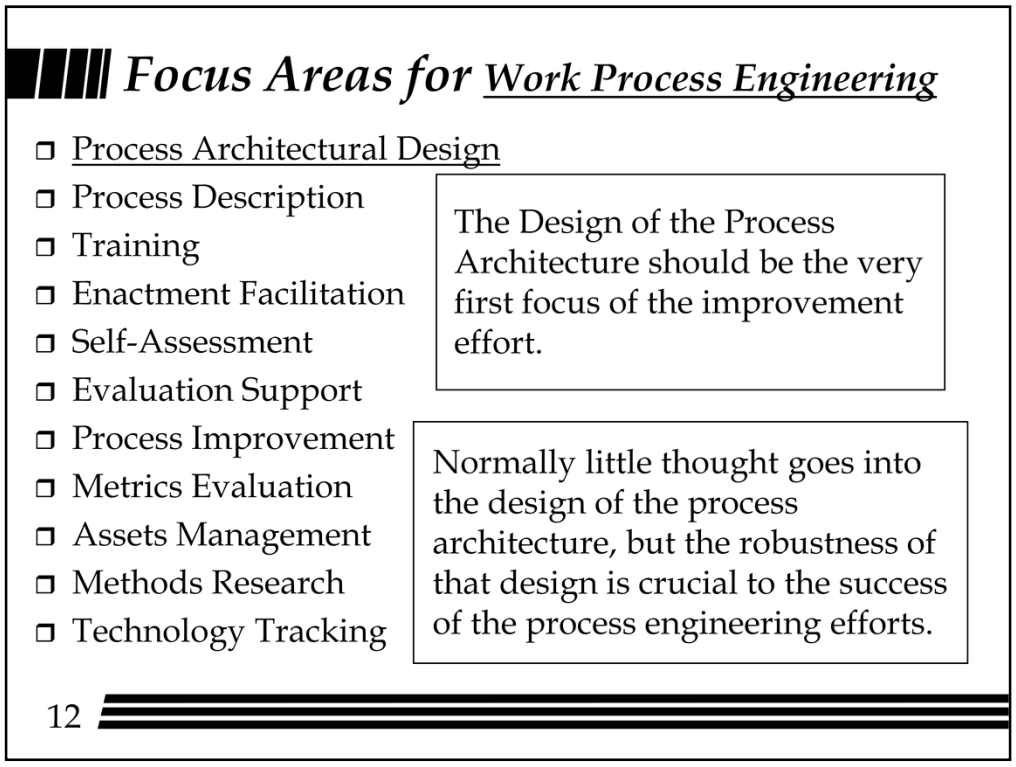


WPE is not tied to any particular discipline. It started off in software but actually applies to multiple technical disciplines. It grew up in industry and is now moving toward academia. Academia is discovering the training potentials associated with WPE. It is also discovering that it is a good way to organize all the knowledge that software engineers need when they work in an industrial setting. It is different from Industrial Engineering that studies and organizes manual labor in factories and Systems and Procedures Analysis which studies and organizes office systems. It concentrates on highly technical engineering work and attempts to apply the same systematic techniques to designing that work as would be applied to the systems that that engineering work would design.

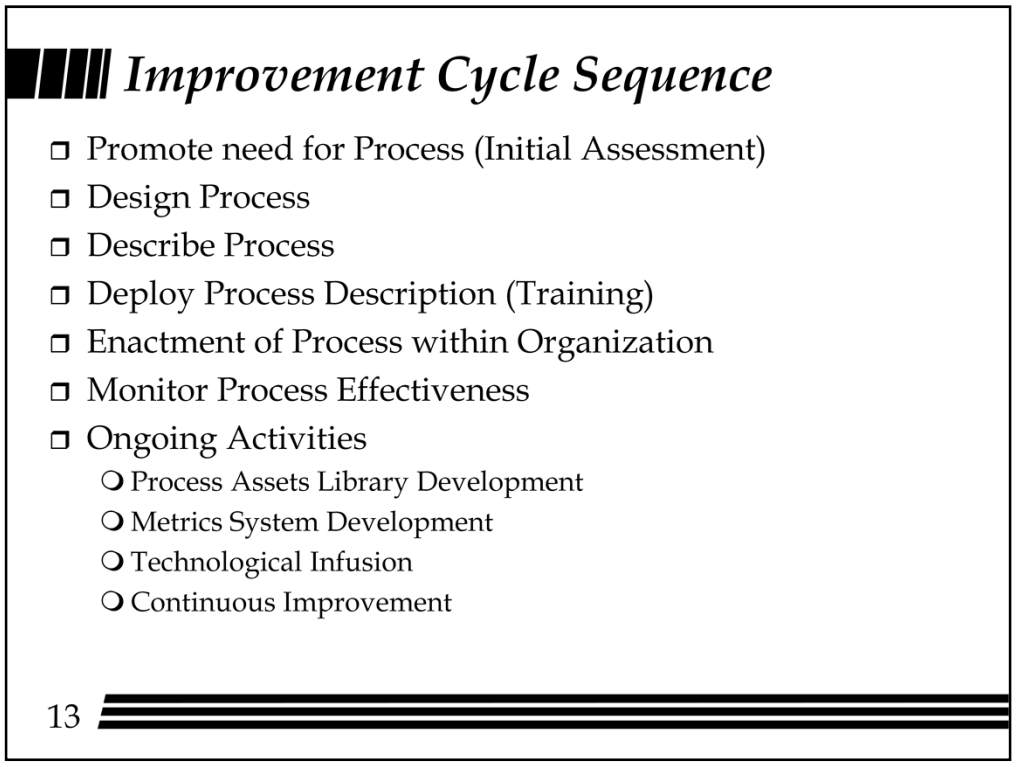


Multiple disciplines come together in WPE. Its practitioners are normally people with engineering backgrounds so that they are not trained in other disciplines -- especially the social sciences that play such an important role in WPE. It is related to Business Process Re-engineering but tends to be more evolutionary rather than revolutionary. It is not attempting so much in restructuring the enterprise, as it is attempting to describe what is being done and adding a few key practices to make what is already done more effective. WPE has a broad applicability throughout industry wherever technical work is done, and actually subsumes Industrial Engineering, Systems and Procedures Analysis and Business Process Re-engineering under a wider discipline that studies and attempts to improve work of all kinds.

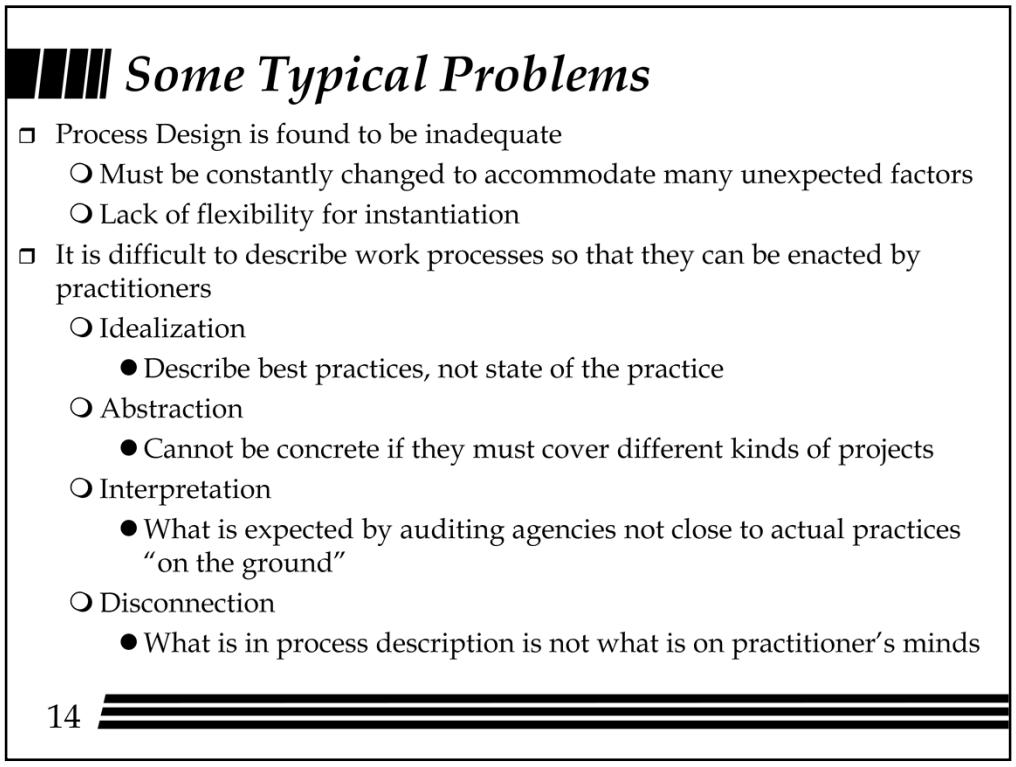
See Lon Roberts Process Reengineering (ASQC 1994)



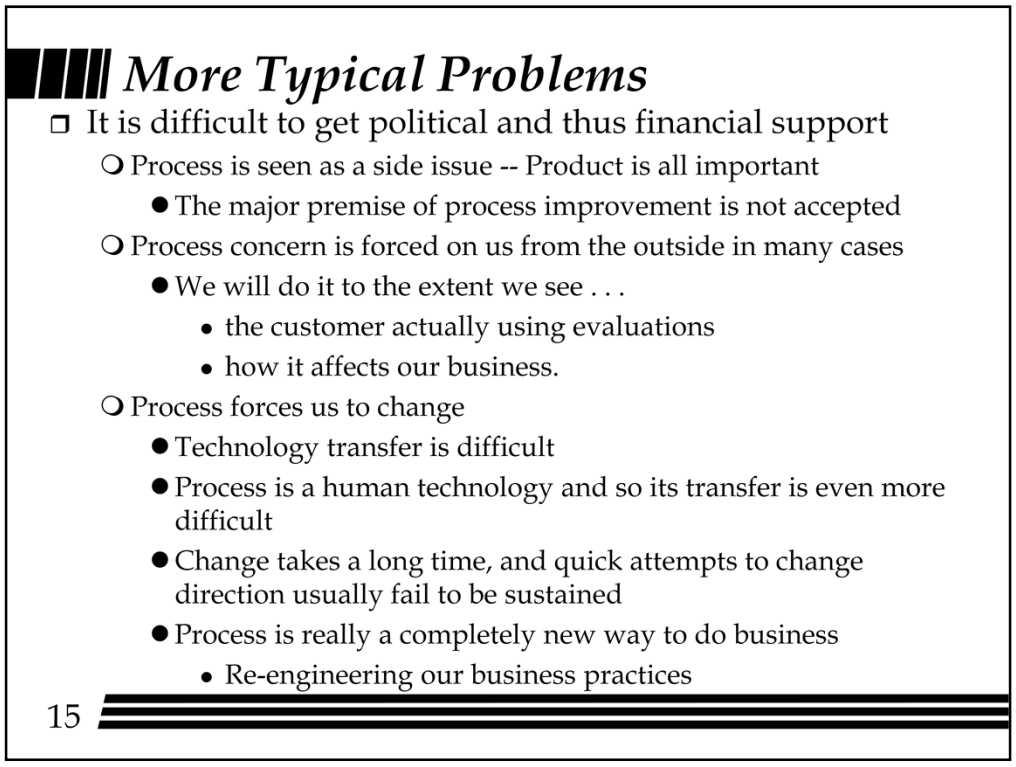
If there were KPAs for WPE, then this might be an example list. Note that the design of the process itself is at the top of this list. Like any other system, work processes need to be designed -- and we must begin by designing the way we describe work processes so that it can apply to all different kinds of work. Most of us have already thrown some kind of process description together and perhaps wished it was designed differently when we began to deploy it. Here we will go back to the very first thing and look at the design of Work Process Descriptions again though the eye of experience. Normally, little thought goes into these designs the first time through. But it is the robustness and resilience of these designs that is one important factor in the success of WPE efforts. We will concentrate on that one factor in this briefing. There are other factors besides Process Description design, but here we only have time to study this one factor in detail.



This is a typical improvement cycle that we have all gone through. Notice the step of designing the process. Normally, that step is skipped over without much attention or consideration of alternatives. In a large corporation, however, many different architectures are tried and this talk comes out of the debates that led to a few designs having prominence out of all the possibilities. In those debates many different alternatives were proposed and won adherents. But over time, we realized that there were just so many possible designs and we will explore what is common to these designs, as we survey the field of possible process architectures.

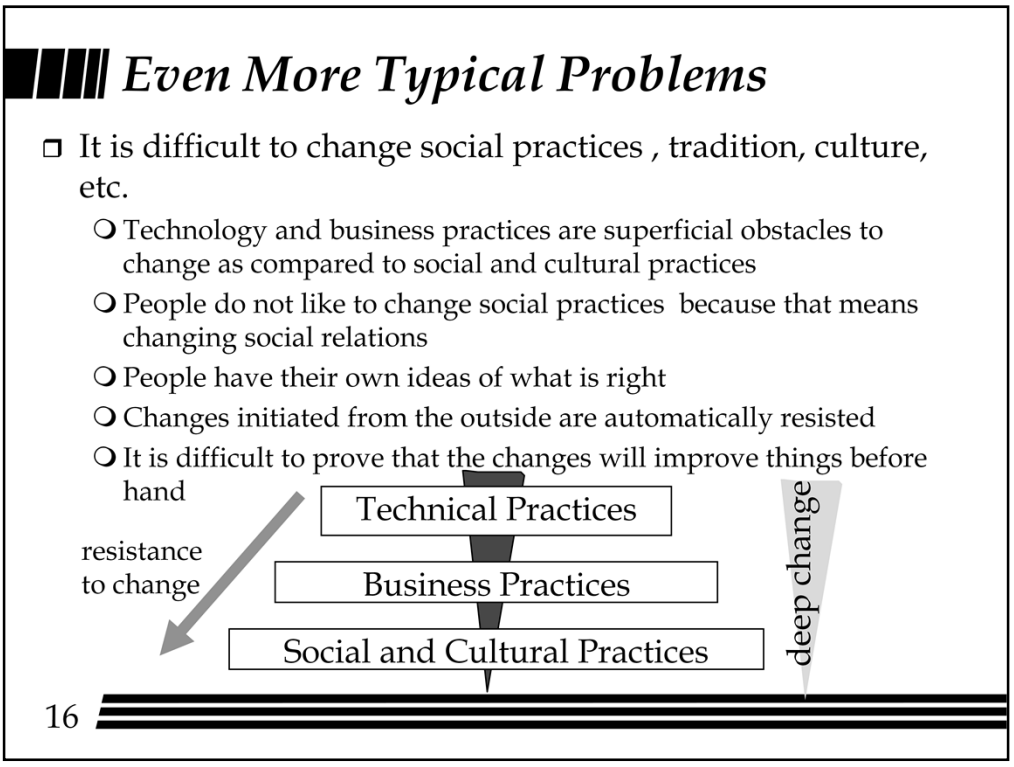


Since we have mostly been through the process of designing, describing and deploying processes, we can look at some of the typical problems that occur in process engineering. One of the significant problems is when the process design is found to be inadequate when we are in the process of enactment. This is very difficult because process descriptions are hard to change -- just like software is hard to change. A redesign of some crucial part of the process can take time and be very costly. Normally we try to live with the problems rather than redesign the work description. But anomalies pile up, and eventually we need to correct the the problems -- just like a software system that can be maintained only so long before it is redesigned and completely re-worked. Hopefully this briefing will bring up some important points to be considered next time you redesign your work process descriptions. Some of those problems are the idealization of the processes that describe not what is done, but ideal practices. Another problem is abstraction. Process descriptions need to be at a high level of abstraction to cover many projects within the organization. Yet another is the problem of interpretation where different people looking at the same aspect of a process could interpret it in completely different ways. Finally, there is the problem of disconnection where what is the focus of the process is something completely different from what is in the practitioner's mind when he is at work.

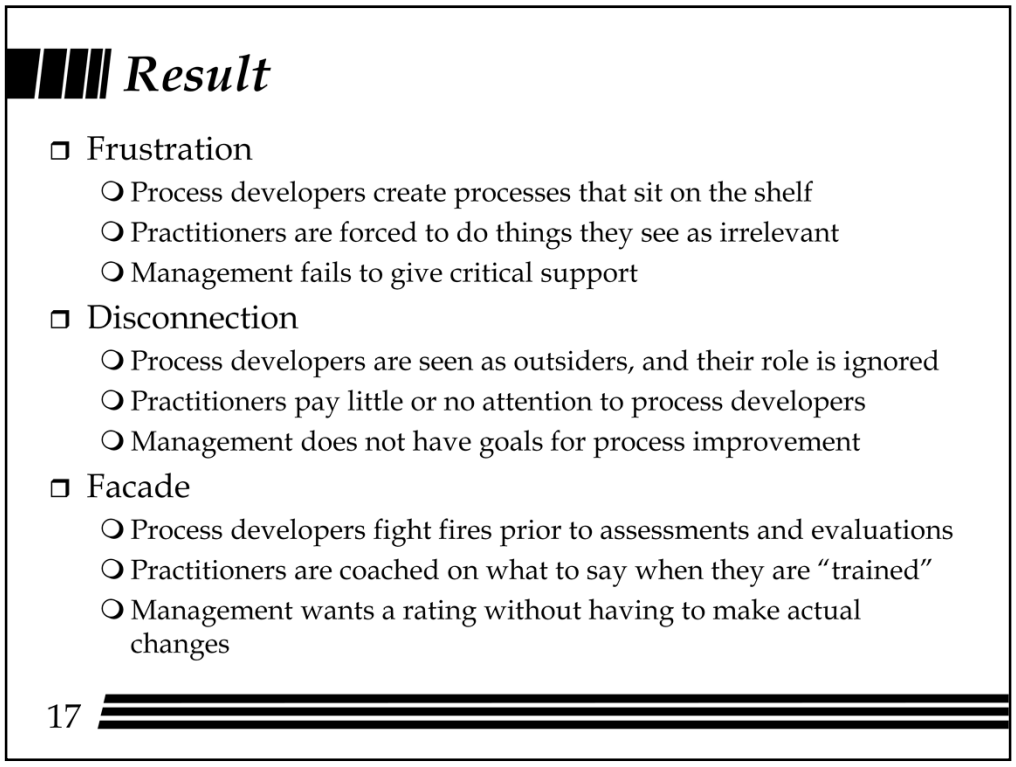


It is difficult to get support for process activities. Basically process is seen as something external and unnecessary by both management and practitioners, and if it were not for external pressure, probably none of us would be doing this kind of work -- or at least not to this extent. Many people do not accept the premise that improving process improves the quality of the product. Many people think that that can only be done by hard work of very bright people. Processes Improvement efforts force us to change, and people do not like to change. Technology transfer is difficult even when the people want the new technology. But when people are being forced to change, they naturally resist. Since process is a human technology, i.e. a technology that applies to the norms of behavior of managers and practitioners, it is even harder to effect change. So these changes we are engaged in attempting to foster are probably going to take a long time and will lead to many failures and possibly few successes. Doing business with processes are a completely new way of organizing and doing business -- it is a radical change even if what the processes call for are not radical. It means that people will have to know what the process is and apply it, and that is difficult. What we see is that normally it is only the younger and least experienced within the organization who pick up on processes because they are a source of knowledge about how things should be done. Many times those who are more experienced resent being boxed in by these descriptions of how work should be done. They realize that the process descriptions are at too high an abstraction to be useful and that handling exceptions is normally the key to

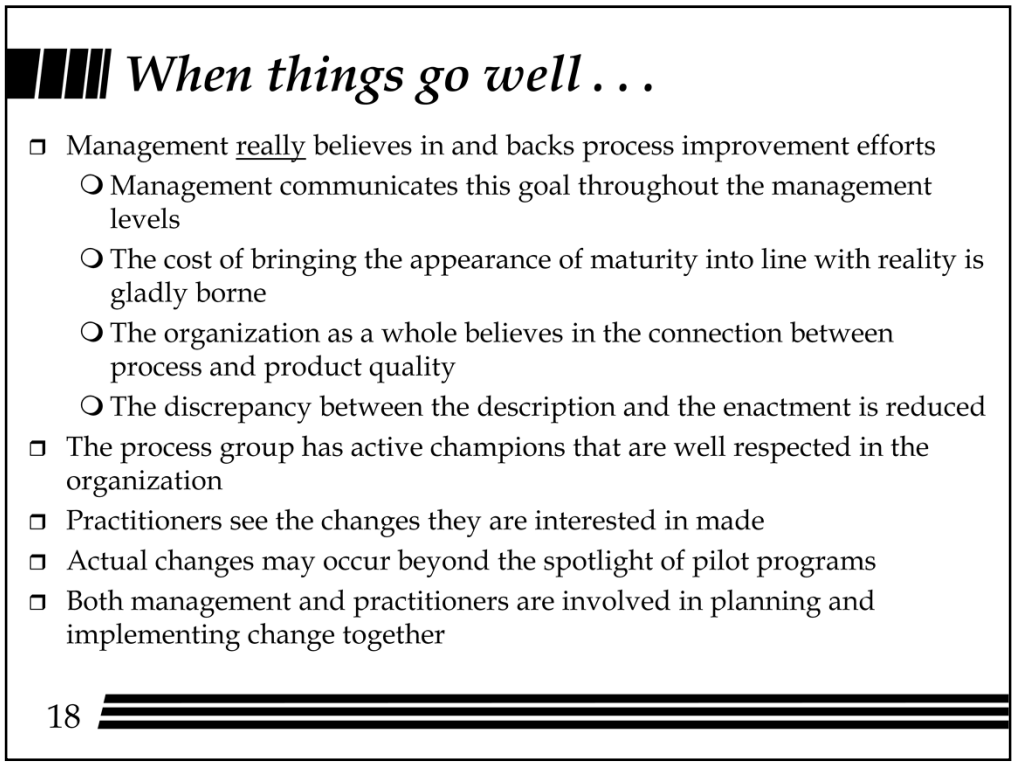
success.



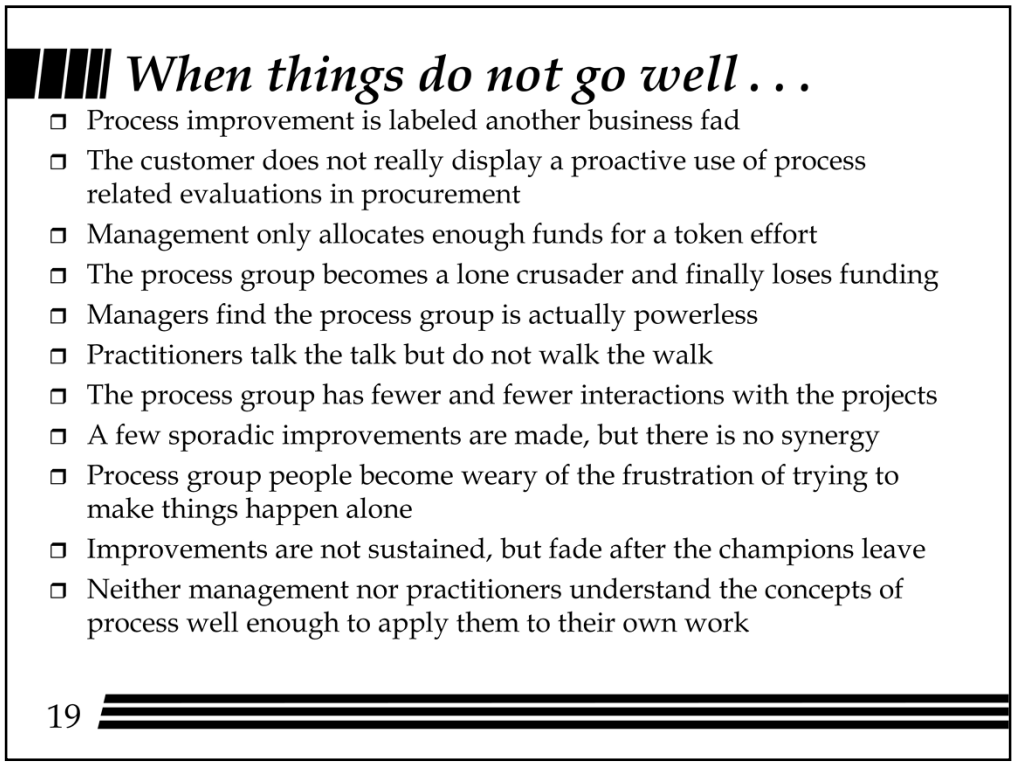
It is very difficult to change social practices and culture. Technological and business practices are superficial in comparison with social and cultural practices. People do not like to change social practices because it causes a change in social relations. Often people have their own ideas about what is the right thing to do, and they do not like to be told how to run their affairs. And it is difficult to prove beforehand that these changes will really make much difference. In fact, the call for proof is the first line of defense. All changes are really made on intuition and hunches as to what will work. There is seldom any proof beforehand, and if there were, it could be easily dismissed. The resistance to change escalates as we go to deeper levels and try to tinker with how things are done. That resistance is basically exponential as we try to bring about deeper and deeper changes. Just the fact that we want people to follow descriptions of work processes is a very deep change. As things stand, people do not operate with descriptions of work. So getting them to follow descriptions in areas that were discretionary traditionally will be very difficult.



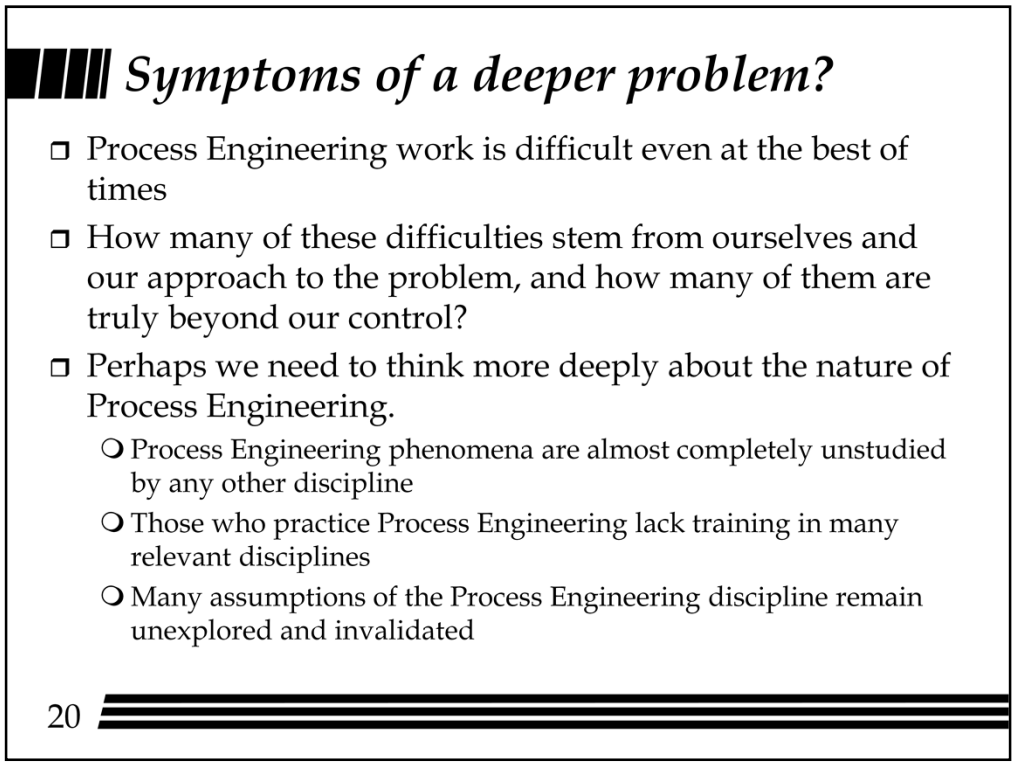
The result of these problems is frustration, disconnection, and the construction of a Facade. The frustration is felt on the part of the process developers, the practitioners and the management. Likewise, the disconnection is felt by everyone concerned. So normally the organizations settle for superficial changes that give the facade of higher maturity without actually changing the way business is done.



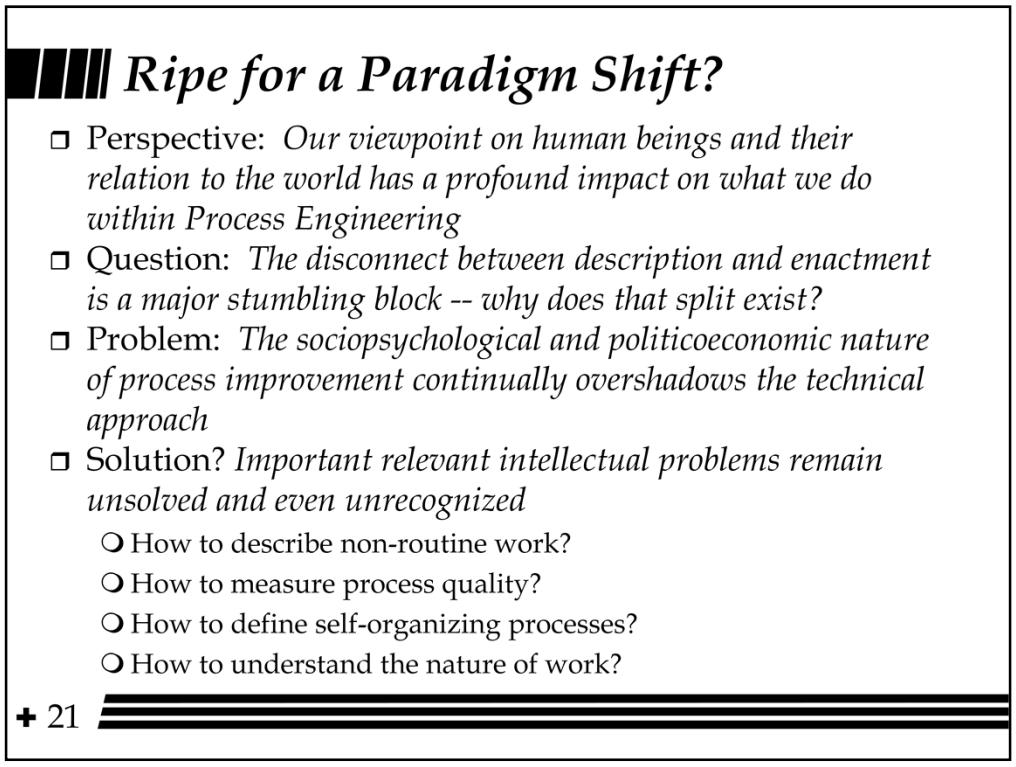
We can look at what happens when things go well. Everyone gets on the band wagon . . . and we get what every process group desires above all else --"management support." But just because management is supportive, does not necessarily mean that any lasting changes will occur. Changes are difficult to make even if all the parties are fully cooperative. And the kind of change we are talking about where people are asked to refer to process descriptions as they are working is a fundamental change for technical people who might feel that their work is being reduced from expertise driven to over-simplified descriptions. If we want them to use these descriptions, they need to be unobtrusive and based on tacit knowledge of how things work in a particular firm. The very process of instituting a description is a threat to the way they conceive of the prestige of their positions. So if the process descriptions do not help them, then you can expect people to be hostile. Besides remuneration, the freedom that technical people feel that they should have in solving their problems is a major component in their job satisfaction. So in introducing process descriptions, we are taking a chance that this new way of doing business will have a high enough pay off to offset the possible damage that they may cause.



But many times things do not go so well. In fact, there are many pitfalls in this kind of high profile work of trying to change our organizations. We can list almost an infinite number of problems that can occur. We run into these problems mostly because we are trying to proceduralize high prestige work within our organization. There are many people who, by cooperating have nothing to gain and everything to lose from their point of view. Therefore, we are almost assured of getting apparent compliance which turns to resistance the moment we walk out the door. Sometimes they do not wait for us to leave, but heap on us all kinds of abuse because we are the bearers within the organization of initiatives forced on us from the outside. However, occasionally we will see someone who is glad to get a procedure which serves as guidance and a reminder for what needs to be done. This rare individual who wholeheartedly embraces process improvement makes our thankless work worthwhile.



The question is whether the fact that process improvement is difficult even in the best of circumstances is a sign of a deeper problem -- a problem with the whole idea of using process descriptions to channel work. Perhaps it is our approach to the problem as instigated by SEI that is the source of the difficulties. Perhaps we need to rethink our ideas about work and its description. This would call for a paradigm shift -- or something even deeper -- an episteme shift. Epistemes are levels underlying theories and facts even deeper than paradigms. We must admit that the whole area of process engineering is almost completely unstudied. Those who practice this new discipline are not trained in many of the relevant disciplines. And the assumptions underlying the disciplines are almost completely unexplored. Therefore, if we probe the underpinnings of this discipline using some guidance from the social sciences, we are likely to discover many ways that it can be improved. In fact, we might find that if we take a radically different approach to the field, that our approach to it might be transformed so that it is hardly recognizable any more. I believe that WPE is ripe for such a revolutionary transformation. And because WPE involves multiple disciplines, we need a transformation deeper than merely a paradigm shift which usually is restricted to a single discipline. We need a revolution that will touch the many disciplines that intersect in the interdisciplinary WPE -- that is called an episteme change.



It is our paradigms that give us our basic approach to the WPE discipline. Paradigms are assumptions that organize in advance how we look at things within the arena of WPE. It is our epistemes that give us the categorizations upon which the assumptions are based. Within WPE there is a basic dichotomy between the work process description and the enacted process. We need to look at our assumptions about work and its relation to non-work. We need to look at the category of work and attempt to gain a deeper understanding of it. By looking carefully at what work is, we can begin the work of revolutionizing WPE. Part of that process is understanding the social, psychological, political and economic web of process. Scaachi and Kling developed the Web perspective which considered all the interacting elements of the work setting in their landmark study "The Web of Computing." That study considered how computers were actually used in the workplace. We need to extend that approach and bring all the supporting techniques from the social sciences to bear on the web of process. In this regard, there are many important intellectual problems still to be resolved. I only list those that this tutorial will attempt to explore. It is strange, but sociology and the other social sciences have had almost no participative studies of engineering work. Thus, there are few explicit studies to help us. But there are many resources that may be brought to bear that have been developed within the humanities of which those that do not have a training in that area would not necessarily be aware without special study.

What is a Paradigm Shift?

- Thomas Kuhn introduced the term "paradigm shift" to describe scientific revolutions
- Revolutions must be seen in contrast to what he calls "Normal Science"
- Normal Science uses a shared "paradigm" or set of underlying assumptions about the world to guide research into the nature of things
- As Normal Science proceeds, anomalies pile up as counter assumption examples which are ignored by the research program of normal science
- Occasionally someone will reformulate the assumptions of the discipline in a way that explains the anomalies and causes new problems to open up for research
- A paradigm shift is when almost everyone accepts the new assumptions

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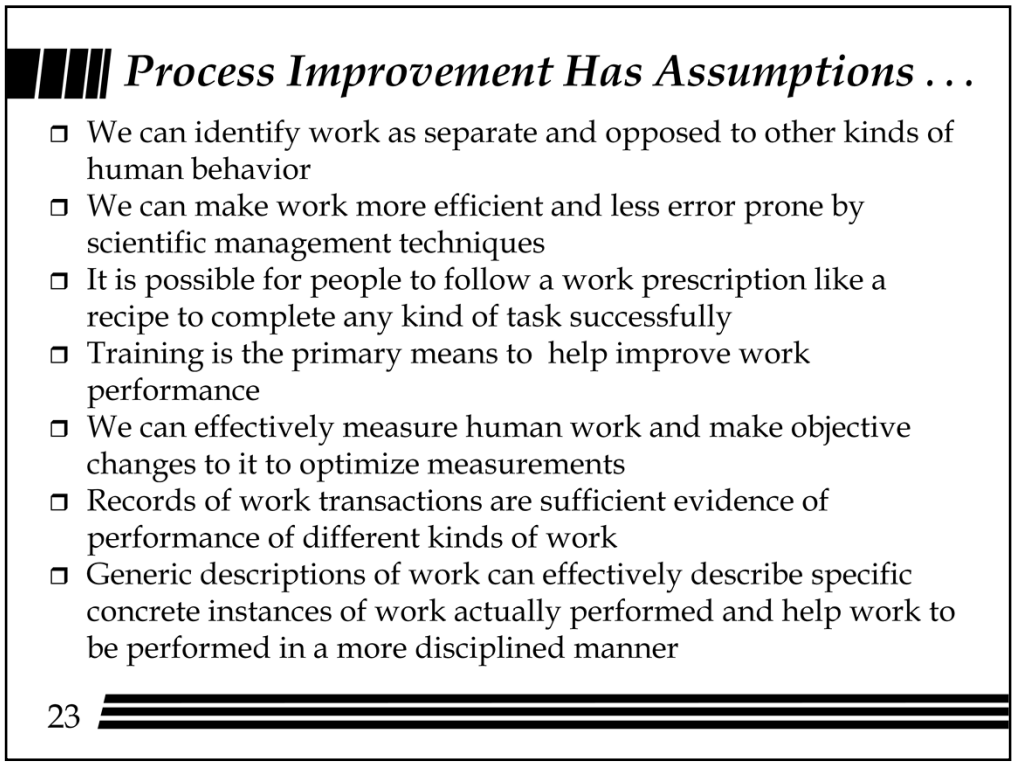
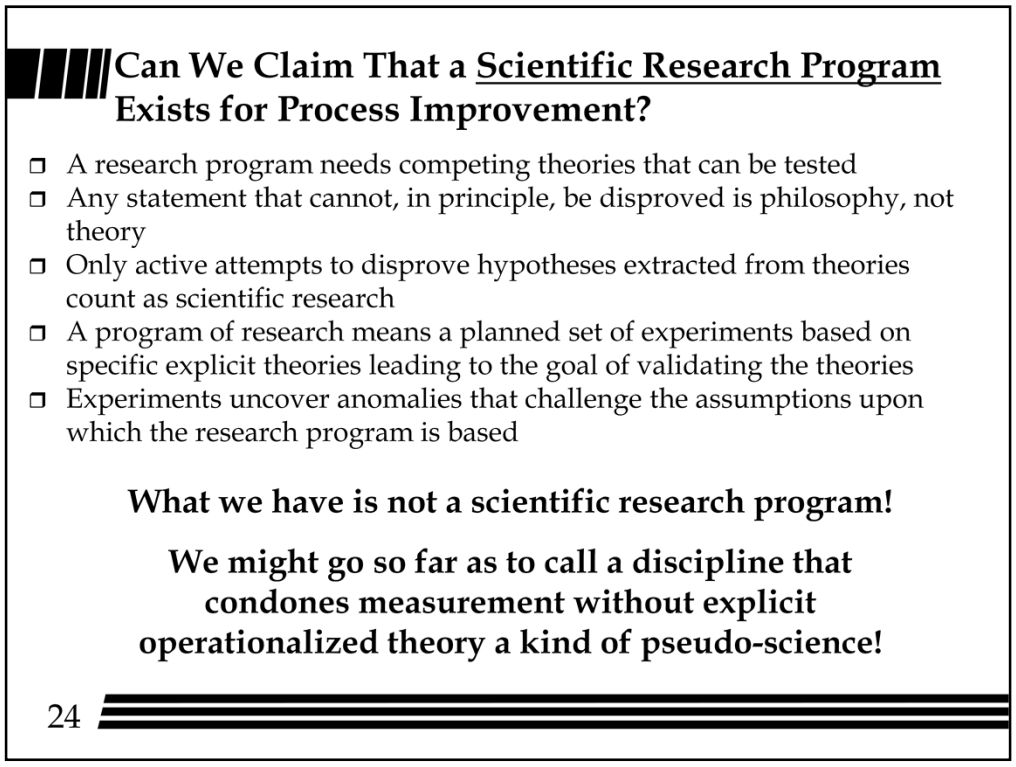
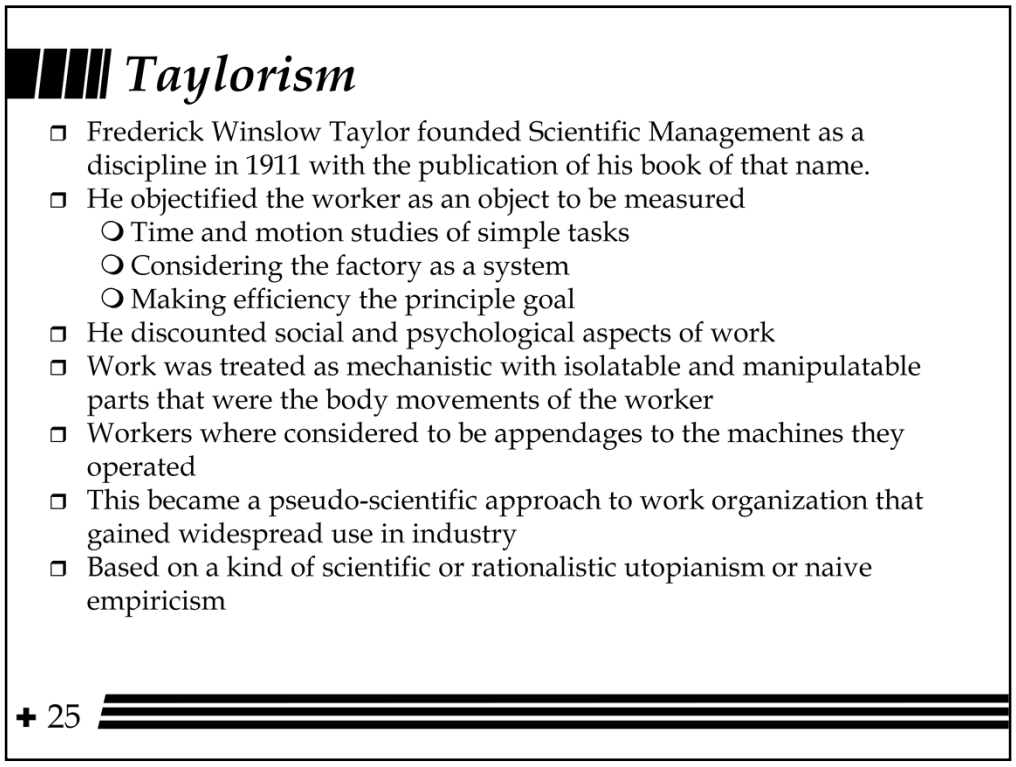
We will first consider what a paradigm shift is before we attempt to understand the more basic epistime shift. It was Thomas Kuhn in The Structure of Scientific Revolutions who first brought this term to prominence. Since that time, it has been used and abused in may contexts. It is best to stick with the original usage that contrasts normal science to the revolutionary science. Normal science based on its assumptions, promotes a research program within limits dictated by the current paradigm. Process Improvement as fostered by the SEI has a lot of similarities to normal science. It does not look at anomalies, but brushes them off to the margins. However, as these anomalies increase beyond a certain threshold of credibility, then we are pushed into a situation where the assumptions grounding the normal science paradigm might be swept aside by a single stroke. This is called a paradigm shift where new assumptions, replace the old assumptions and we find a completely different way to look at the subject matter of our discipline.



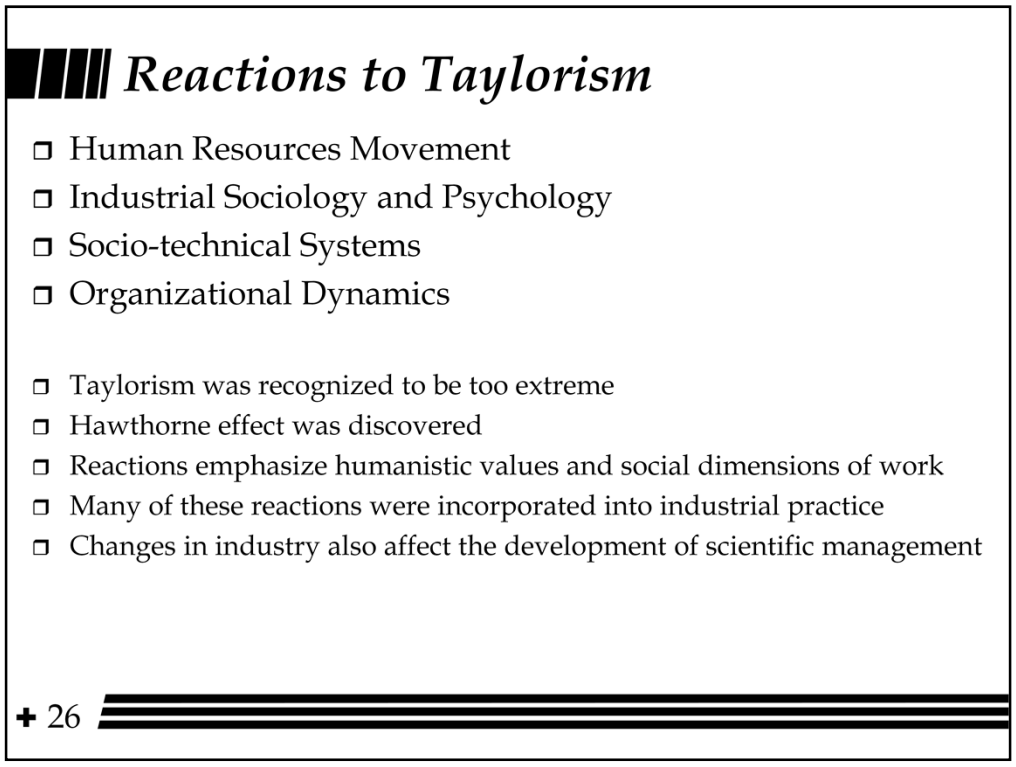
Here are some of the possible assumptions upon which our view of process improvement might be said to be based. We could single out any one of these assumptions as something that might be tested in order to see if we could find a way out of the straightjacket of the assumptions that underlie the normal "science" of process improvement initiatives as they stand today. The real question is, what is the most fruitful avenue for the exploration of our assumptions? We do not intend to overthrow the old paradigm just for the thrill of change. Instead, we are looking for some approach that will shed greater light on the subject matter of our field. And again, we note that this field is interdisciplinary, so really we are talking about a change that would affect multiple fields at once. We are looking for a deeper change that will give us a means of progressing further in the goals of the WPE discipline.



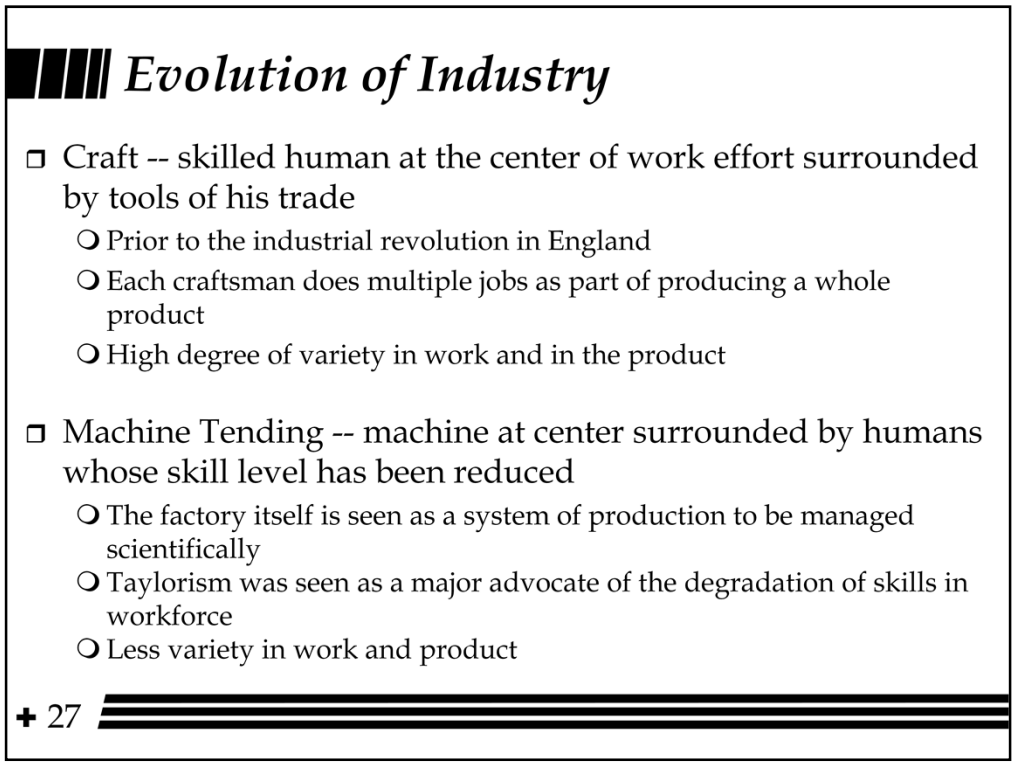
Certainly, it is clear that this comparison between Process Improvement initiatives and Science is not the altogether a good analogy. Process Improvement is not so much like a science as a pseudo-science. The main reason to say this is that this discipline of ours does not formulate theories and then advance hypotheses to be tested. Instead, it has a single underlying premise that measurement can be used to improve human work the way it has been used to improve the workings of chemical plants or assembly lines. There are not multiple competing theories of the nature of work nor of how to improve it. Instead, there is the assumption that describing work and then using these descriptions as a basis for measurement will be efficacious. These are all statements of philosophy, not theory. Theories must be stated in a way that they can be disproven in order to count as real theories within a scientific regime. Everything that cannot be disproven is merely philosophy. Therefore, we can say that this discipline of Process Improvement is, at best, a kind of naive empiricism or positivism which believes that facts are independent of the observer and that by measuring facts objectively, we can change the way things work out in an objective world like we would work with some machine, some processing plant, or assembly line. It has been clear in the humanities for some time that we cannot turn the instruments of science against ourselves with the same effects as we have when we turn them against nature. Not recognizing the limits of scientific methods and techniques within the humanities is an error that has been made many times in the past.



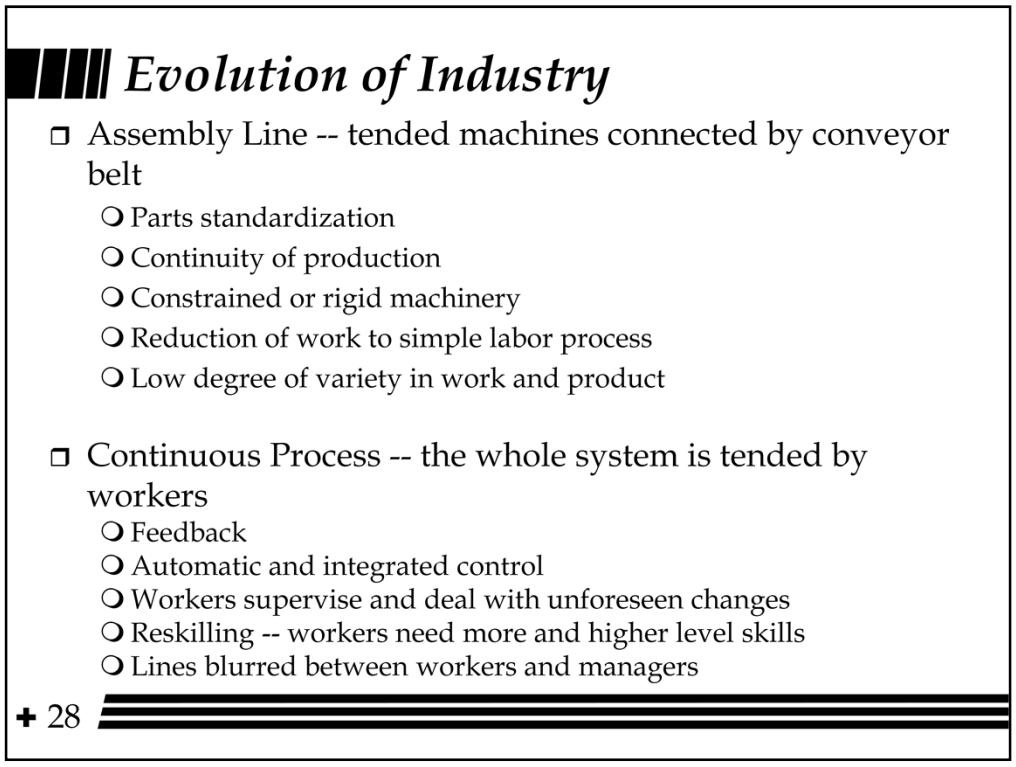
Process Improvement has its roots in Scientific Management in developed by Taylor in the 1920s. This movement was the first to attempt to apply scientific methods to work. Taylor attempted to completely reify workers and their movements, reducing them to objective series of measurable movements. He tried to look at a machine shop as if it were a system of integrated movements that could be measured and arranged at will. We may liken this use of measurement of human action to phrenology which used the measurements of human anatomy to categorize types of human beings. In such a naive empiricist discipline there are some broad unproven assumptions that lead to measurement for its own sake, but which grossly fundamentally misunderstand the nature of the thing measured. In the case of Taylorism, what was misunderstood was the social and psychological nature of the person being measured. We are the ones measuring and being measured. In such a case, measurements take on a completely different meaning than they do when we measure physical things. As in quantum physics, the very act of measuring changes the nature of the thing being measured. Not recognizing this basic problem with measurement of human behavior has led to the excesses of Behaviorist psychology that attempted to reduce all human behavior to stimulus and response causal effects. Scientific Management at its extreme falls into exactly this same kind of trap.



There were many reactions to Taylorism. All of these recognized that this dehumanization of workers was an extreme that needed to be compensated for in one way or another. The most successful of these was the studies at the Hawthorne plant of Western Electric. In those studies, it was found that any change, positive or negative, to the environment of the plant would cause productivity to increase because the workers knew that they were being measured and acted according to our expectations. This is also called the placebo effect in which a substance with no curative powers will cause changes in a patient due to the patient's expectation that the drug will work. These effects are not illusions, but are real effects that occur because our social interaction is extremely important. We cannot reduce that interaction to its behavioral or physical level and still have an accurate picture of the complex of interactions on the social and psychological level that is the context of everything we do. Many of these insights had an effect on management practices, and the reactions to Taylorism had a humanizing effect on business practices. Scientific Management thereby became more sophisticated as well, incorporating many elements of these reactions to its initial extreme dehumanizing position.

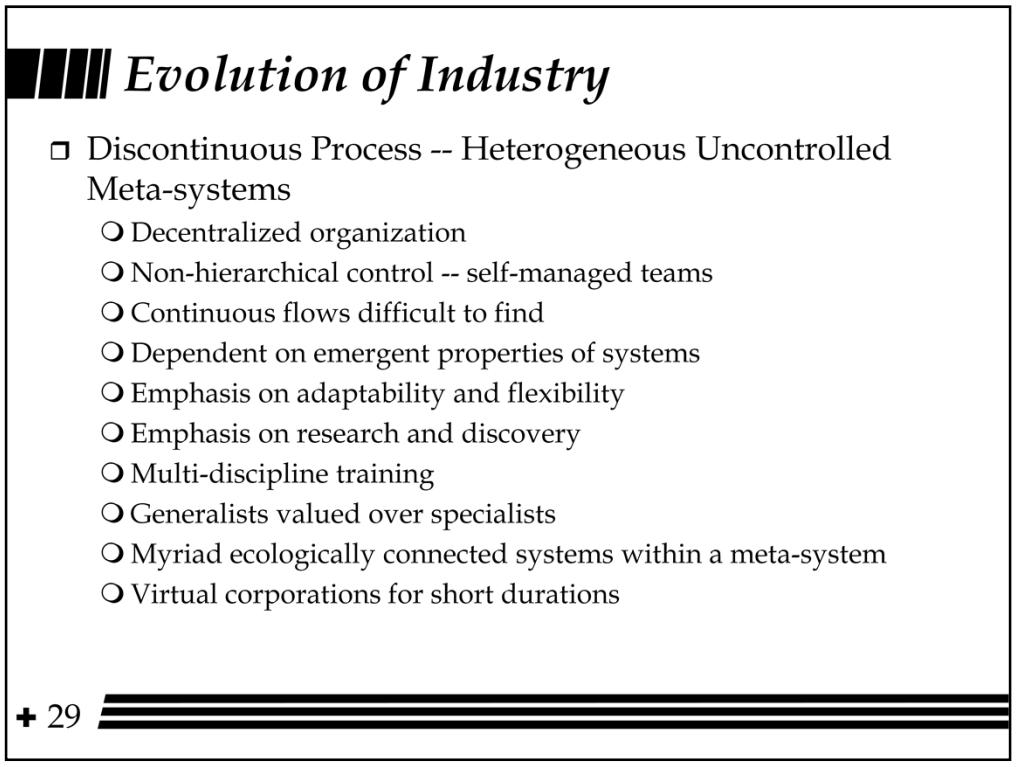


These changes in management practices took place in an industry that itself was evolving. Everyone more or less agrees that we began before the industrial revolution with production based on crafts. When Taylorism came into vogue, crafts were in the process of giving way to machine tending in machine shops. In a craft environment, a skilled craftsman would be surrounded by his tools of the trade. Each craftsman did multiple kinds of work, leading to a whole product which contained a great deal of variation. Each piece was unique. Machining led to an ability to produce a great deal more of one particular thing. But still there was a great deal of variation, and the pieces would have to be custom fit to each other when assembly took place. Standardization of parts began in this period and was part of the obsession with empiricism that led to measuring everything as precisely as possible. But it meant that the machinist only produced part of a product and not the whole thing. So where production was increased, the control of the worker over his product was lost, and that is when labor began to be divorced from the value of the end product. As Adam Smith pointed out, this division of labor for efficiencies sake was the hallmark of industrial growth. It allowed efficiency of scale to come into play that are not realized at the craft level or production.

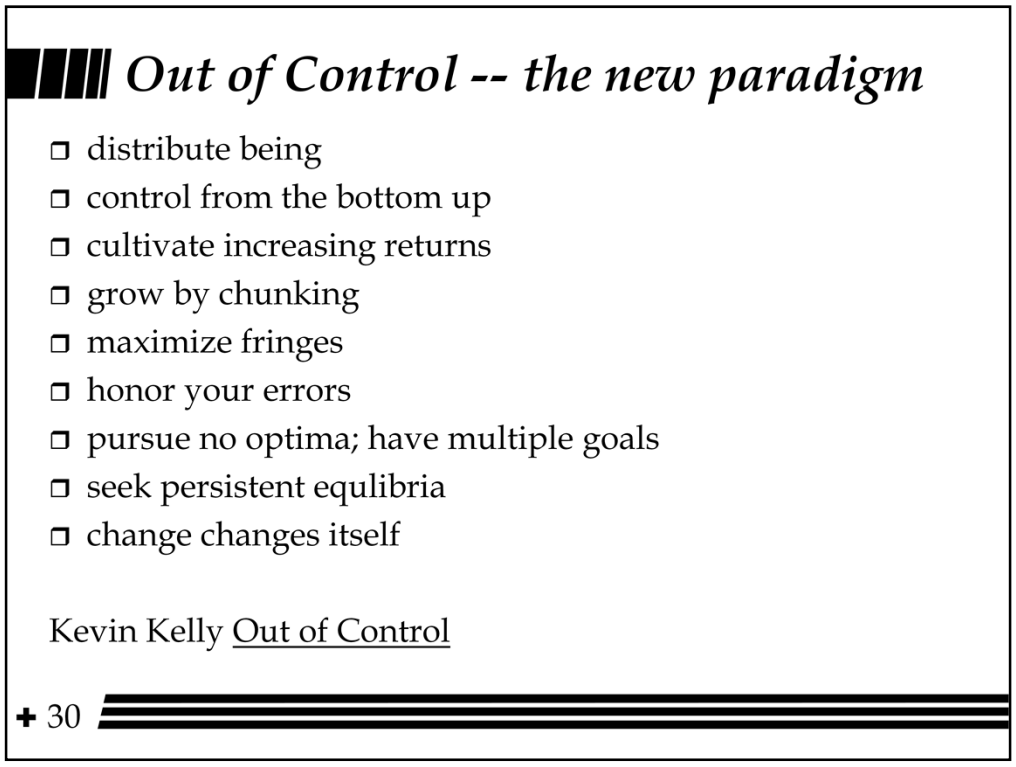


The next major advance was in the assembly line which routinized the production. It was possible because parts had become standardized in the tools as well as in the products. The continuity of production allowed for maximum efficiency of production, but also required that the machines be brought into a specific rigid configuration in relation to each other that was decided on beforehand. So at this point, the factory as a whole had to be designed along with the thing to be built. Work was reduced to its simplest tasks that were repeated over and over by the same worker. Variety in the product was reduced as much as was possible.

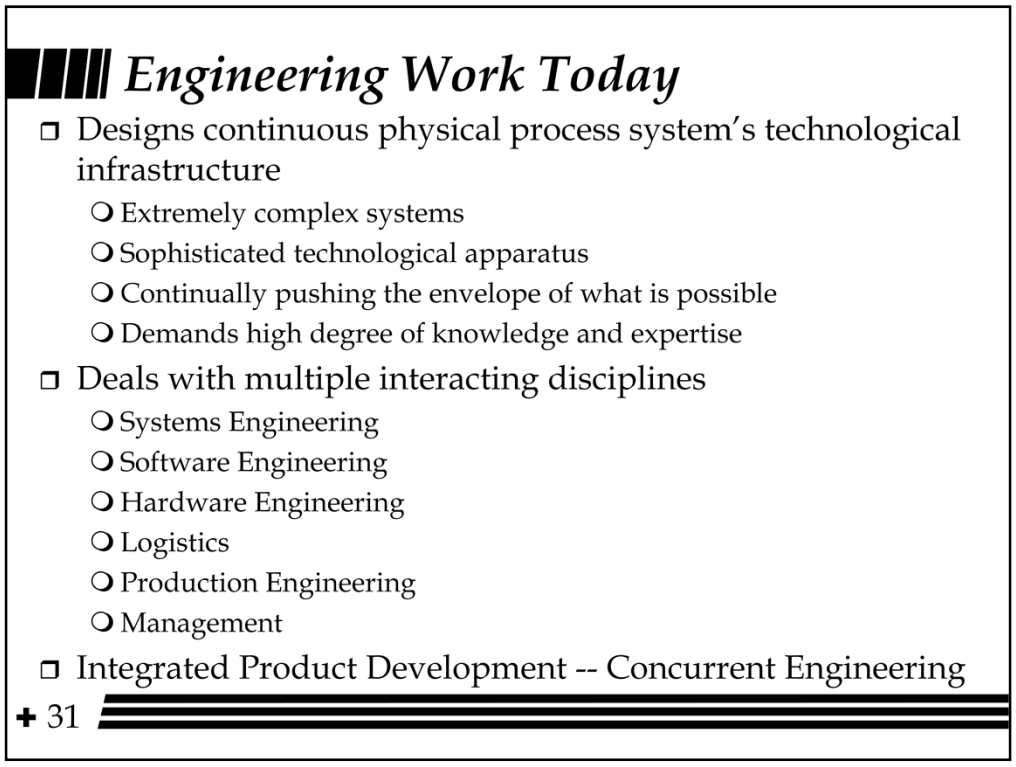
Continuous processes such as chemical plants or nuclear reactors were the next advance in the creation of plants. In such a plant there are processes that cannot stop and which must be continuously monitored by the workers. The workers become more like managers of the system than manual workers applying force or skill. This caused a reskilling of the work force which had to be much better educated in order to run these kinds of factories. Continuous plants are extremely sophisticated from a technological standpoint and need expertise to integrate technologies with a control system capable of keeping such a plant running.



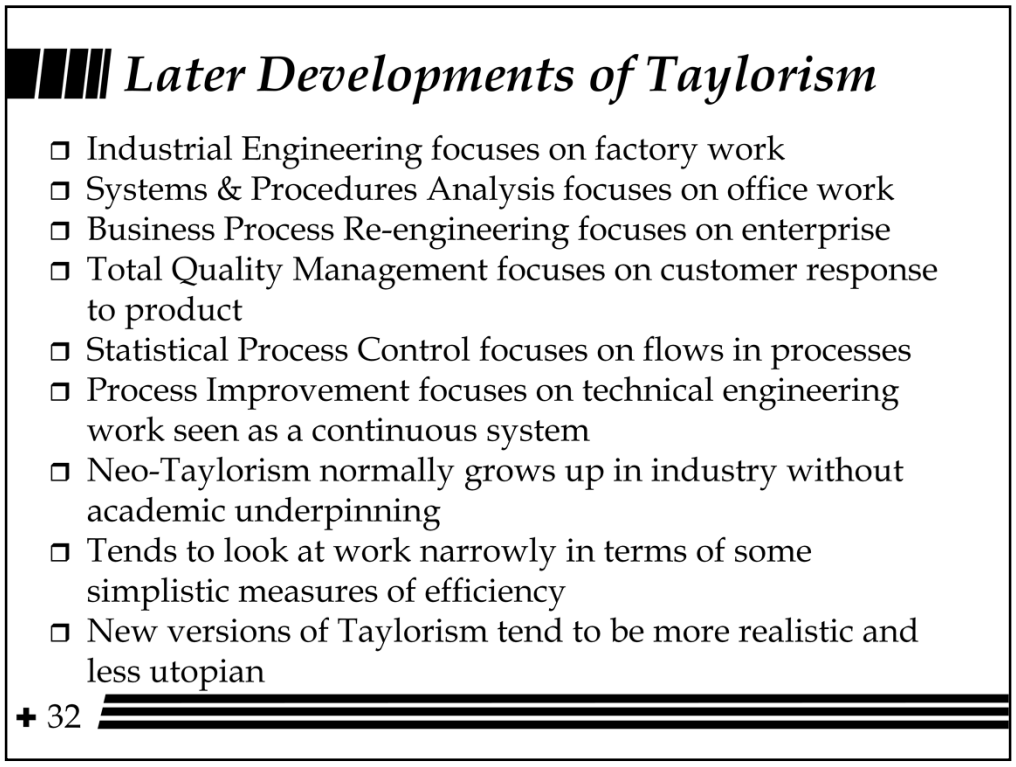
The final stage of this progression seems to be the Discontinuous Process fragmented plant. Instead of the operation being centralized, it is spread out and connected by a communication system. It has elements acting autonomously without hierarchical control. An example of such a system might be the world's stock and commodity trading markets. They all are integrated, but one could not call them a single system. They are, in fact, a meta-system that contains many systems all loosely interrelated and spread out around the world. Another example might be the world's air transportation systems. These are very complex meta-systems composed of myriad systems all working together. As more and more industries become global, there will undoubtedly be many more examples of such meta-systems that are heterogeneous and dispersed rather than centralized and monolithic.



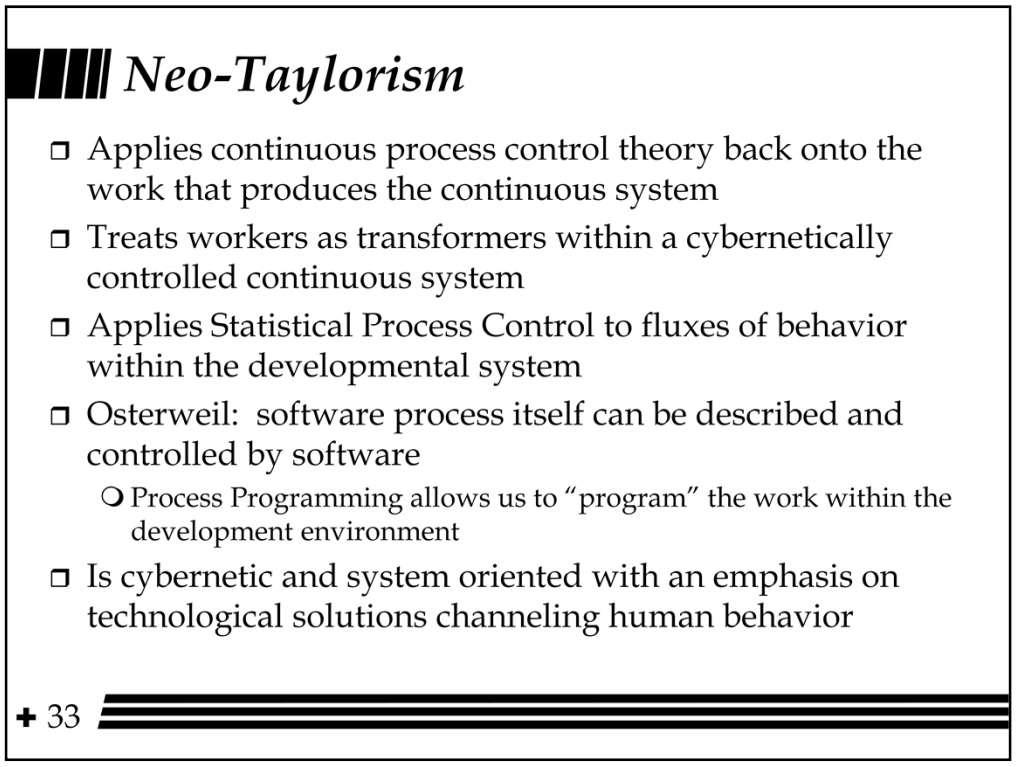
Kevin Kelly attempts to summarize this trend with his nine principles from his book Out of Control. Basically he is turning this trend toward heterogeneity into a positive value based on the indications from the fledgling sciences of Chaos and Complexity. He says that we should distribute rather than centralize and give autonomous control to the dispersed units. We should allow the autonomy to manifest a variety where we can observe what works and then support that. We should grow our systems in stages and maximize their fringes as fractal patterns do. We should realize that errors are mutations in the overall system and may lead to important differences that are productive. We should not try to optimize the distributed systems, but have multiple goals that they are trying to satisfy at the same time so that can be more or less successful based on different criteria. We should not seek homeostasis, but continuously keep the system out of balance as equilibrium means stasis instead of change, and that is the same as death in such a meta-system. Also, every change is a meta-change inasmuch as all changes cause themselves to change. In other words, the Hawthorne effect is a basic fact of reality at the human level, not a strange quirk.



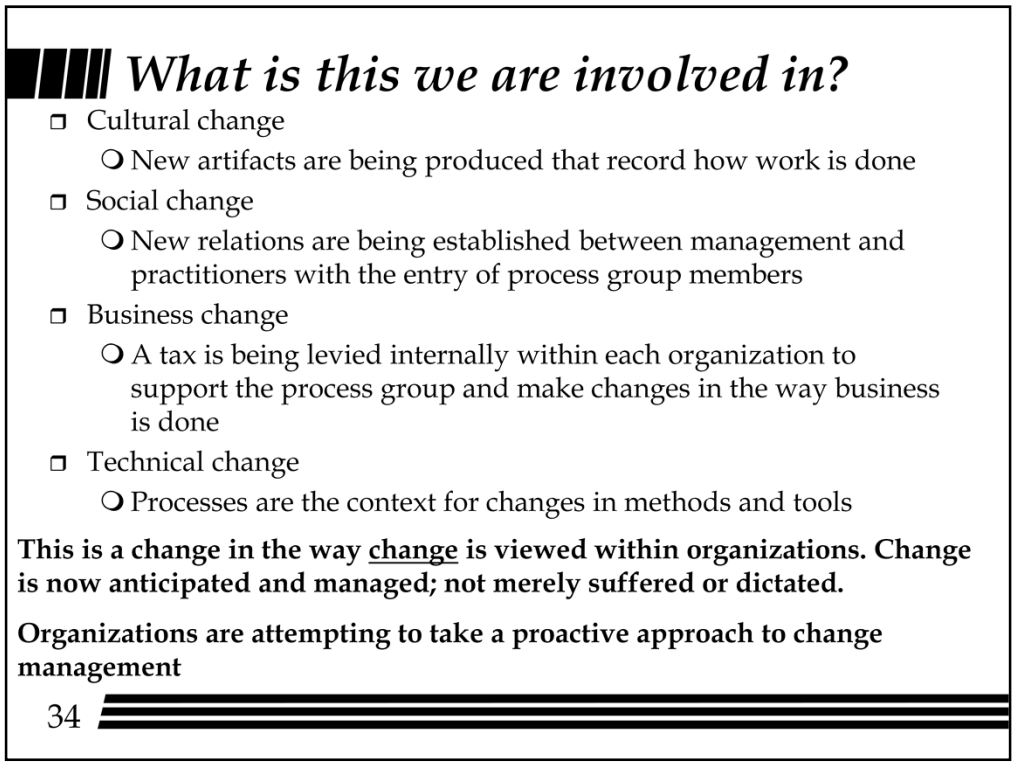
Today Engineering work builds these continuous and discontinuous plants. They are extremely complex based on sophisticated technological foundations in which many different technologies are interwoven into a single manifestation. Our engineers are continuously attempting to push the envelope of what is possible with these systems and meta-systems, and that calls for a high degree of knowledge and expertise. These are some of the most prestigious jobs in our society to be able to build these kinds of systems. And it is these jobs we are trying to describe and channel the behavior of the professionals who do this kind of work. Here we are talking about multiple engineering disciplines coming together to create these systems in an integrated fashion. We are transitioning to concurrent engineering or IPD at the same time as we are trying to get these same professionals to accept the following of work prescriptions. Basically, we are turning the metaphor of continuous systems back on their makers. We are treating the makers of continuous process plants as if they were themselves continuous processes that can be controlled and channeled like the chemicals or assembly lines or other kinds of continuous processes. But perhaps they resemble more the discontinuous processes described by Kevin Kelly. Perhaps our paradigm that we are applying to understanding technological work is already out of date.



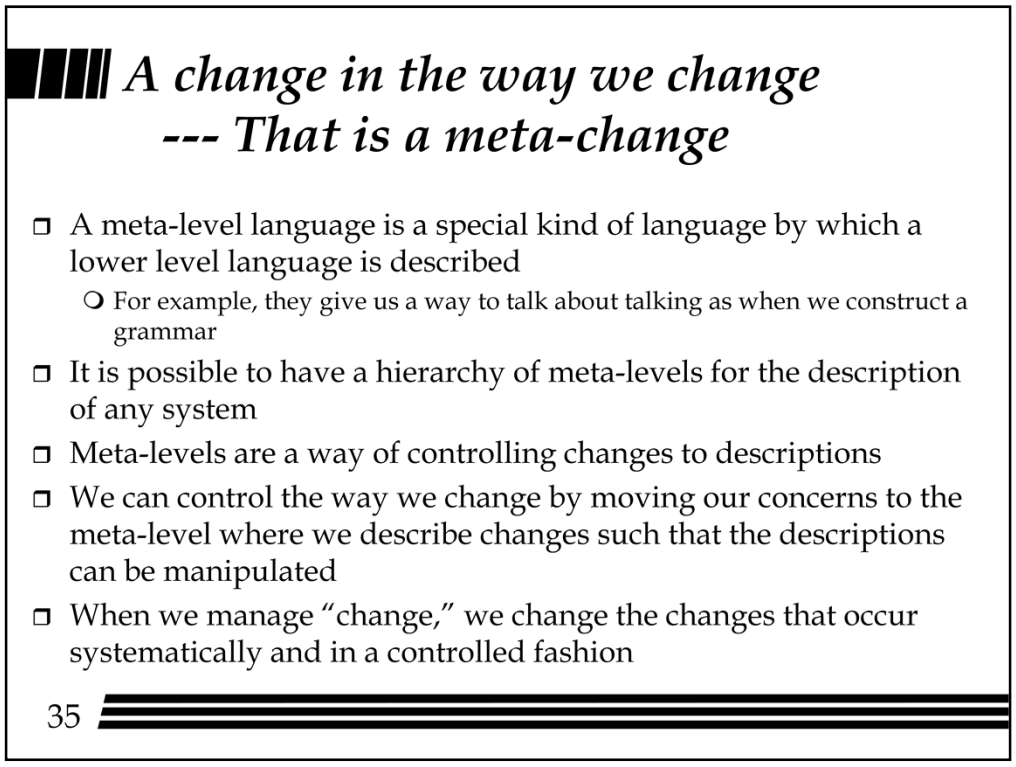
Taylorism has several latter day manifestations that are more sophisticated than the earlier naive attempts to dehumanize workers. Some of these latter day forms of rationalization of work are mentioned. Here we are most interested in Process Improvement which is an invention of industry. It has no academic underpinning in social sciences, but is an invention of those who would use measurement to improve things, making them more rational and efficient. So the basic motivations are the same as the old Taylorism. Only the means has become more sophisticated. Still in order to measure ourselves, we must become reified. In this case, the reification is the reduction of our work to descriptions and proscriptions. Since we are not measuring manual labor, for the most part, there is no question of reducing the workers to their mechanical movements. Instead, there is an instrumentation of the workflow which will allow it to be treated as a continuous process. Its discontinuous processes are ignored and called ad hoc or chaotic and treated as signs of immaturity. We draw invisible lines in these continuous processes and then measure the process as a whole using statistics. This should allow us to get a global picture of normal behavior of the entire system and optimize various parameters statistically. It has worked on Japanese assembly lines -- should it not work on “software factories” as well?



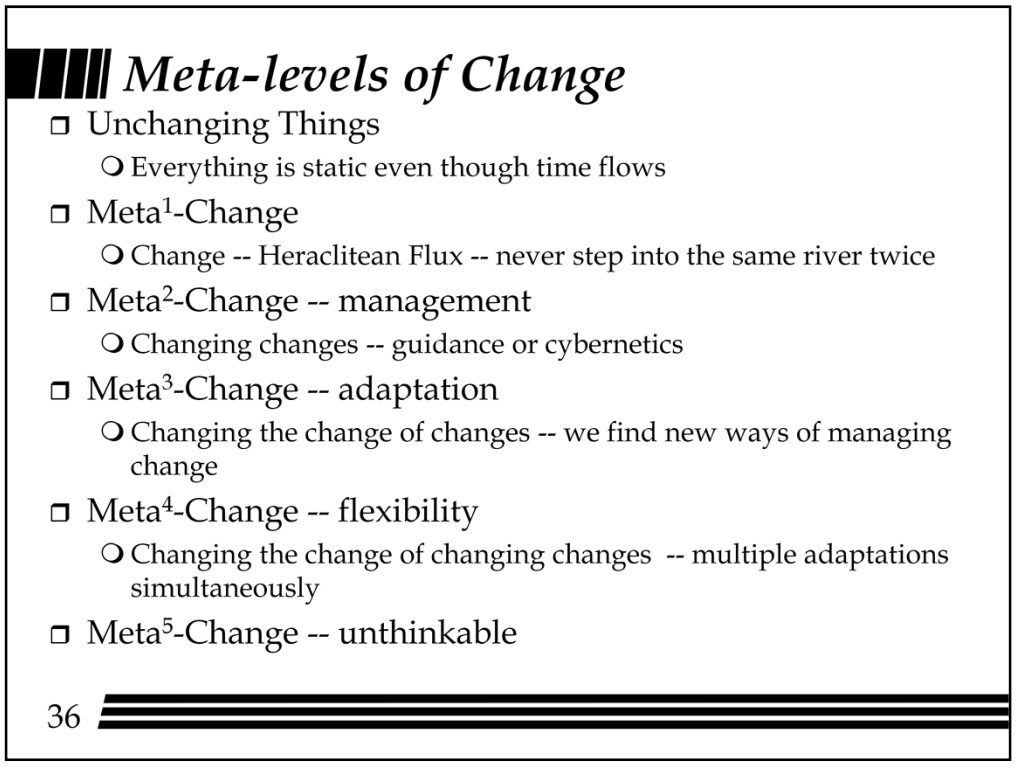
When we take our artifacts and then see ourselves as a mirror reflection of those artifacts, we are committing a fundamental category mistake. In order to be the creators of continuous processes, we must have some surplus over and above what those systems contain. There must be something about our make up that is more complex than our most complicated artifacts. If nothing else, we can point to the brain. We do not understand how it works and may never understand it. We cannot capture ourselves in any representation that we ourselves paint except in the most superficial ways. Neo-Taylorism, for all its sophistication picked up over the years, still has this fundamental flaw. It continues to reduce man to images of his own products and sees him in terms of measurements that he can make of himself, even if we know that these measurements can only be made by reifiying ourselves -- by changing ourselves into something different in order to make the measurement. Statistical Process Control is a particularly sophisticated technique, but it assumes that we can become sufficiently reified and understand the feedback loops in the process sufficiently to make changes that are effective once we have obtained measures. It assumes that the next run of the process will reduplicate the last run of the process so that we will see the results of our changes. Chaos and complexity theory should be enough warning that this hypothesis is probably not true. We have difficulty whenever we reduce ourselves to a system and apply technological solutions to ourselves.



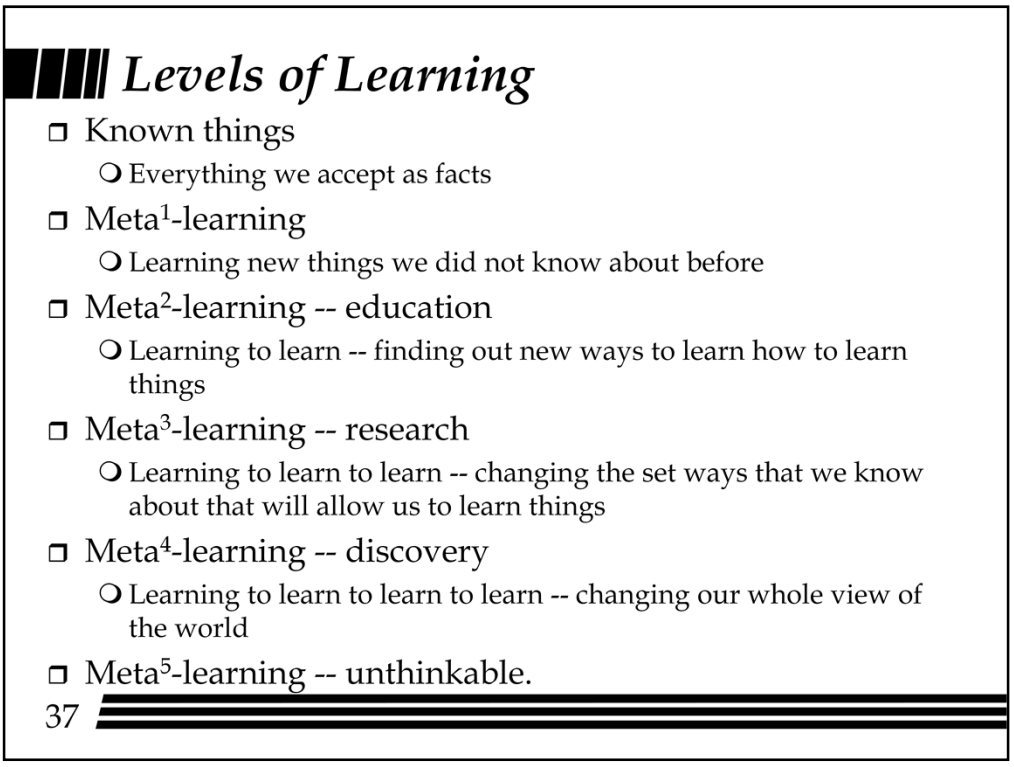
So what is this activity of WPE that we are involved in really all about? If we cannot appeal to science, then what are we really up to? And the answer to that is change at all levels of our organizations. We are trying to manage change instead of just suffering it or having it dictated willy nilly. We are attempting to become Learning Organizations as Peter Senge (The Fifth Discipline) would describe it. Whether Scientific Management oriented Process Improvement is the best approach to this task remains to be seen. Organizations are becoming proactive with regard to change, and that necessarily entails their learning because these organizations are composed of people who are involved in the change process which changes itself. The learning aspect is the positive face of the Hawthorne effect. It means that we can learn and improve what we are doing by making changes in almost any aspect of our organization. So we can expect Process Improvement efforts to have some effect even if they are ill conceived. Whatever we measure will be optimized by the participants. So the lesson of this should be to be careful what we choose to measure. There is no telling what other things will go awry in compensation for the improvements seen in any particular aspect of the process. We need to have a deeper understanding of human processes which does not reify us into images of our products.



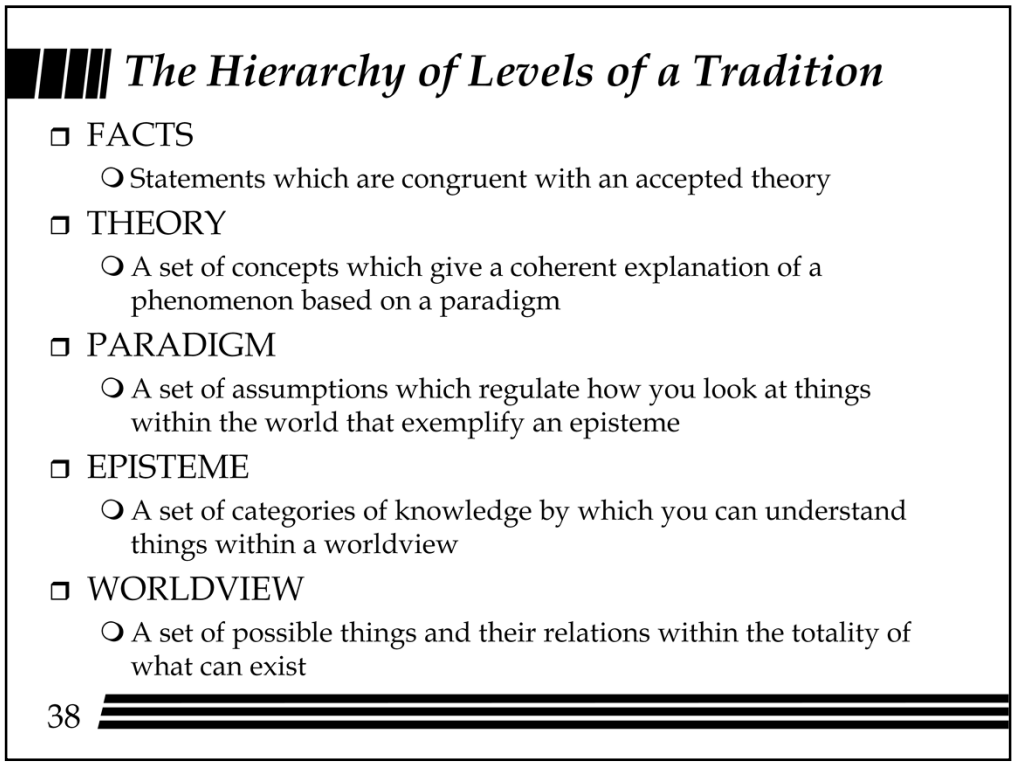
So if we are to appeal to any science, it should be to the human sciences as the basis of our work in improving human behavior. It is only the human sciences that are familiar with the problems of defining and understanding the human. We need to take the Hawthorne effect very seriously. It is precisely the effect of change back on change which leads to paradox. One way to deal with paradox is to use the ruse of Russell of defining higher and higher levels of logical typing. This method ultimately breaks down as well, but at least it allows us some room to maneuver and gives us a way of thinking about the effect of change on change within the arena of work process studies. In this approach, one arbitrarily makes a rule that no class can be a member of itself. Thus, we posit that change is not a single category that can have change as its own sub-component. Instead, we must posit that there is a general category of flux made up of different kinds of changes. A change in one kind of flux may cause a change in another kind of flux, but change itself does not cause change of the same kind. This opens up the possibility of thinking within the arena of the Hawthorne or placebo effects within society. It says that one kind of change, may cause another kind of change but the same change does not cause itself. We may have rings of changes causing other changes that, in turn, cause the same change, but we cannot have perfectly reflexive causation of change causing itself. We then use meta-languages to talk about the different kinds of change, and this way we open up the possibility of discussing what is going on within the arena of human meta-change.



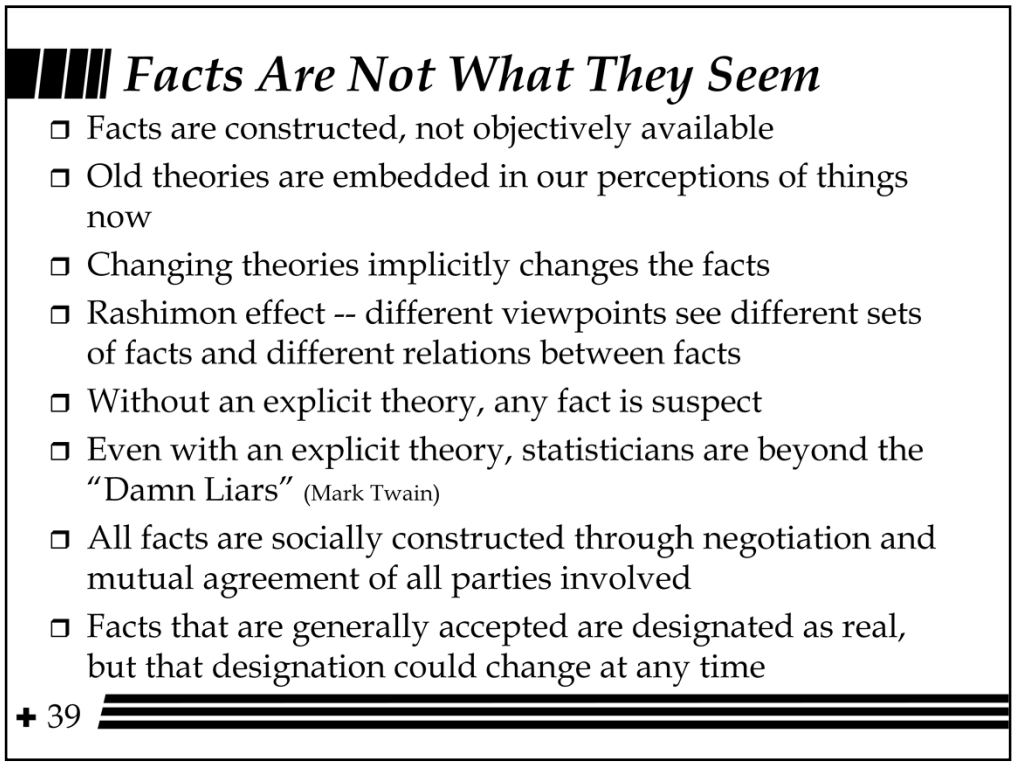
When we establish that there are different kinds of change that exist as a series of meta-levels, each of which has its own meta-language, then we are opening up an arena for discussing how changes can change themselves meaningfully. We notice that there are many things in the world that stay essentially the same despite the flow of time. Normally these are the basic constituents of our world upon which we focus. However, when we look at change, we see that all of these seemingly static things are themselves all changing to some extent and to some degree. Thus, despite the appearance of stasis, there is what is known as the Heraclitian Flux in which all things are subject to continuous change at differential rates. Many of these changes are inconsequential. But some of them are significant. When we change changes consciously, that is when we attempt to make significant changes in flows. This is what we call management or control within our experience. But management is not the end of the meta-levels of change. There is also the next higher meta-level of adaptation. Here we change with the changes that we cannot change. Instead of trying to control things, we seek the wisdom to know what we can and cannot change and adapt our management strategies to that understanding. This leads to the highest meta-level of change which is when we acquire flexibility which means we can have multiple simultaneous adaptations in reserve to handle changes in changes that are not foreseen. Beyond this, Bateson, in Steps to the Ecology of the Mind, using an analogy from physics posits that any higher meta-level of change is essentially unthinkable.



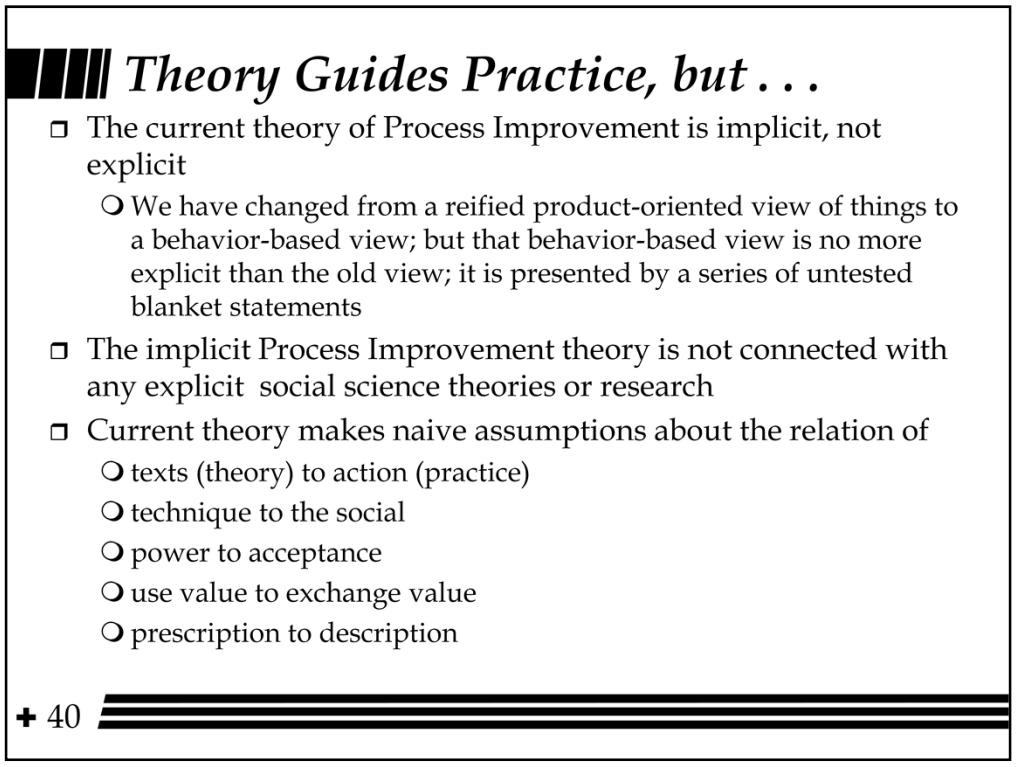
When we speak of meta-levels of change, we are talking about changes that are basically extrinsic to ourselves. When we translate this into something intrinsic to ourselves, we must think of these changes in terms of learning. We are caught in all kinds of changes, but it is the changes that translate into knowledge that are most crucial for us. Thus, we can see that there are multiple levels of learning that are associated with how we comprehend the various levels of change in our world. Again we start with what is known -- the facts of our world. And at the first meta-level we learn new facts that we did not know before. There is an endless horizon of new facts to learn. But sometimes we need new ways of learning in order to expand that horizon. In that case, we move to the second meta-level of learning that is associated with education. Ideally, education teaches not just facts, but new ways of learning that we could not develop ourselves without a great deal of exploration and trial and error. Through education we learn many different ways of learning which we add to with our own personal repertory of modes of learning. When we seek to add yet more new ways of learning, then we are engaged in research. Research gives us a means of acquiring new ways of learning how to learn. Research is very difficult, and there is much trial and error and even failure that must be gone through before we can find yet new ways to learn how to learn. But when we are successful, we talk about discoveries. Discoveries are the highest meta-level of learning. A discovery, if it is significant, can change the whole way we look at the world. Bateson again says that we cannot think any higher levels of learning beyond the fourth meta-level.



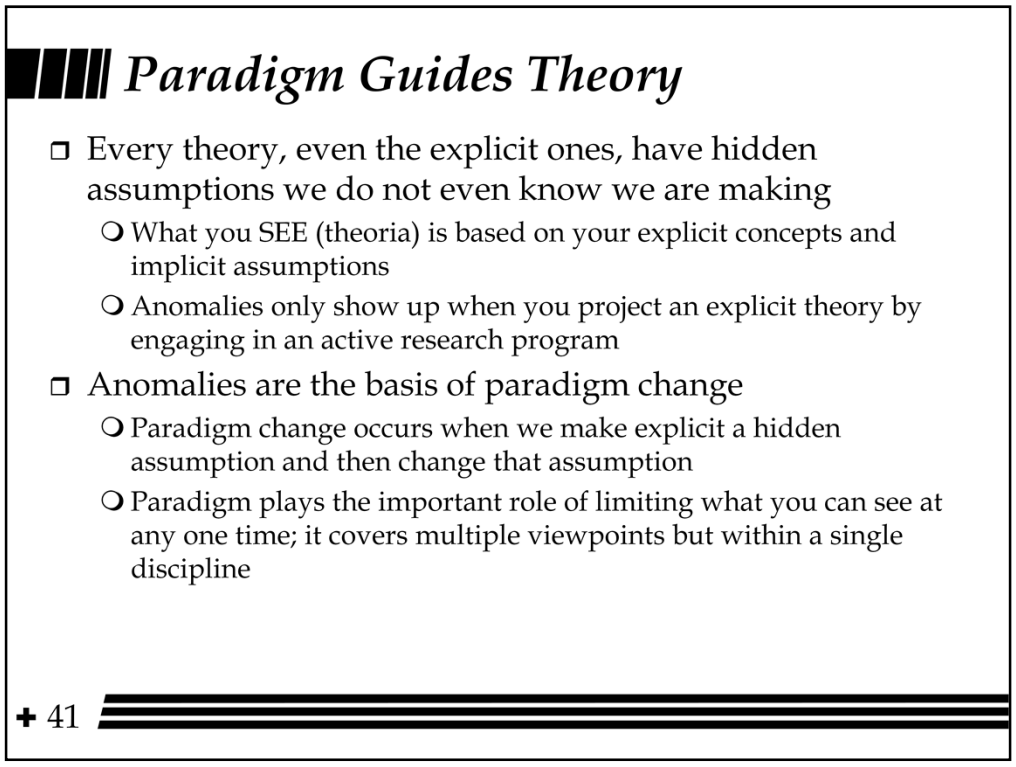
It is significant that knowledge is the most persistent thing in our experience, and the various fluxes are the least persistent thing. So learning, which is intrinsic change, yields knowledge that is extremely persistent once it is won from experience. Between the intersubjective Knowledge that is transmitted in our culture and Flux of experience there is the tradition itself. The tradition is the thing that changes through learning and by changing, our tradition changes who we are. Traditions are both static and in flux at many different levels as they produce our culture. Traditions are socially constructed, but also the culture which is what is produced by the tradition is the basis for all future social production. Thus, there is a continuous feed forward and feed back between the tradition and culture through the process of social production. When we talk of engineering and other technical work, we are really talking about a certain highly refined kind of social production based on the sphere of technology. Technology is the means by which we accomplish things by using other things. So technology is the feedback loop of social production seen from the direction of things. If we see this from the direction of ourselves, then we must talk in terms of social production of culture through a tradition. That tradition has various levels as seen by the chart which extends from the facts of knowledge up to encompassing the entire worldview through a series of levels that include theories, paradigms and epistemes. Epistemes were introduced by Foucault in The Order of Things and Archeology of Knowledge. They exist at the level of our categorizations of things. Through epistemes we learn our basic differentiations that allow us to define the terms we use to make assumptions that underlie theories and are used to express theories and facts.



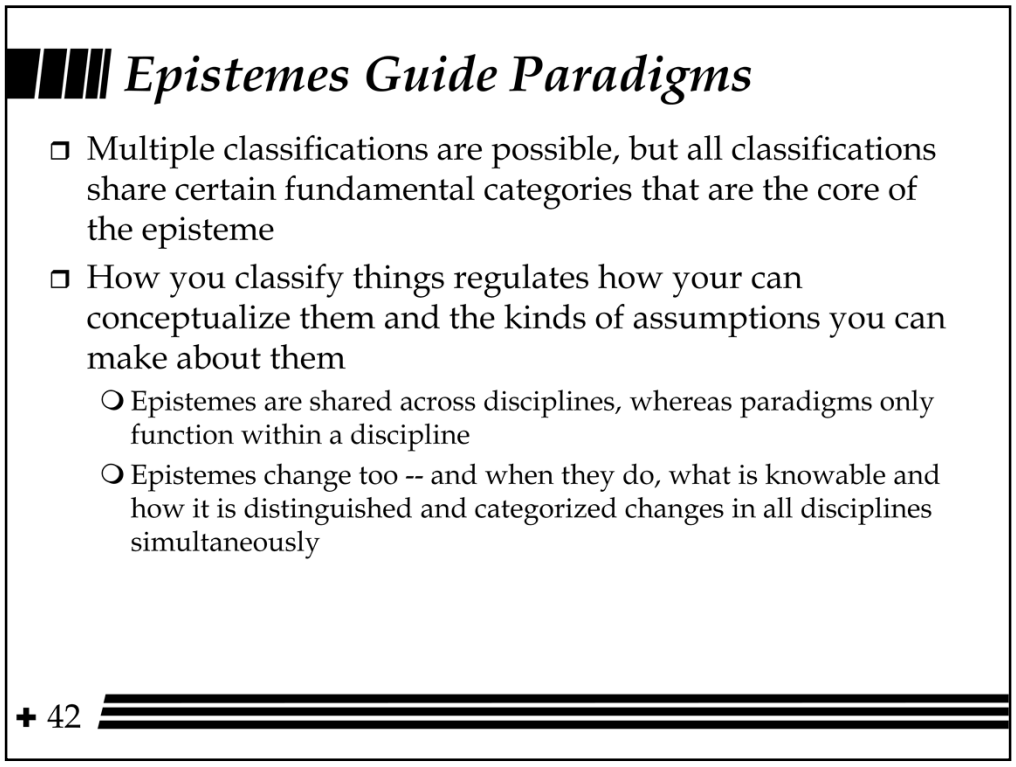
When we talk about the tradition, it seems to us something solid and static because it is constituted as a myriad of facts that we must learn that are historic. It tells us about all the greats of our tradition and what they discovered and what we can use those discoveries to do. But what we must realize is that facts are only constituted from a certain viewpoint, and almost everything within the tradition is not just open to interpretation, but also critical analysis. There is no fact that cannot be contested from some viewpoint. So the seeming static and stable nature of the tradition is really a sea of shifting dunes. It only looks like it is stable from outside the tradition. From inside there is constant research to reestablish the facts from different viewpoints. And if the facts are established, then they may still be twisted by various ruses like clever statisticians can prove anything with data. So we need to beware of thinking we know the facts -- the basic building blocks of the tradition. The facts are continually changing and being re-produced in different configurations to fit the situation. In fact, some like Paul Feyerabend in Against Method say that facts are merely theories that have become so well accepted that they are submerged within our perceptions, acting there like a filter. Take any well known fact, like Columbus discovered America. If you are told it was really discovered by a Northern European instead of a Southern European, you would immediately reject that. But when I show you the ruins of the buildings of the Norsemen in Canada, then you realize that nononly was Columbus not the first European to discover it, but that discovery is relative since the native population always knew it was there.



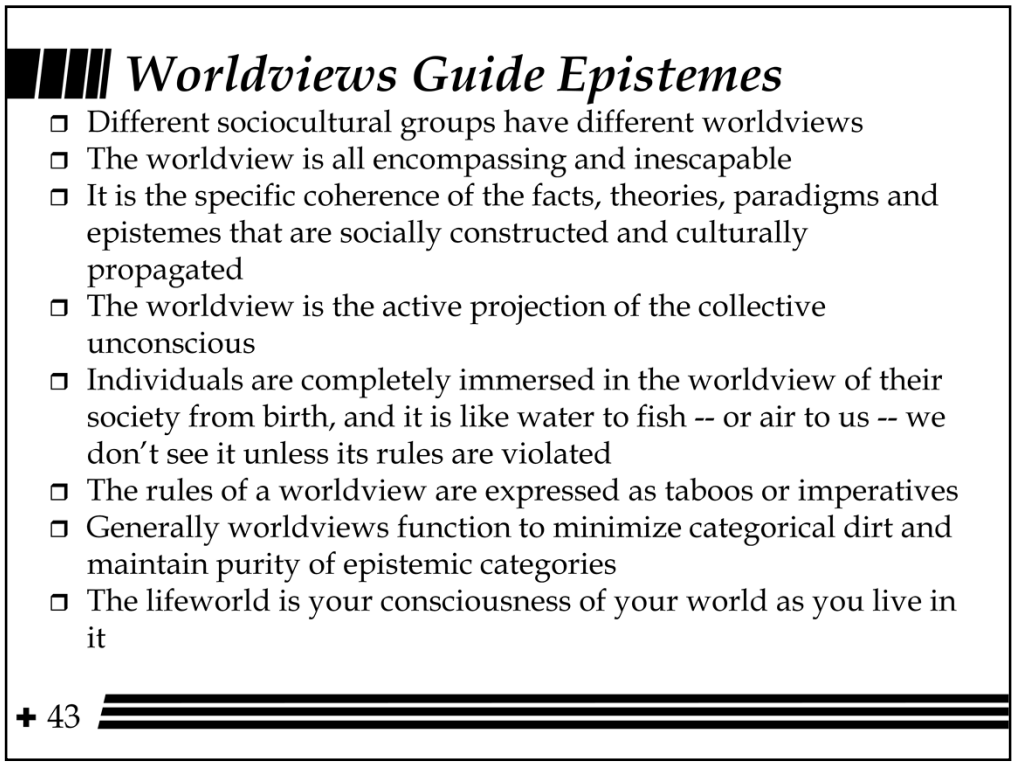
Theory is really the center of our learning and changing responses. Theories produce the facts based on assumptions. Theories are the means of creating new knowledge. But this is a complex process that cannot be summarized quickly. It is on the basis of theories we do our controlling and management, but after we have learned from our experience. But we cannot just learn directly form our experience -- without a theory we cannot even really have any experience that is comprehensible. In theory our experiences are conceptualized and digested through thought and reflection. Theories may be implicit or explicit. We can only have a science if there are competing explicit theories. This is exactly what is missing in the process improvement literature and which forces us to think of it as a pseudo-science rather than a science. Measurement without competing explicit theories can be classed as naive empiricism or mere positivism; that is, measurement for measurements sake. When we formulate explicit theories for process improvement, these need to be connected with explicit theoretical foundations in the social sciences like behaviorism and symbolic interactionism in order for us to evaluate the various theoretical perspectives. Now most of the implicit theories use their own unique vocabularies which are difficult to connect to the traditional humanistic and social science perspectives. Implicit theories tend to make many naive assumptions because they are not formulated in such a way that it is easy to look at their assumptions like explicit theories. Bland statements like improving processes improves product quality contain a plethora of unexplored assumptions which cannot be unfolded until an explicit theory is produced that can be operationalized and disproven. Knowledges are composed from explicitly operationalized theories that have stood the tests of experimentation over time.



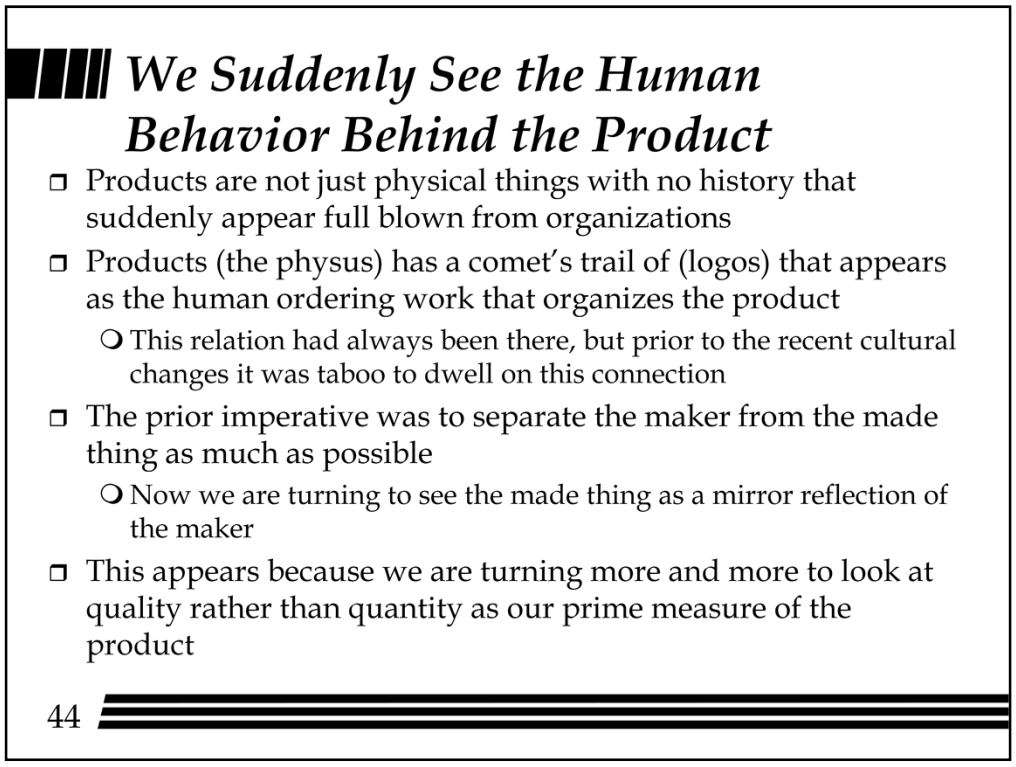
We hear a lot about paradigms and how we must change our paradigms. All this talk is lost on those who have not even begun to express explicit theories. You cannot explore, let alone change, the assumptions of a set of theories until that set of theories are explicitly rendered and made available for scrutiny. When we render theories explicit and test the hypothesis that we operationally derive from them, then we can generate anomalies that none of the sets of competing theories can explain. It is not the anomalies to a single theory that end up shifting a paradigm. It is, instead, the anomalies that none of the available theories explain. Each particular theory has some parts of experience that it explains and others that it does not explain. The problems are the things that no one can explain. Many times these are observations that are made in experimentation that have no corollary in the theory. Sometimes they are effects where one theory explains some of the phenomena and another explains the rest, but the two theories are incompatible. These anomalies are collected over time until there is enough data for someone to jump to a new set of assumptions that are productive of a whole new horizon of theories that view things essentially differently from the old set of theories. Many times the new paradigm will be seen as a refinement of the old paradigm. Until the new paradigm is realized, we were not explicitly aware of the nature of the old paradigm. It was always implicit to us. We can only contrast the new paradigm to old ones. We never know how it relates to new ones beyond it. Paradigms can be thought of as blindspots of a set of theories which are competing. The whole set may have overlapping blindspots which together add up to assumptions that all of them are making together without knowing it.



Beyond paradigms are epistemes. Epistemes were defined by Foucault in The Order of Things and The Archeology of Knowledge. Epistemes are category schemes that are common to multiple disciplines. A whole set of disciplines act somewhat like a set of theories. They, too, have blindspots that none of their theories reach because of the way things are cut up within the world. We only see these meta-blindspots when we learn to cut up the things of the world differently by imposing new categorical frameworks in place of the old. Episteme changes are more rare than paradigm shifts. But they are important measures of the change of a tradition. Ultimately, the episteme rests in the philosophical categories that describe the highest concepts we have by which we state our knowledge to ourselves. Normally, we never explore categories at this higher level because we assume our category schemes, and only philosophers tend to question them. When categories change, then that change has a tremendous impact on the way we look at the world. The categories furnish a scheme which imposes a grid on experience prior to our looking at the world. Paradigms may come and go without altering that grid. However, when multiple disciplines change together, you can bet it was because of an episteme change in some category that they all shared. By changing the way we cut up the world, all the different disciplines shift in relation to each other.



In the hierarchy of the components of our tradition the worldview is the highest level that encompasses all the others. We speak of the world of art or the world of learning. These sub-worlds all nest together to create the worldview of the Western tradition. We can only get a perspective on the worldview by comparing it to other worldviews like the Buddhist or Chinese worldviews. It is very difficult to translate between worldviews. But every worldview has certain characteristics of its own beyond the facts, theories, paradigms and epistemes it exposes. Worldviews are generally unconscious. It is the totality of all our projections and productions that form our tradition. To us, the worldview is transparent and encompasses everything in our world. From our embedded perspective we can call it the lifeworld as it encompasses all aspects of our lives. The lifeworld was defined by Edmund Husserl and elaborated by Alfred Schutz as a way of looking at things from a particular humanistic perspective called phenomenological. This is only one of many such perspectives. But it is one which allows us to understand our relation to the world because it emphasizes that we project the world and describes the processes of consciousness by which that projection takes place.



There are changes going on in our Western worldview that oblige us to begin to look at processes instead of merely end products. Process Improvements stem from some of these changes. They have been brought on by the fact that we have realized that there are different ways of looking at all phenomena that are mutually exclusive. Thus, we can see things as products or as processes -- as things or series of coherent events. Phenomenology looks at things that appear in consciousness as series of perceptual and cognitive events. WPE is a similar attempt to shift our attention to something that has always been there but has been ignored up to this point. The fact that products were produced by human beings has always been clear. But in our culture up until recently, it has been verboten to dwell on the series of events and human actions behind the products. The illusion that the made thing came out of nothing was jealously guarded. But this illusion is breaking down, and we are realizing that the made thing is no better than the processes of the maker. It is no longer cost effective to concentrate only on the end product. Instead we are looking at the constitution of that product in the social field of work in much the same way as phenomenology looks at the constitution of objects in the field of consciousness. We are seeing that the product is a mirror reflection of the forces within that field which can tell us about quality rather than quantity. Between these two perspectives arises our view of the human producer who creates the quality thing -- be it a technological system of continuous or discontinuous production. The human producer was hidden behind the product when that was the only perspective. But as soon as dual complementary perspectives arose, then suddenly we can clearly see the human processes beyond the artificial things in our world.

Change and Learning in a Tradition

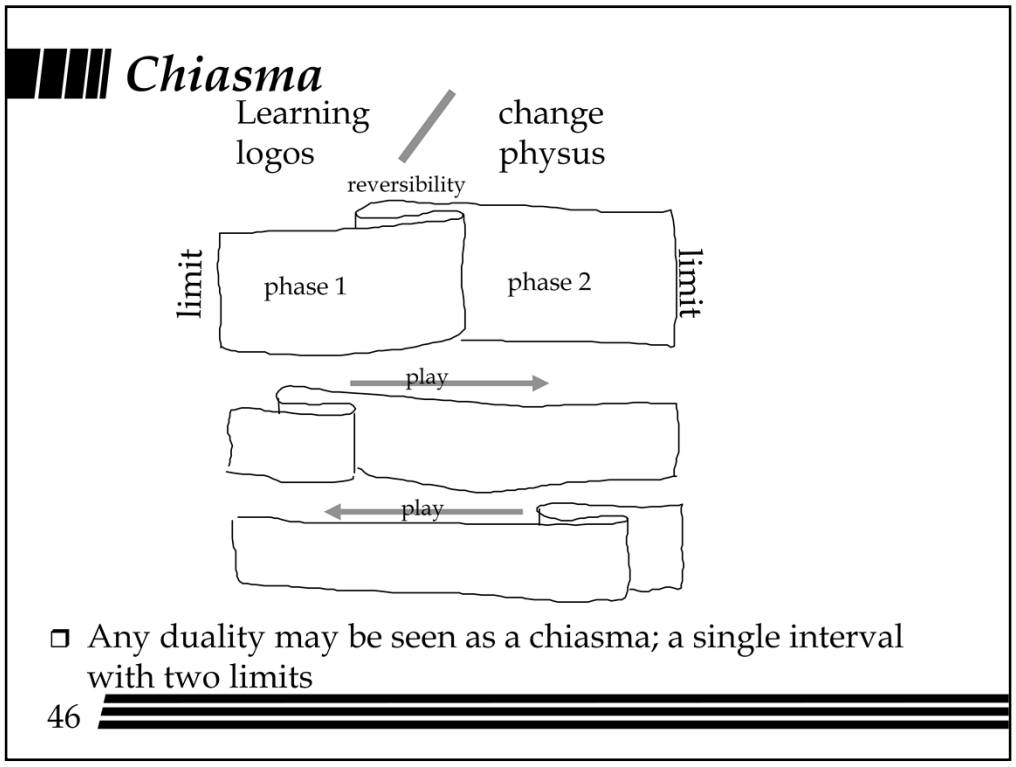
- All the different meta-levels of change and learning could conceivably operate on each of the levels within a tradition
  - Each of these levels have specific kinds of knowledge associated with them, and the meta-levels of learning would apply to those kinds of knowledge at each level
- The differences between change and learning reflects the fundamental split between physus and logos in our worldview

Physus	Logos
meta-levels of change	meta-levels of learning
control oriented	understanding oriented
objective group consciousness	subjective consciousness
practice	theory
physical	***intellectual***

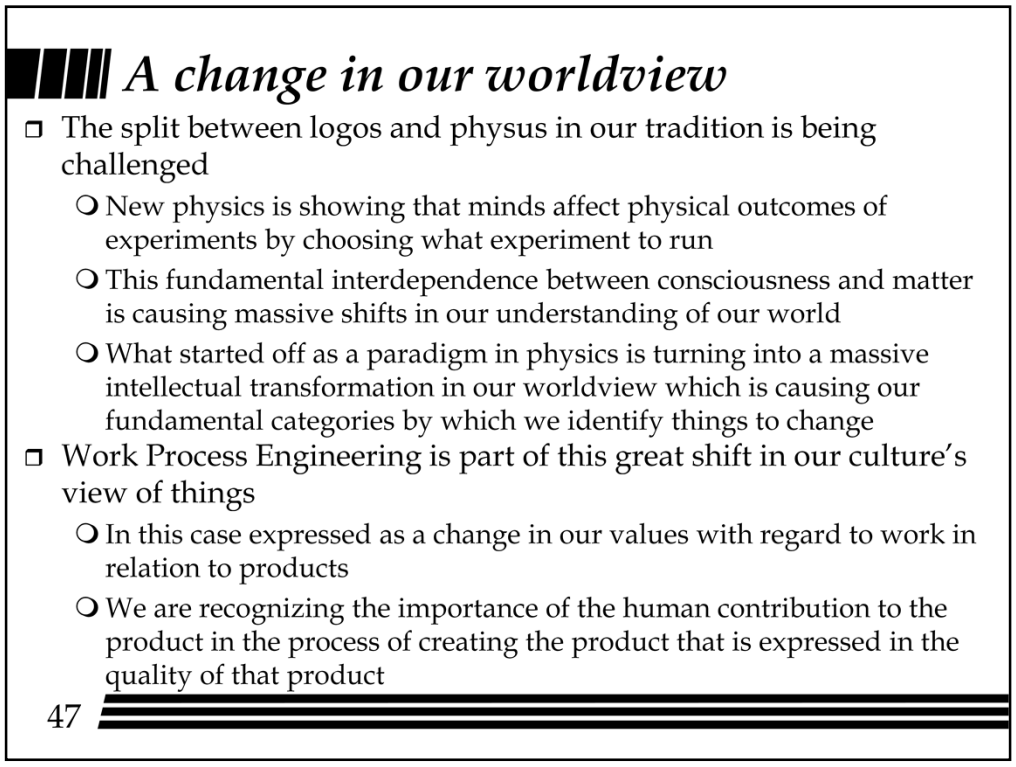
45

These changes in the Western worldview have effects at the epistemic level where a major duality underlies many aspects of our tradition and culture. That is an age old distinction made by the Greeks between Physus and Logos. Physus is the unfolding of order in nature through growth. Logos is the unfolding of order within man through the upwelling of language in society and the individual. These two terms are part of a basic duality that runs through our civilization from the earliest times. Quantum mechanics has challenged this basic duality at a fundamental level, and through our discovery of non-dualistic non-western traditions, we are starting to question this basic epistemic distinction for the first time. In our model, the meta-levels of learning represent the structuring of Logos; whereas the meta-levels of change represent the structuring of Physus. We can talk about these opposites in terms of mind/body, consciousness/things, idealism/materialism, theory/practice and through many other distinctions that are fundamental in our tradition.

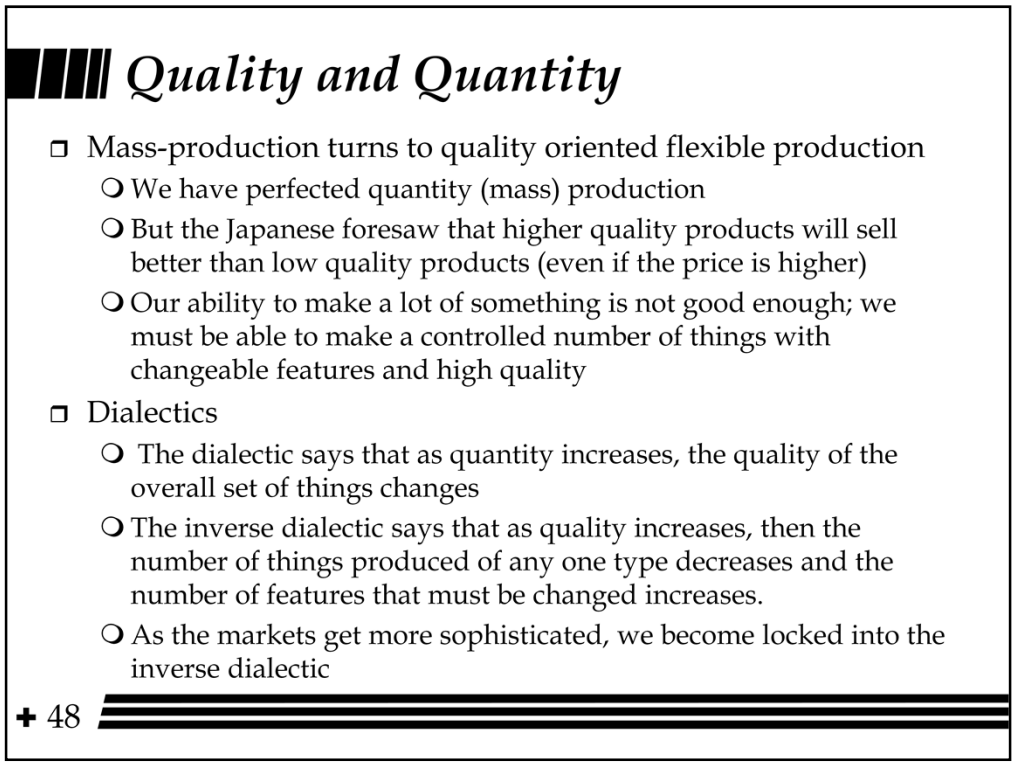
This distinction is a duality because one of the elements has complete control over the other element. Depending on your point of view, either of the pair may be taken as dominant. Dualities are not just opposites, but are opposites where one of the pair has total control and power over the other.



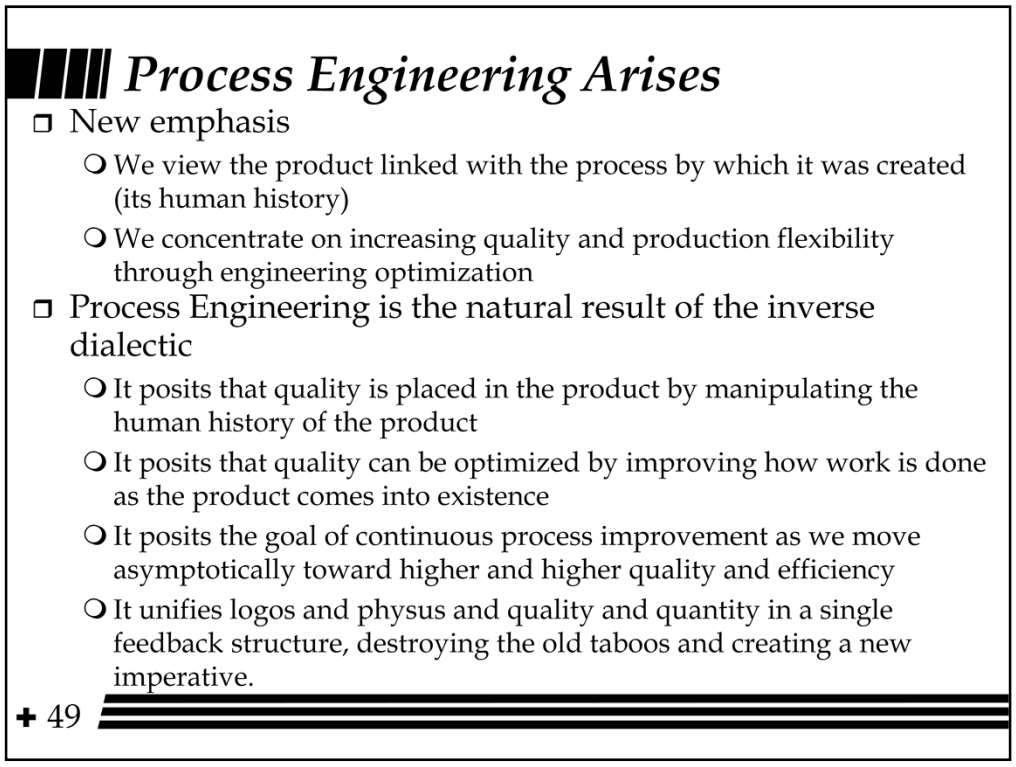
This dualism can be seen as the reification of a non-duality. A non-duality can be expressed as a chiasma. A chiasma has a reversibility between opposites. Each opposite is represented as a phase, and depending on your point of view, the phase of one can appear bigger than the phase of the other when the real reversibility between the two is fixed. This is the basis of spacetime relativity. Different inertial frameworks see the same spacetime chiasma as having different proportions between the phase of space in relation to the phase of time. The difference between the two apparent reversibilities is the "play" between the pair of dual components. The chiasma has a single limit which has been split into two like the two lines and two phases of the mobius strip that locally appear separated but are globally the same thing. Thus, Physus and Logos are a duality in which opposites have differential domination depending on viewpoint. That differential expresses the play between the two duals as the reversibility moves back and forth as we change our points of view. The actual reversibility is static, but it appears to move as the observer moves. Thus, sometimes we have idealism where Logos appears dominant, but if we change our point of view, we see the same structure as a materialism where the physus is dominant.



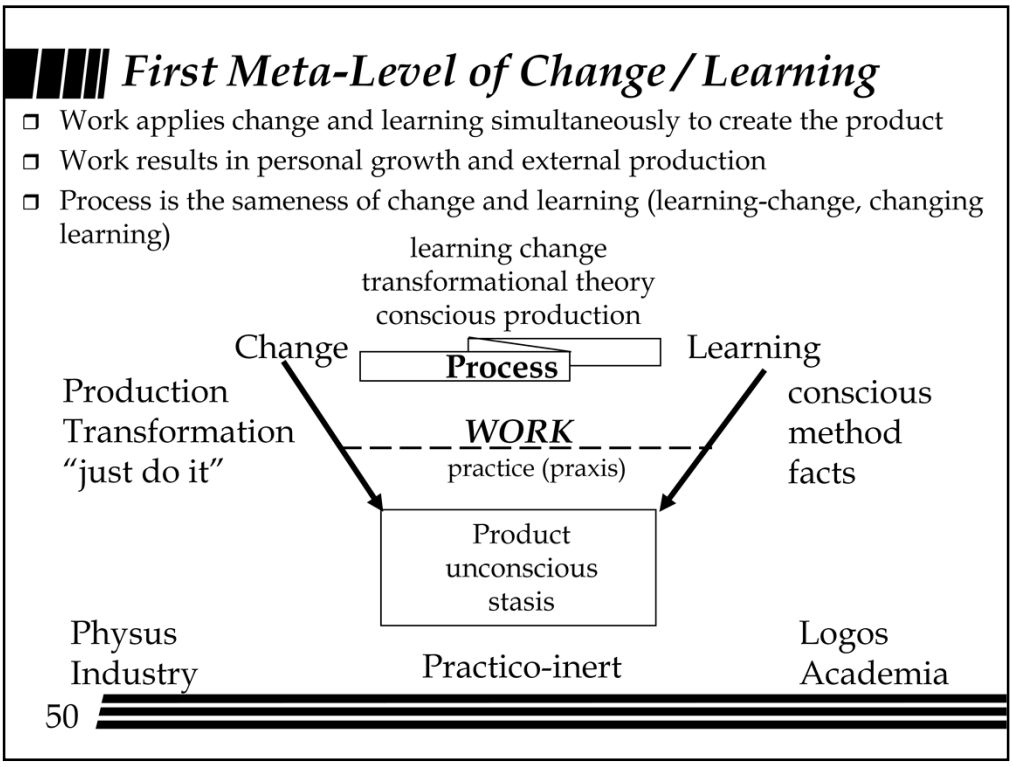
This basic split is being challenged from within physics by the discovery of the fundamental participation of consciousness in our experiments. What we see as an outcome depends on which experiment we choose. This incomprehensible inner connection between Physus and Logos that is an inexplicable outcome of many experiments has caused many to question the old dualism that has dominated our culture so long and which is missing from other cultures such as the ancient Chinese epistemics. Another example is the wave/particle duality that is discovered to be intrinsic to nature and inescapable for us. Yet another example of a collapsing duality is that between the observation of position and momentum which is called the Heisenberg Uncertainty Principle. You can observe one, but not both at the same time. Thus, there are very basic limitations on our knowledge of nature that revolve around the dual categories we project on the world. Similarly, WPE shows us the duality between product and process, or quality and quantity, as similar kinds of dualities that are really chiasma that are apparent at the macro-level. Taking dualities and seeing the reversibility between the components from different viewpoints is a skill that we all need to practice. It is by doing this that we diffuse competitive situations into cooperative situations that are called win-win strategies.



The split between quality and quantity is another example of a basic duality on which WPE is founded. The now classic story is how the Japanese beat us at our own game by taking to heart our insults of their product's poor quality. They learned how to produce very high quality products that were so good they broke the game of mass production that was always played in the United States that only cared about quantity but never quality. The Japanese produced products that were so high in quality that customers would actually pay more for them in order to get the higher quality rather than buy something cheaper that was of poorer quality. In this way, the Japanese took away many markets from competitors in the United States that could not adapt as the rules of consumer products marketing changed. It is always said of dialectics that its hallmark is that when you increase quantity, the quality of things change. The inverse dialectic states that if you change the quality of things, the number of what is produced of any type decreases and the number of features increases proportionally. Higher quality products have more features and choice connected with them to fit customer needs and desires so that fewer of each model is necessary. This leads to a market where adaptability and flexibility is all important in manufacturing, and where the discovery and research pays off big dividends. This means we must invest in the long-term development efforts instead of going for short-term gains and quick profits -- a radical change in the economic and marketing landscape that many American companies have still not learned. This inverse dialectic with the advent of process improvement efforts is now coming to high technology with one-of-a-kind products. Now instead of productivity numbers and schedule being all important, there is a balance of these with quality-related numbers such as defects and number of successful reviews completed.

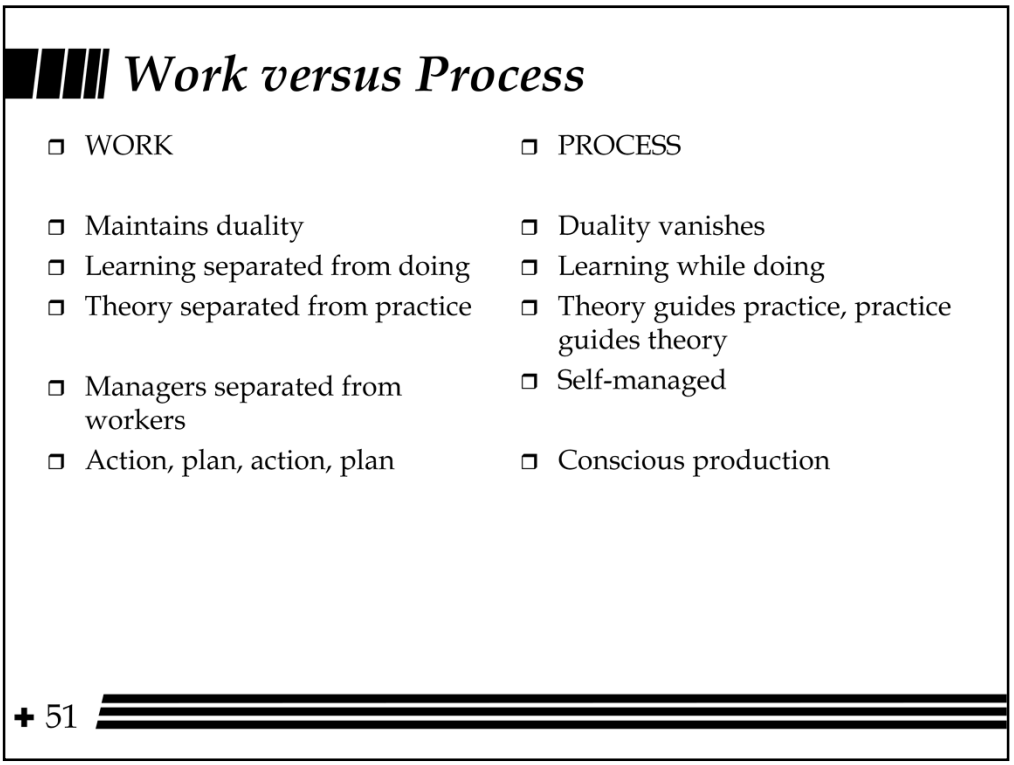


When we view the process-product chiasma, we are actually looking at the human history of the product. Now we do not just engineer products, but at the same time we engineer the processes used to build these products. So process engineering is the natural long suppressed twin to product engineering. We only have done physical process engineering before such as that in chemical plants and nuclear facilities, so these are the same techniques we begin to apply to the human processes that result in high-tech cultural artifacts like engineered systems. Process engineering is the natural product of the inverse dialectic. It unifies process/product and quality/quantity dualities in a feedback and feed-forward structure. Instead of product quantity being dominant, we recognize that each element deserves its due and that we only increase one beyond a certain point by decreasing the other. The problem is to find the right balance or point of reversibility between these four chiasmic elements. This, of course, is a difficult task, much more difficult that just emphasizing the dominant product quality at all costs and in every circumstance regardless of the cost.

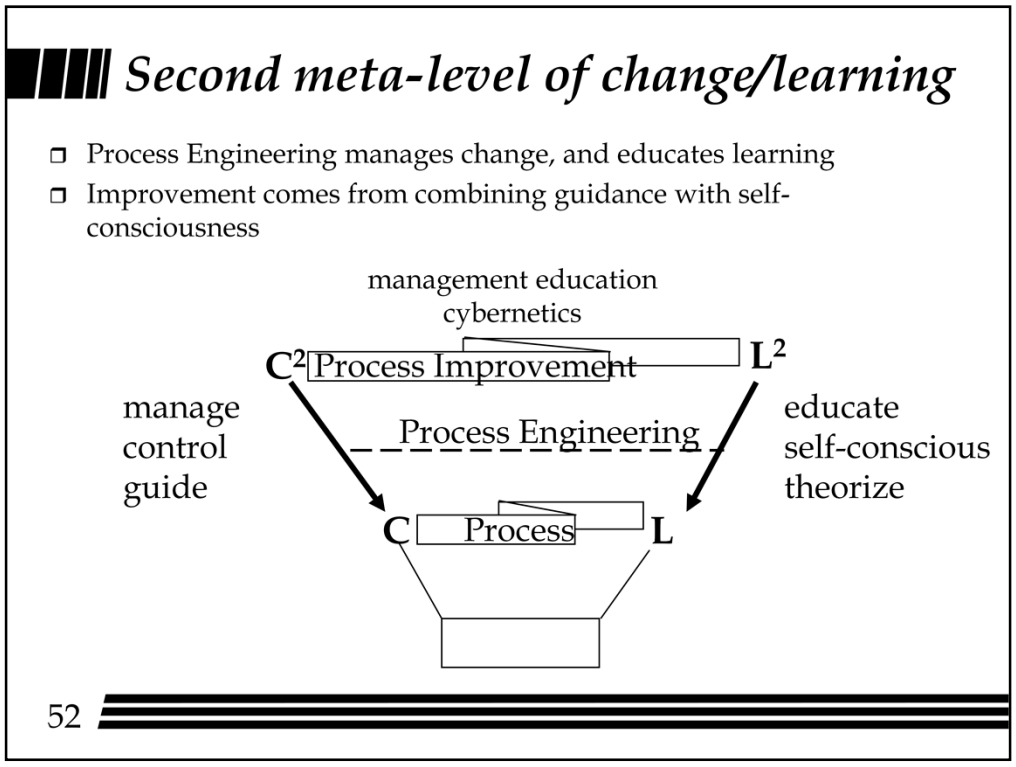


Now we can begin stepping up through the ladder of meta-levels of learning and change. At each level, we will see the difference between the chiasma and the application of the duality as separable elements in which one can dominate the other completely. In fact, we can see that our society is organized by this duality by reflecting on the the basic duality between industry and academia. Industry emphasizes transformational change in production, and academia emphasizes learning. Industry transforms stuff outside of us and academia concentrates on transforming us. As we mature, we move from one of these spheres to the other, and that is a difficult transition in our lives where expectations change completely and where what we did in the academic sphere has little relevance for the industrial sphere.

Here we will look at the product as unconscious stasis or habit that is the result of prior action. Sartre, in The Critique of Dialectical Reason calls this the ***practico-inert***. It is now inert, but it is the result of practice. When we do work, we take practico-inert resources prepared by someone else, and we transform it. As we transform it, we transform ourselves, learning on the job. We posit that WORK is the differential application of elements form the duality of change/learning. PROCESS is the chiasma between change-learning. The point of reversibility between the two is WISDOM which is the right balance between knowledge and experience. Change and Learning belong together because globally they are the same in the sense that man is no different than nature at some level in his being. This is a major point that Deleuze and Guattari make in Anti-Oedipus. At some level, natural unfoldings and the unfoldings within us are the ***Same*** because they *belong together*. This is a terminology that Heidegger developed in Identity and Difference to express non-dual chiasmic relations between opposites.

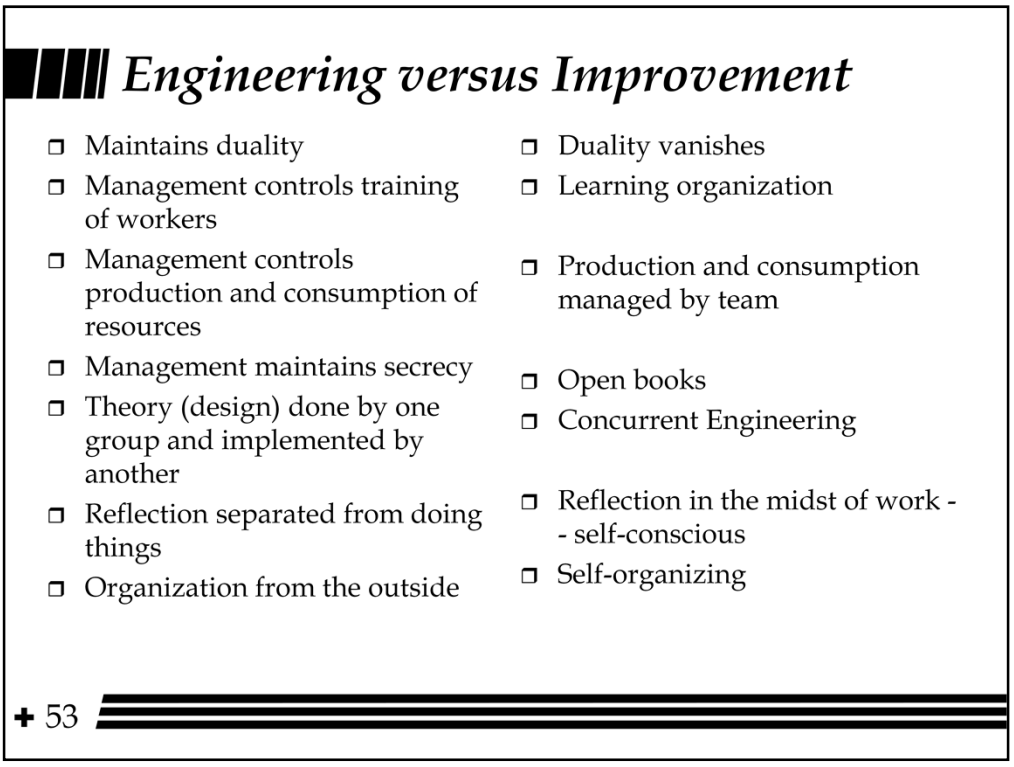


Here I have attempted to capture some of the differences we might infer from the dualistic work versus the non-dual process. Process implies continuity. If we see the production process as an interleaving of intermediate products and human activities then we can either focus on the activities, between the products or the products between the activities. But there is a third view that looks at products and activities as two poles of the same chiasma of learning-change. A change is effected outside by reciprocal change inside the person doing the work. This chiasma is viewed from one of four viewpoints: *Agents, Functions, Events* or *Data*. If we look at it from the Agent viewpoint we see *Roles* of the people. If we look at it form the Event viewpoint, we see lifecycle and schedule. If we look at if from the functional viewpoint, we see the activities that take inputs to produce outputs. And if we look at them from the Data viewpoint, we see artifacts or intermediate products. Thus, it is the viewpoints that create our dualistic views of the underlying unified process. When we make this switch in our thinking, we see the whole production process in a completely new light. A process has an underlying continuity before the separation into the different things we see from different viewpoints. If we can make this transformation in our way of looking at processes, then we can effect fundamental changes because we side step the normal dualities that lock us into either/or or win/lose dead ends and stifle creativity.



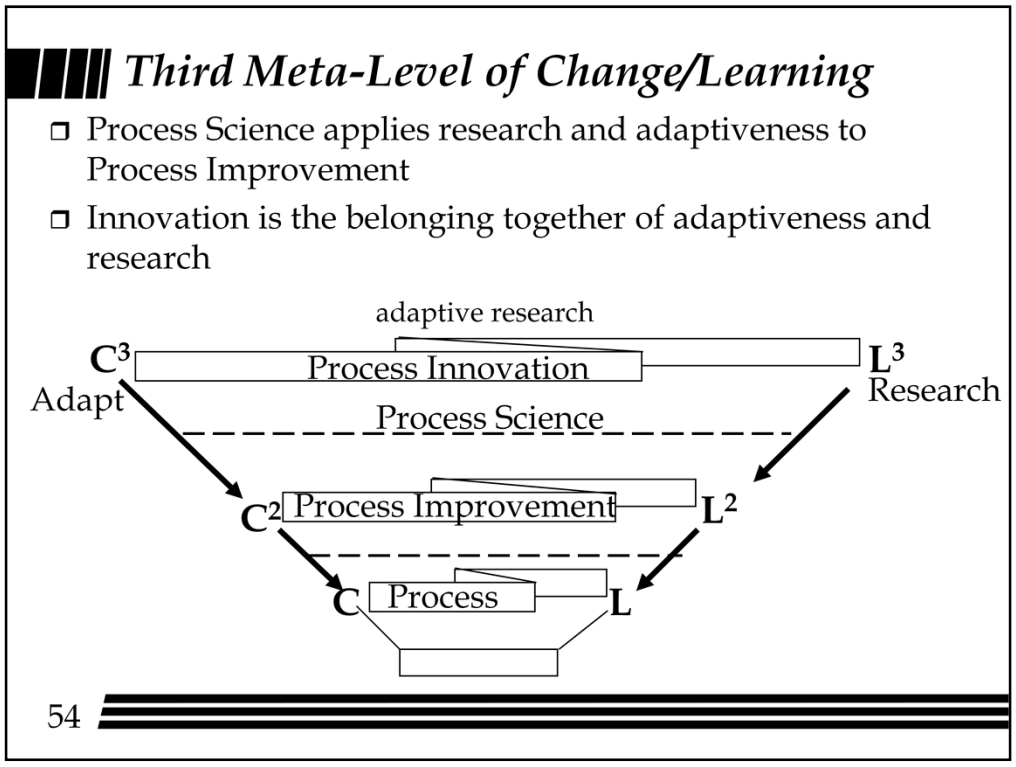
Now we are going to move up a meta-level. This means we are going to develop a language to talk about change-learning. That meta-language will be essentially different from the language we were using at the last higher logical type level down. At this level we are changing the way things change or we are learning how to learn. This is the level at which the Hawthorne or placebo effect come into their own. This is the level at which measuring something affects and changes that thing. We see this in our quantum measurements, and we see this same effect in our sociological and psychological measurements. It is an effect we cannot avoid by wishing it away and pretending that we can be objective toward ourselves.

At this level *Process Engineering* arises as the differential use of education and management/control back down on the Work-Process level. When we change how things are changing, that is when we are exerting control of them and guiding them. When we learn how to learn is when we are forced into being self-conscious about what we are doing, and by that we are educated by learning many ways of learning. This is the level at which theory arises because theory is merely a means of learning through representations that connect concepts to facts. *Process Improvement* on the other hand is a chiasma between Learning^2 and Change^2. There is a continuum between the Hawthorne effect inside us and the feedbacks from our own instruments that sully our measurements outside us. They are two aspects of the same fact that change changes itself as Kevin Kelly has said, either internally or externally.

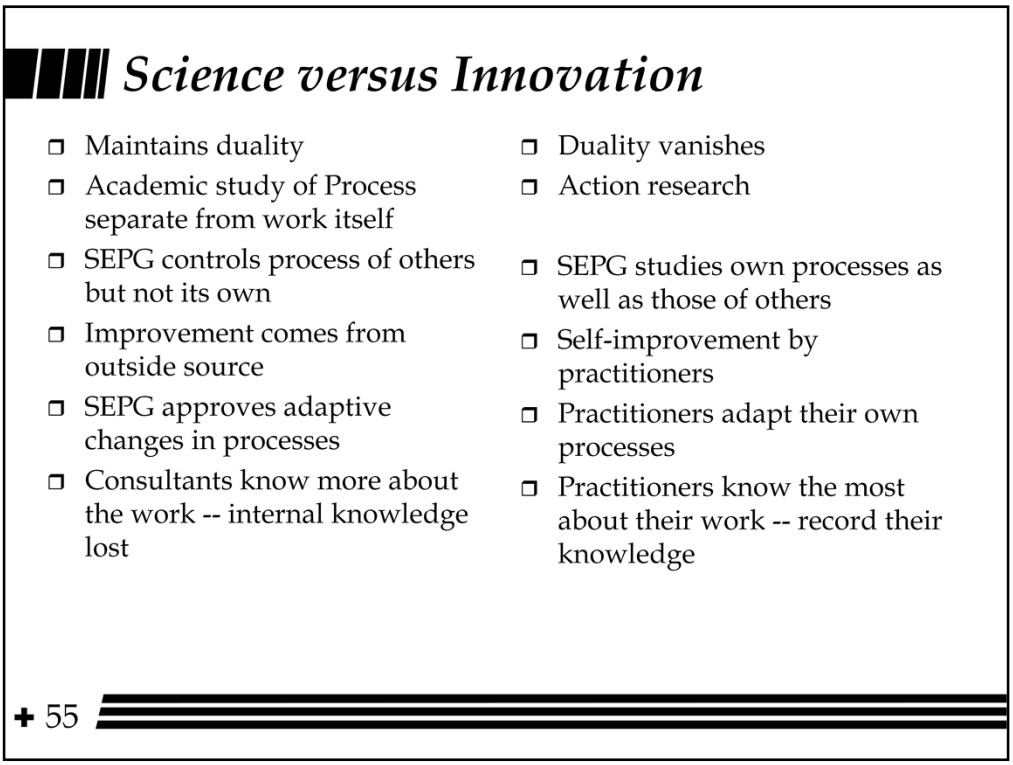


Here I have tried to outline what might be some of the differences between the dualistic and non-dual ways of looking at this meta-level.

Process Improvement must be considered a human science and be played by the rules that all human sciences follow. It cannot be played by the rules of the physical sciences. For instance, special ethics must be put into place when we do our research because our objects of research are human. This both gives us an advantage and limits us. We have the advantage that we can put ourselves in the place of those we study, but it also means that we cannot be as destructive as we normally are when we want to get to the heart of how something ticks. If we treat project personnel like lab mice, then we will have made a fundamental error in our calculations. If we treat them like computers or software programs, that will also be taken as a sign of deep ignorance by future generations of process engineers. We must accept the advantages and drawbacks of having human subjects as the object of our science. One of the major limitations is the Hawthorne effect and the fundamental reflexivity of change. We can use meta-levels to disentangle the paradoxicality that this entails, but ultimately the ruse of higher logical types collapses, and we are left with ourselves as an unfathomable mystery. Know thyself is the hardest of injunctions to put into practice.

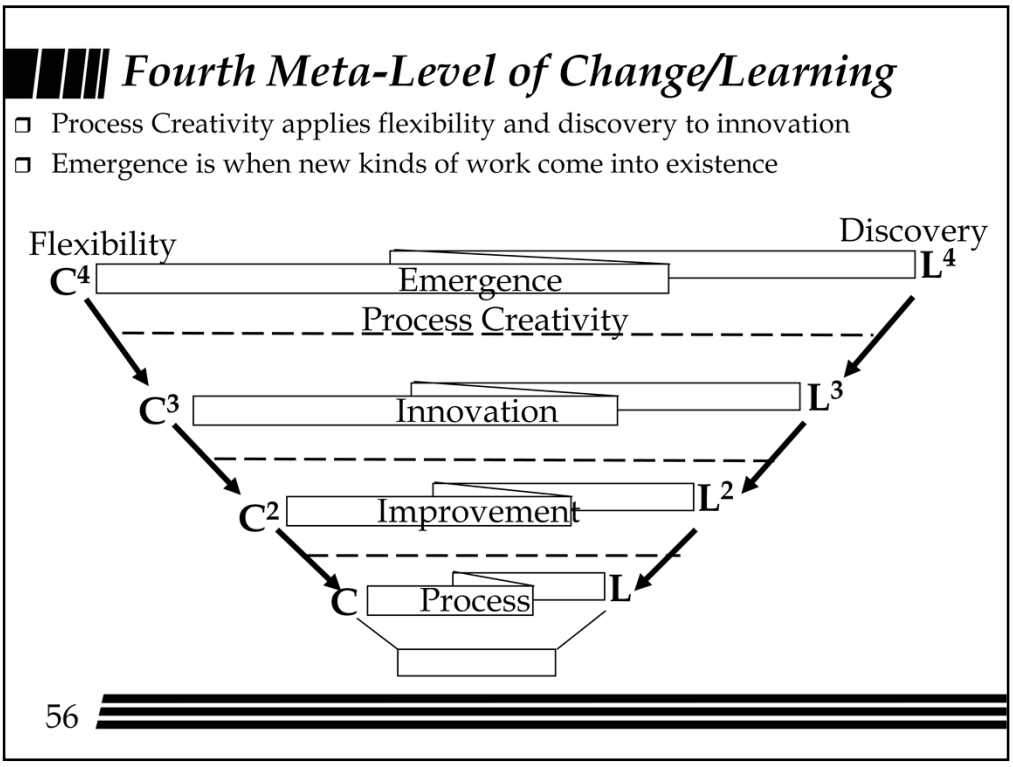


Now we enter the third meta-level of change-learning. Here we see meta-level three change as adaptiveness and meta-level three learning as research in which new ways of learning how to learn are found. When we change our management strategies, we are adapting to circumstances, thus making our organizations more viable. The differential application of the duality between adaptiveness and research to the next lower level is called *Process Science*. In this case, we do research on different aspects of the Process Improvement agenda and increase our knowledge which is then applied in our improvement work. Very little of this kind of research is not being done because of the split between industry and the academic community. Therefore, we are limited in the amount of actual Process Engineering we can do because engineering must always apply the knowledge gained from science to its field in order to be real engineering. Likewise, as we do our improvement work we are continuously having to adapt our processes to changing circumstances. The recent push toward commercialization is a case in point. These changes which bring us into harmony with the environment make our processes not just improvements of the status quo, but adaptations to changing business conditions. When we recognize the chiasm between adaptiveness and research as twin and ever present needs and even drivers of our process efforts, then we recognize that process innovation is the order of the day. This is the point that Business Process Re-engineering attempts to get across -- we need to sometimes take radically different routes to achieve our process goals that simultaneously are adaptive and apply the latest things in process research. When we take these risks on the basis of our intuition, then we are approaching a process wisdom.

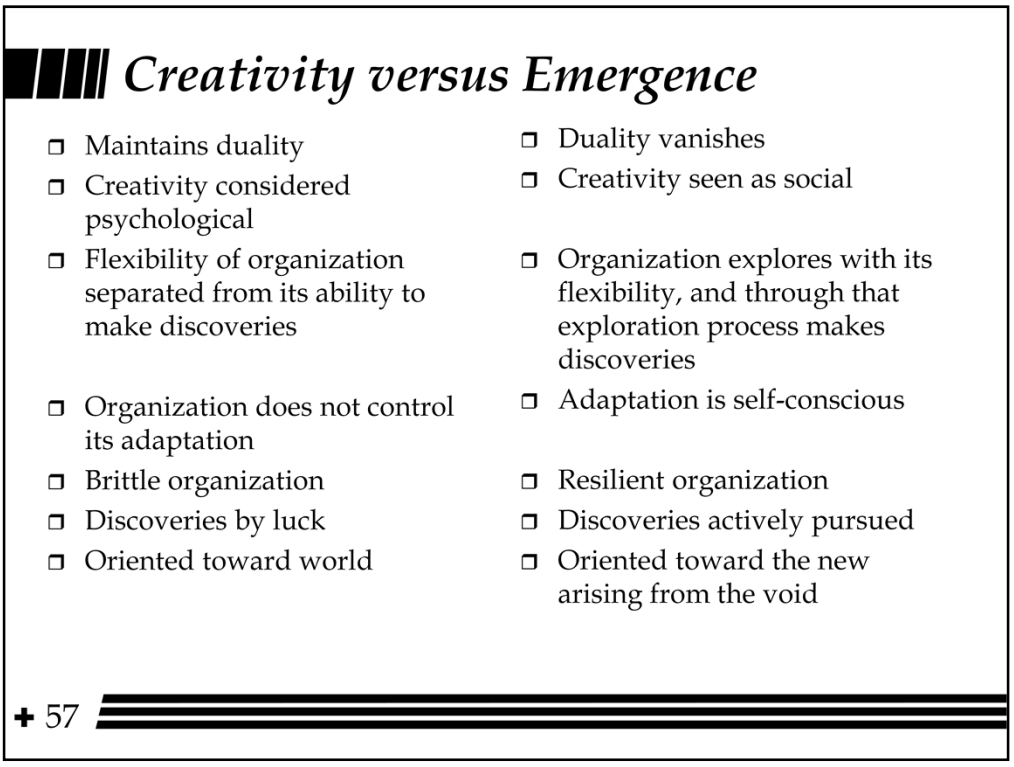


Above I give some of the possible differences between maintaining the duality and turning away from it. Each direction has its own uses. It is not that one is better than the other, only that in our culture duality has so dominated non-dual modes of approaching things that most people do not know that you can look at things in a non-dual way and remain cogent.

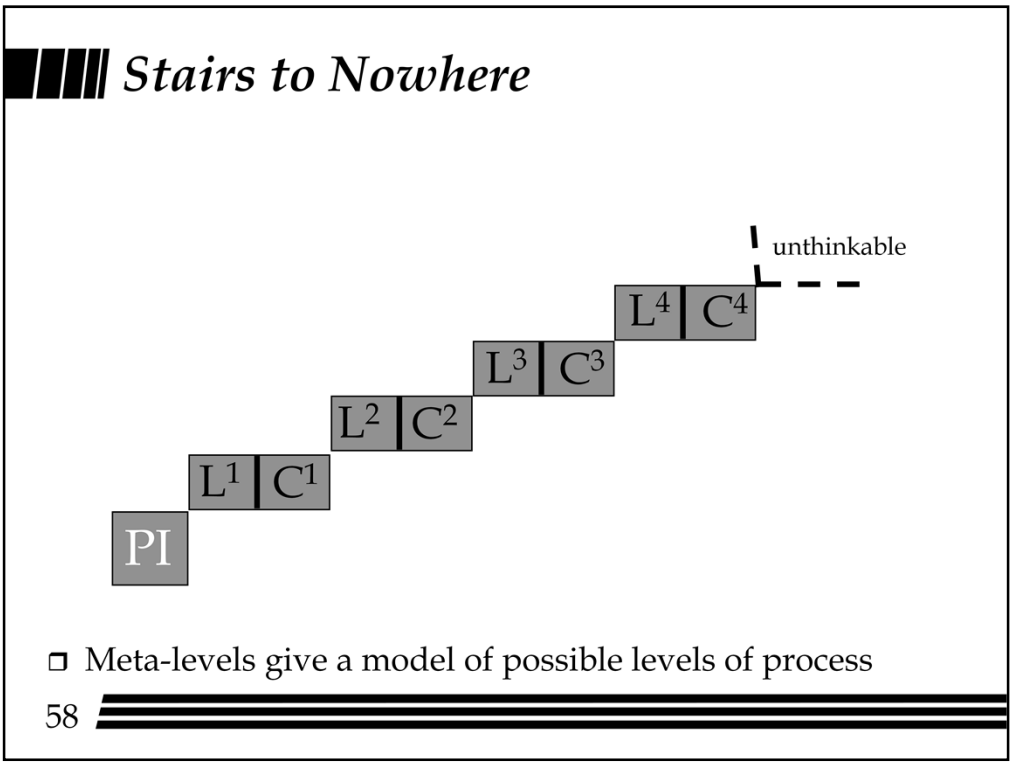
This level is a very important one because it is really where our emphasis should be in our process work. Instead of attempting to maintain the status quo, we should continuously engage in adaptiveness and research simultaneously in order to develop new ways of looking at processes. This is really a virgin territory for Westerners who have ignored this process quality way of looking at things for so long in favor of product quantity that we are really on the edge of much unexplored territory in our culture. It is imperative for us to develop sophisticated understanding of the human dimensions of product development and use the process as a means of introducing those more sophisticated viewpoints into our business endeavors. Now there are suddenly four bottom lines where there used to be only one. As we connect process and product to quality and quantity, we get a field of multiple goals that we are attempting to achieve at once. This field of multiple goals causes us to have to balance priorities instead of overemphasizing one to the detriment of all the others. It is clear that we need to meet this challenge by introducing more sophisticated perspectives on the human dimension of work in order to be able to achieve this goal. These more sophisticated perspectives can only be gained by simultaneously pursuing the complementary approaches of research and adaptiveness in our process development efforts.



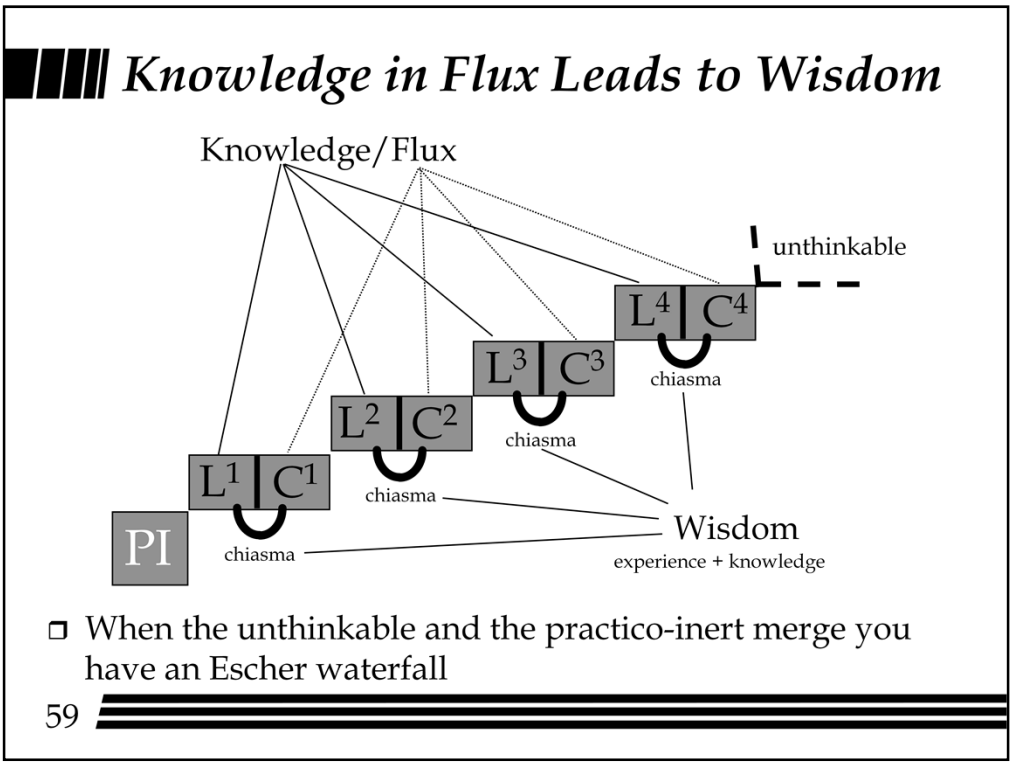
Finally, we arrive at the highest meta-level in which it is possible for us to think. Of course, this is a challenge, and so if you can think a higher meta-level that is not reducible to one of these, then please let me know. At this meta-level Process Creativity and Process Emergence appear. These are complementary opposites. One looks at new things arising from the point of view of the subject/object dichotomy, and the other does not. Emergence of the new can occur from either the inside or the outside. That is by theory, paradigm, episteme, or worldview changes or by the arising of new unheard of phenomena. Creativity, on the other hand is seen as the activity of the genius who produces the new object, whether of art or technology from out of himself. In either case, what is occurring is a combination of flexibility and discovery. In the case of Process Creativity there is the differential application of flexibility and discovery to the next lower level in the series of meta-levels. When we are simultaneously adapting to different circumstances, we are considered flexible. When our research does not uncover what has always been there by searching again, but instead uncovers something completely unexpected, then we class it a very special kind of research that is seen as scientific discovery that uncovers the radically new. Any process that can handle both simultaneous adaptations and the radically new is truly sophisticated, and in fact, we might say has reached the very pinnacle of sophistication. However, this perspective of Process Creativity does not take into account *Process Emergence*. This is to say that Processes themselves are simultaneously flexible and new can appear suddenly without warning. This is what occurs when a new kind of work appears within the midst of known kinds of work. Thus, we must be prepared to look at the arising of completely new kinds of work processes as well as merely make those that exist more flexible by incorporating new discoveries. This is the horizon of process where new work is created and concomitantly old work is destroyed -- for as new work appears, it replaces some kinds of older work which is destroyed in the process.



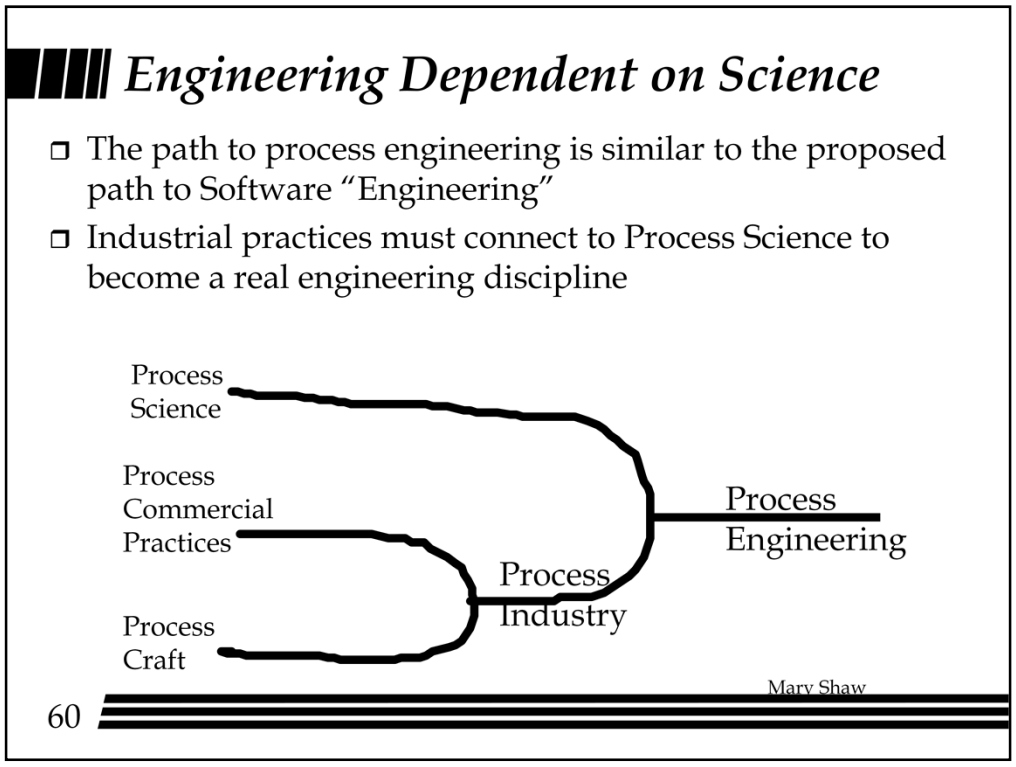
This slide attempts to outline the possible differences between Process Creativity and Emergence as different ways of looking at processes. One explores the absolute fringe of process by looking at the creation and destruction of work as new work appears in our world and old work is devalued and destroyed. Every new thing that appears must be related to by human beings. So with every new thing comes a new kind of work that is the process shadow of the new thing. If we take flexibility and discovery together, then we see this as the process of emergence or the emergence of processes. On the other hand, if we view the flexibility and discovery differentially via the duality, then we see instead a creative subject who makes a discovery and how the system is made more flexibile by becoming simultaneously adaptive to multiple circumstances. From the dualistic point of view, you can either have creativity of subjects or flexibility of objects, but not both at once. From the non-dual point of view you can have a process of emergence instead that is shaping the creativity of the individuals and the flexibility of the organization simultaneously. These are complementary views of the same thing. One views new things as arising from the void of the unthinkable next higher meta-level, and the other views new things as arising within the world as new relations between existing things. One looks back down the series of steps of the ladder of higher logical types, and the other looks up toward the unthinkable as a positive resource that will always keep the processes renewed and ever changing. We need both of these perspectives if we are to escape from dualities and be able to understand the realm of process from a more sophisticated standpoint.



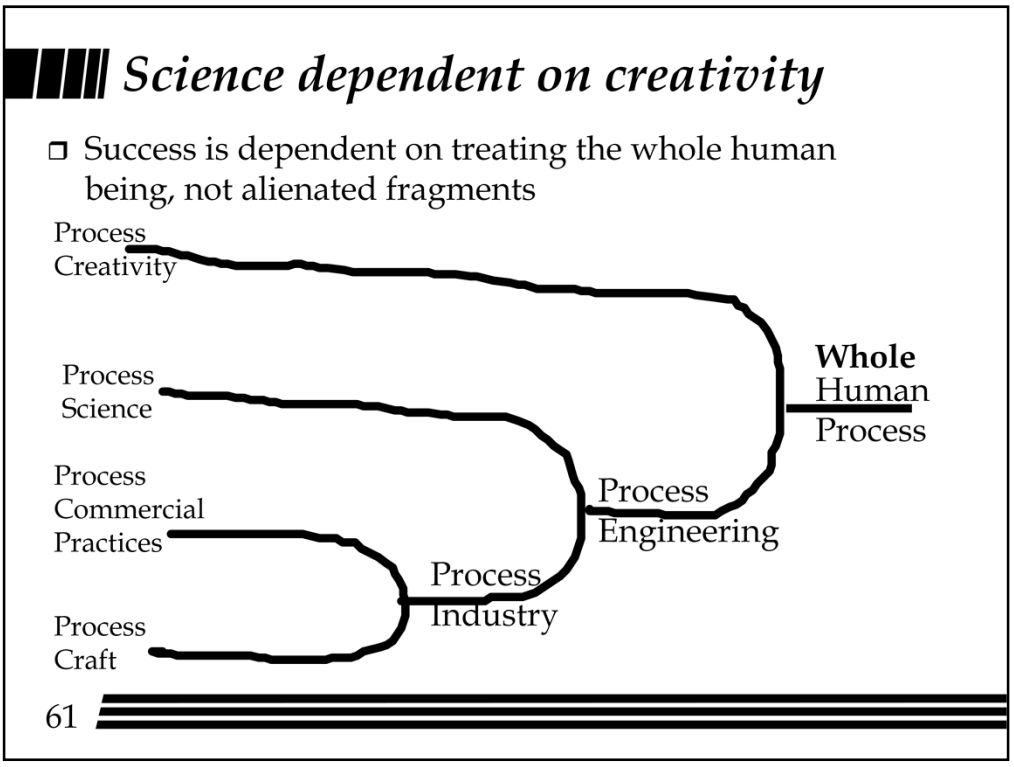
When we look back at our model, we see that what we are provided with is a series of provisional stairs that start in the unconscious (the inert results of static practice) and move upward toward the unthinkable. Maybe the unthinkable is at some higher point than Bateson believes that it appears. But at some point it is going to be very difficult to think the next higher logical type in this progression. The point is that it is only within the progression of these models and meta-models, or languages and meta-languages, that we can actually differentiate things. The meta-levels arise from darkness and fade back into darkness. In fact, we can see this as a kind of a vicious circle or hermeneutic circle in which we are spiraling around as we traverse these meta-levels multiple times. As with the hermeneutic circle of interpretation developed by Heidegger in Being and Time and Gadamer in Truth and Method, each time we go around this circle, there are fundamental changes in our understanding of the levels and the meanings of the terms encompassed by our models and meta-models in the circle. Yet, despite this continuous change by which the very process of modeling changes the thing modeled, this dynamic is preferable to the pure paradoxes engendered by contradictory dualities conflicting which can only be comprehended, if at all, through dialectics. Even though we realize that these meta-levels ultimately collapse into each other, they provide us with a provisional model for understanding processes in the most sophisticated fashion yet developed by logic for avoiding paradoxicality.



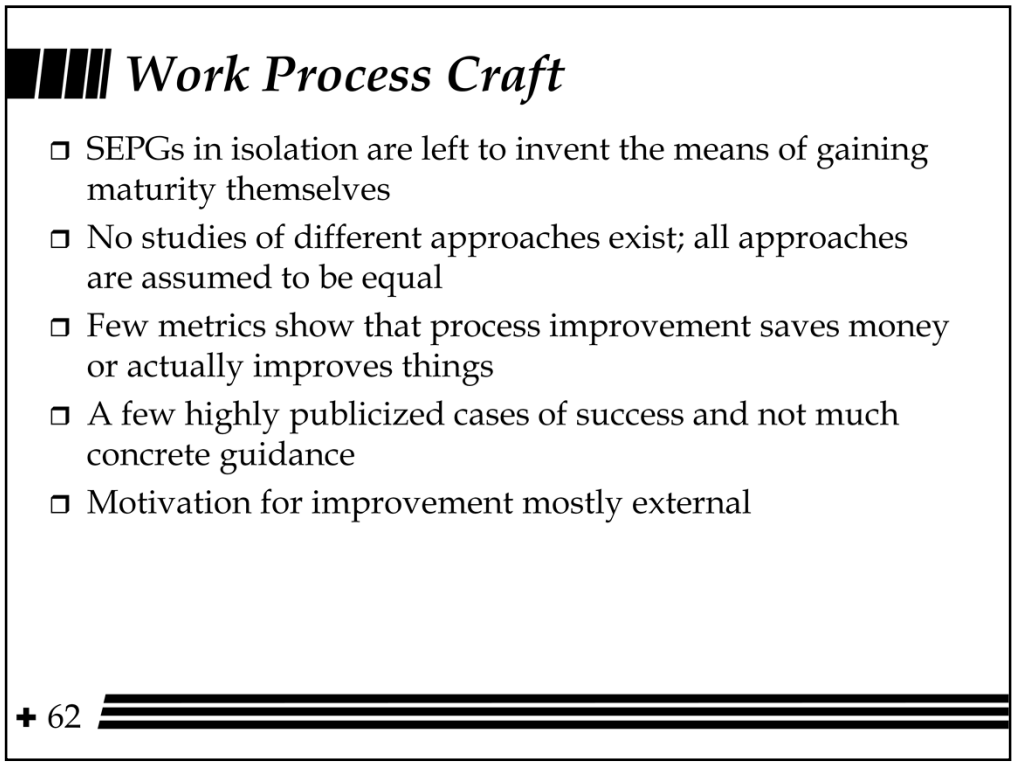
As Wittgenstein has said, once you arrive, you can throw away the ladder. But before throwing it away, let us look more closely at its structure. At each level we have the differential application of the duality of learning and change. The application of learning produces knowledge -- the most persistent aspect of our experience. The application of change and especially the fact that change changes itself gives us a universal flux which is characteristic of all experience to the extent that some philosophers like Heidegger say we are continually falling because of the groundlessness of existence. Knowledge and Flux are produced by all these meta-levels of learning and change. But we can look again and see complementary to this the perspective of non-duality where the chiasma at each level produces wisdom to some degree. Wisdom is the combination of knowledge and experience. When we transform things, it changes who we are. When we control things, we are educated by them. For instance, the teacher who controls the learning of the student is usually the one who learns the most from the exercise of teaching. When we do research, we must adapt to the things studied in order to gain insights about it. Real flexibility is being ready for the totally new thing yet to be discovered that will transform the world. Wisdom comes from the simultaneous application of the two limits of the duality. It is ineffable but should be the ultimate aim of our process work. There must be something in life beyond merely becoming mature and that can only be process wisdom that comes with experience and knowledge after maturity has been reached. If we strive for process wisdom, we will make fundamental changes in our culture merely by seeking and discovering wisdom that inheres within us already.



Mary Shaw has developed a way of looking at Software Engineering's possible trajectory of development as a discipline. We can apply this same possible trajectory to Process Engineering. We can say that what most SEPGs are now engaged in is a Process Craft. When this is combined with Process Commercial practices such as those that the SEI has promulgated in the CMM, then you get the development of a Process Industry where people specialize in process work and gain much knowledge in that one specialty and come together at conferences like this to share knowledge and experiences and perhaps even attempt to learn some process wisdom. However, we will never have Process Engineering until we are able to develop a Process Science and bridge the gap into academia. At this point there is precious little we can call Process Science, and thus our capacity to pursue Process Engineering is severely limited.

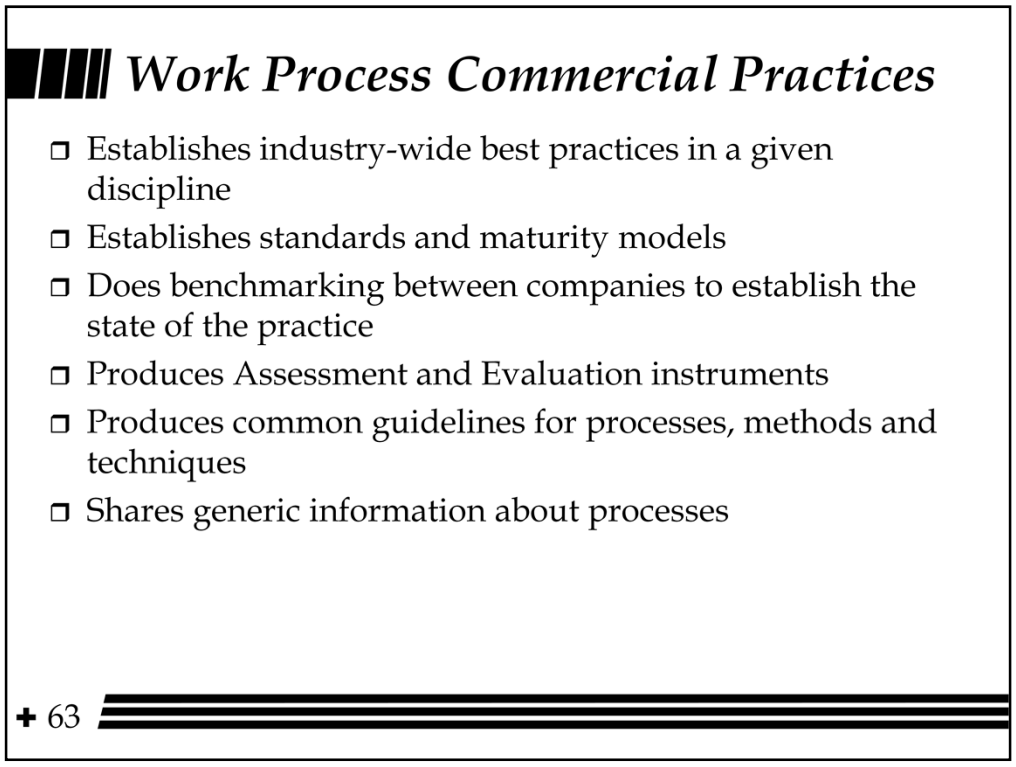


Beyond the development of a Process Science we need to explore the horizons of Process Creativity and develop a whole human process perspective that incorporates the insights of the humanities as well as the physical and technological sciences. The whole human process refuses to fragment our experience and recognizes our human potential. This goal is at the limit of interdisciplinarity because it involves bringing to bear the appropriate aspects of all our arts and sciences into this one problem domain. To do this, we need to become generalists, not just specialists or those who work between a couple of disciplines. We need to know many disciplines and develop a general or liberal education which brings people into process work who have been educated in multiple disciplines and perspectives. This is a far off goal. But it is important to articulate such a goal at the beginning in order to make our framework for comprehending the whole human process as robust and resilient as possible. What we are talking about is human productivity in general, and understanding that will be a monumental task that we leave as a legacy to succeeding generations. But we must begin by not limiting the directions from which insights into human productivity and whole processes may come.

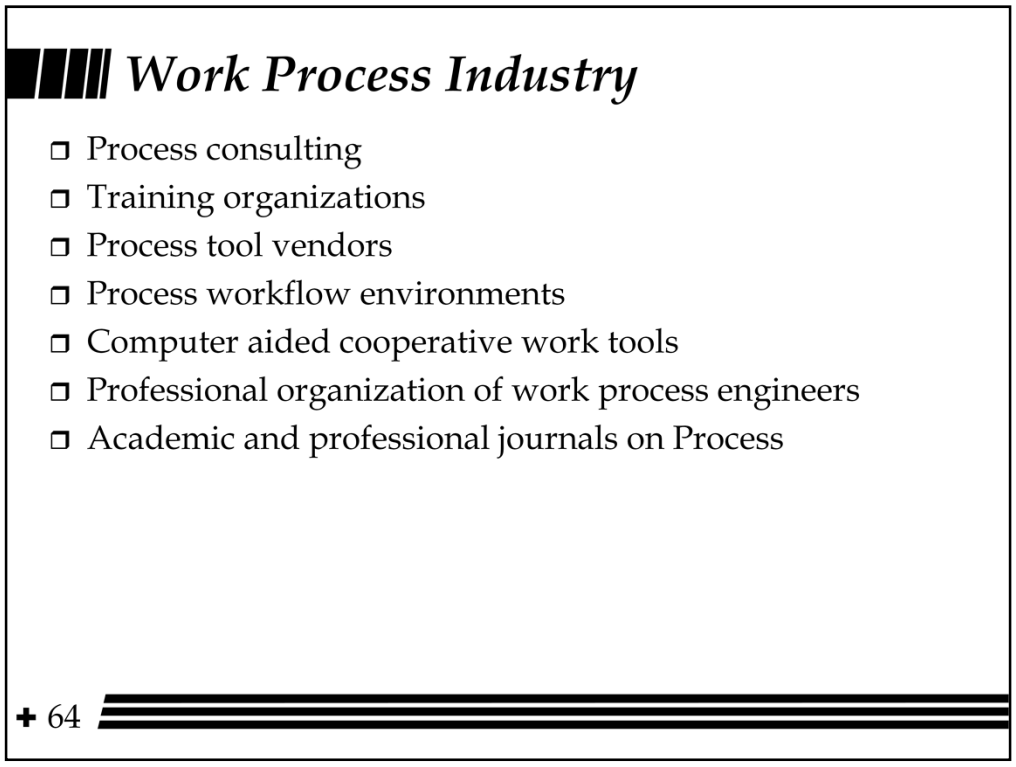


Also, this temporal framework and ultimate goal help us to understand that we are just beginning in this new field. We must note that process engineering is itself an emerging kind of work which has displaced other kinds of work -- it is something special because it is work on work or meta-work. We make conscious the development of processes within our organizations. Is this new kind of work a real contribution and development of our industries' self-consciousness, or is it merely something created by fiat by the SEI who requires an SEPG be formed and which would vanish without trace the moment that the SEI lost its funding. This is an important question we must ask ourselves constantly. Are we providing a real service and advantage that makes this kind of work viable within the competing demands of our organizations that are still embedded in the old way of thinking that there is only one bottom line. Thus, the development of the craft of the SEPG is very important to the viability of the process perspective and its continued survival within businesses. We need to share lessons learned, our knowledge and wisdom in order to learn to survive in a complex and transforming industrial environment. The real test of this perspective and its viability would be made by the closing down of the SEI and revoking the customer demand for process evaluations. But this test will not be made for at least another five years as things stand since SEI has had its contract renewed. There is a pressure on them and all SEPG members to show actual gains in concrete measureables to justify our existence. And that will only be accomplished by the development of a grass roots craft as intelligent people try different approaches and succeed and fail many times in order to find out what works and what does not work. Then, as that knowledge circulates among us, we will establish this new kind of meta-work as something viable and important for organizations to maintain in its own right -- not because it is arbitrarily

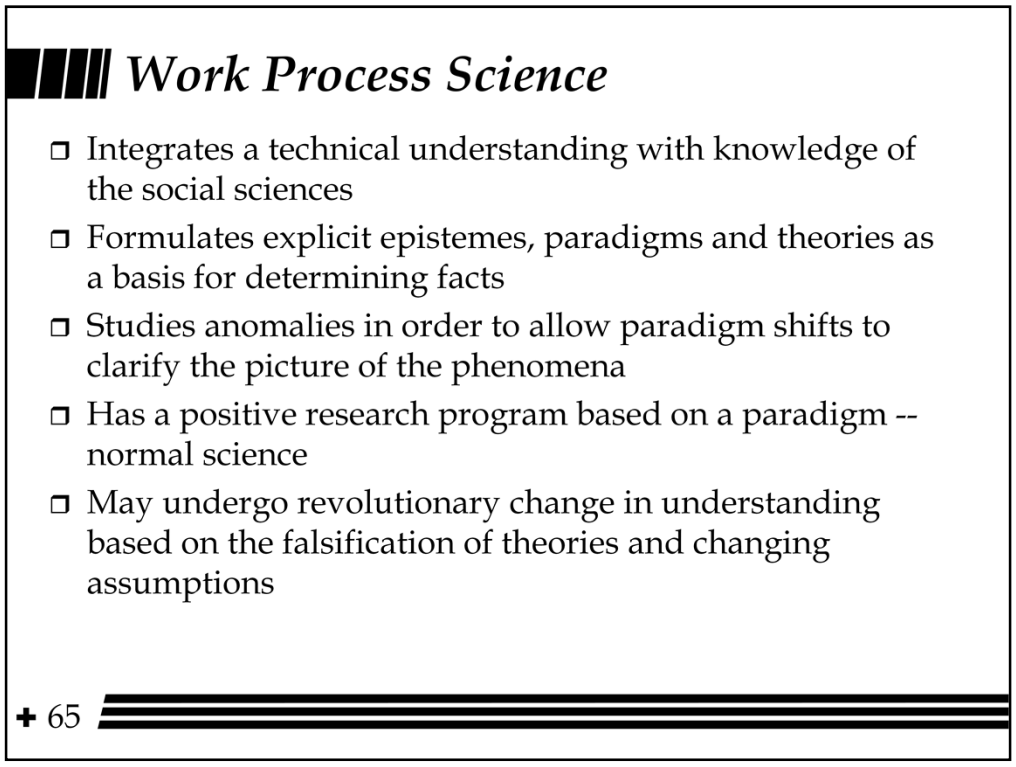
imposed from the outside.



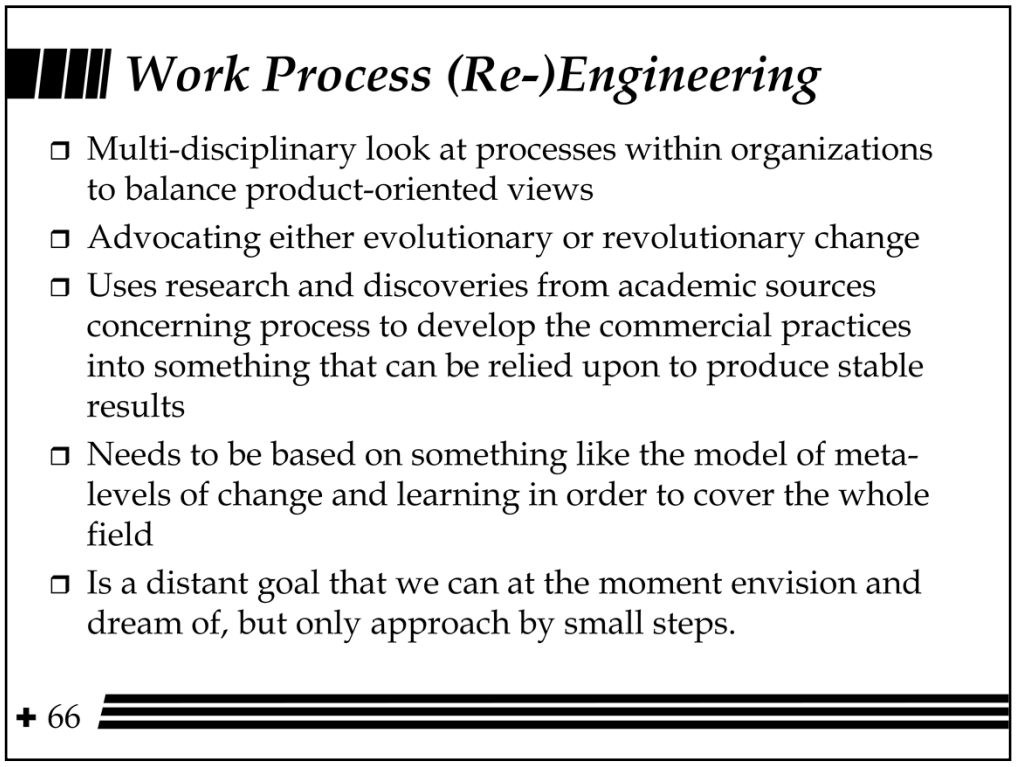
At this point, due to the existence of the SEIs various other similar efforts, there is an upsurge in growth of process Commercial Practices. This is also beginning to create a fledgling spin-off Process Industry, at least with regard to Software Engineering. But we should look at how much of this is taken up in Systems Engineering where it is not yet decreed in order to gage Industry's reaction to these initiatives. Here we see some cooperative effort between SEI and NCOSE to develop the Systems Engineering Maturity Model. But we see that Industry is very slow to pick up on these initiatives even though interest is increasing. It is interesting how much awareness is created by just having a maturity model available. We can see that this has been SEIs key innovation in this arena which they are exploiting by attempting to create maturity models for every kind of work under the sun except process improvement itself. There is a strange silence in this respect. One guide book has been developed for defining an SEPG, but little else has been done. I think we should help ourselves by developing a maturity model for Process Engineering work as a means of establishing a framework for sharing our knowledge and experiences. This very successful innovation should work as well for defining this kind of work as any other. The real problem is that this new kind of work is really meta-work, and so it needs a different kind of description than ordinary routine work.



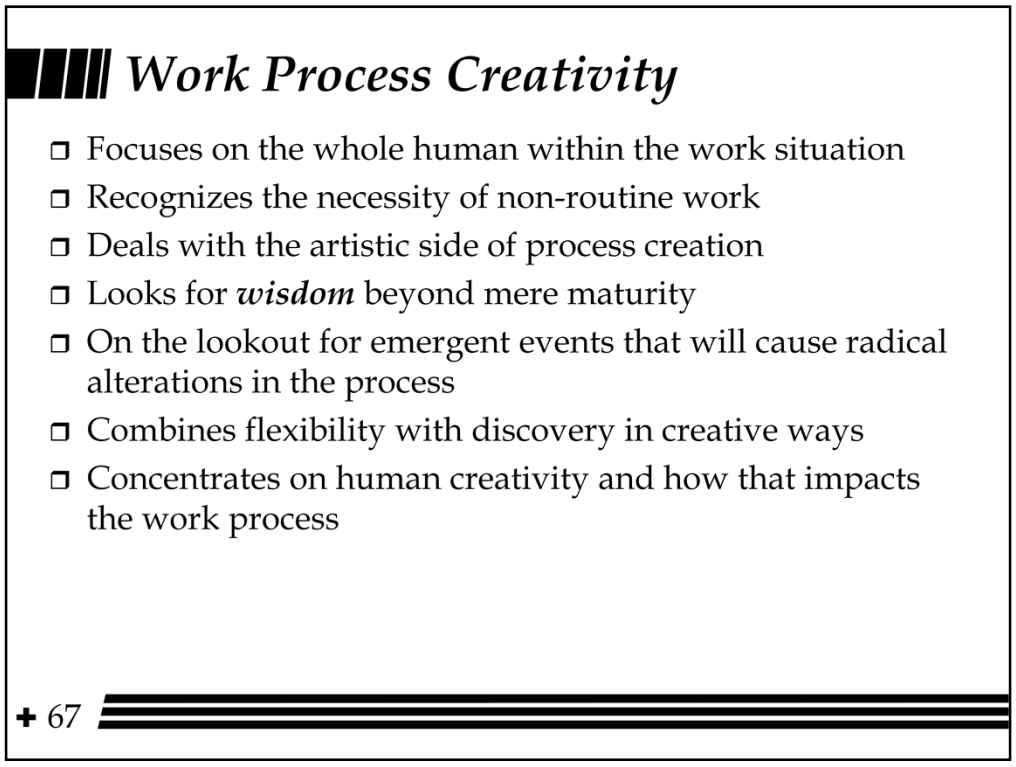
We see many signs of a Process Industry growing up in relation to software processes. There is quite an industry associated with Business Process Re-engineering as well. These are really two aspects of a bigger overall Industry that is in its nascent stage that will serve the professional Process Engineering community. Recently the most activity has been in helping with assessments and in the provision of tools for designing processes. Some workflow products have also appeared that allow designs of workflows to be used to control actual workflows. There is also some activity in training. However, at this point, the industry is in a nascent stage, and it is difficult to tell which directions it will be developing. Except for the SPC there seems little input from this industry toward the definition of WPE as a discipline. The fragmentation of the industry among the disciplines served is a major handicap. The industry needs to strive for generality covering all kinds of work, not just one particular field. Developing niches in other disciplines is also a crucial need. Especially the need to establish a foothold in Systems Engineering and Hardware Engineering where processes are not mandated yet would be an indication of the resilience of this new meta-industry.



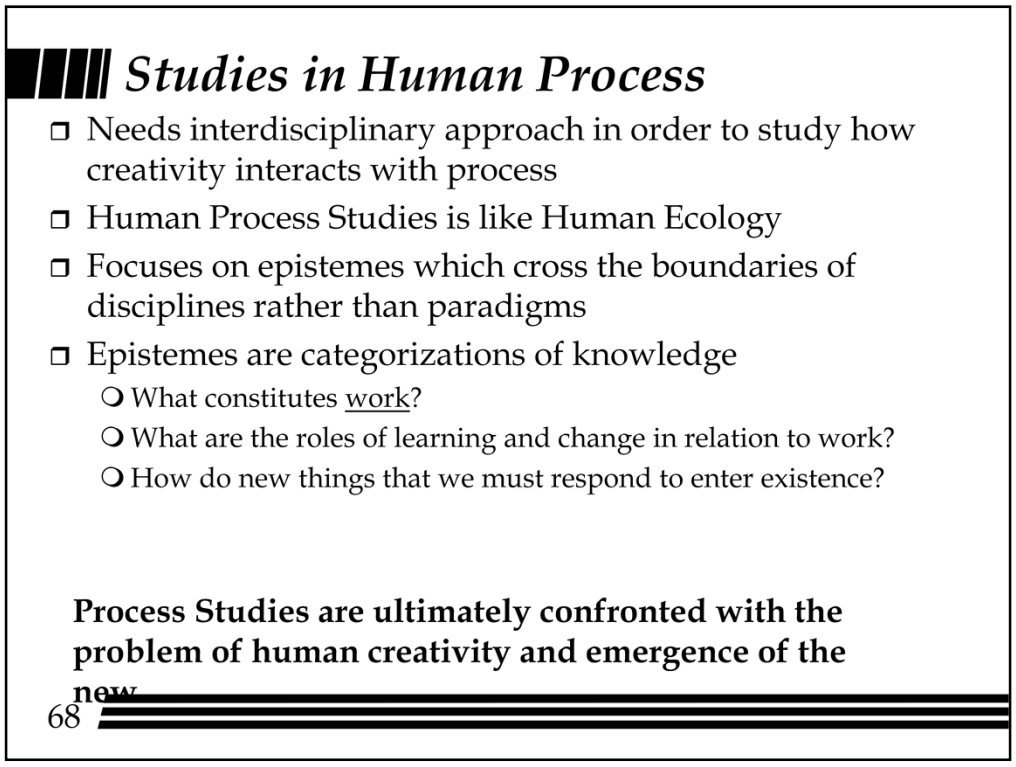
There is a conference on Software Engineering Process and Working Group meetings where developers of formalisms for describing processes meet. However, in general academia has not really recognized the need of developing WPE as a discipline in its own right. Notice the little headway that has been made in creating a Software Engineering Masters program as separate form Computer Science. In most cases, the Computer Science Departments have merely absorbed these efforts and subverted them within their own curriculum. This power struggle for recognition within academia may be a lost cause. There are, of course, examples of schools that have recognized this need and have changed their curricula, making way for the recognition of software engineering as a discipline separate form computer science. Software Engineering is inherently interdisciplinary, and so this causes problems in the academic environment where territories are jealously guarded. So how will WPE fare -- an even more esoteric interdisciplinary subject of study. Split between Business Schools and Computer Science Departments that in a few rare instances might study software processes there is not much hope for recognition of this new discipline. When an interdisciplinary subject does not get recognized, that tends to stifle development within academia. That usually throws the ball back into the court of industry to fund the education and research that needs to be done.



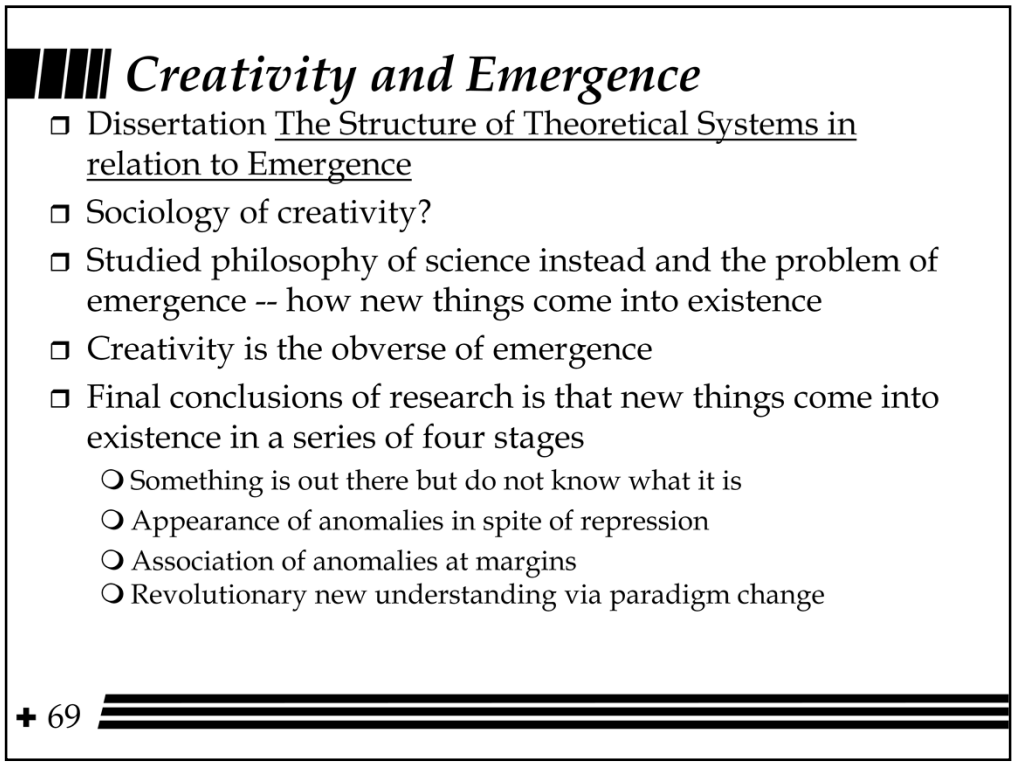
We have begun the process of approaching this goal by attempting to define it rigorously using modern logic to map out its possible characteristics and physiognomy. Every long journey must start with a first step. However, there are real fundamental problems that must be dealt with which are created by the fragmentation of our own tradition. Few people have the necessary integrated view of disciplines to pursue such a lofty goal as a truly interdisciplinary expansion of Process Improvement as we now know it into something more general and at the same time more useful. It is exactly like the problem of abstraction one confronts when one tries to describe work with process descriptions. If they cover lots of instances, then they are too abstract to be useful. Similarly, the vision of a discipline of WPE that addresses multiple disciplines in concert instead of separately may be seen to have the same failings as General Systems Theory -- that sounds good in theory, but gives few practical results that can be used by specific disciplines to describe systems within their domains. In fact, we might learn a lot from General Systems Theory -- because WPE would need to develop a General Process Theory. There have been various attempts to develop process philosophies like that of Alfred North Whitehead in his classic Process and Reality, but no one to my knowledge has attempted to develop a theory of General Processes at the same level that General Systems Theory operates above all the specific disciplines. Process Science would have to take on this task if WPE were to actually flourish as a discipline. WPE would apply the general theory of processes to specific situations within particular disciplines.



Finally we can think of developing WPE within a humanistic context instead of merely a scientific and technological context. This goal is even more distant. But it is important to state it because if we are to ever heal the wounds brought about by the obsession with duality in our culture, we need to begin by addressing the split that prevents us from thinking in humanistic terms about work done within industry. There is a whole kind of critique and study that is never done that needs to be done where artifacts of industrial production are subjected to the kind of critique that artistic artifacts are subjected to on a regular basis within academia. The ignorance of industrial processes by academics is a major barrier to the development of adequate theories concerning the nature of these artifacts. It means that science and technology remain un-self-conscious in their pursuit of their goals. An exception is the discipline that looks at the social construction of Science and Technology (STS). This discipline attempts to treat science and technology from a sociological perspective similar to that developed by philosophy in the development of philosophy of science. Philosophy of science has had a profound effect on what we think we are doing when we engage in scientific discovery. The study of actual historical instances of discovery has disabused us of many of our preconceptions about these activities. Similarly, STS uses a sociology of knowledge perspective to study science and technology, and this has caused a great deal of controversy recently as scientists have realized that their methods are under scrutiny. We can expect this discipline to begin looking at industrial practice as well, and in fact, a few studies have already been done. However, this is a new area of research, and it will probably be some time before it bears fruit. This is mainly because the people doing these studies have not yet gotten to the point of realizing that they must have education and experience in the disciplines they are studying.



So at this point we can only recommend that we start by making various studies in the emerging field of Human Process. This tutorial is a beginning in this direction and will cover the full range of the discipline from looking at kinds of work to imagining what WPE and Process Science might be like, as well as making philosophical statements along the way concerning the nature of human processes from various perspectives within our tradition. This discipline of Human Process Studies might be considered something like Ecology or Human Ecology except with respect to the artificial environment of our own productions rather than the natural environment. Ecology looks at the meta-systems of nature and the relation of many systems to each other within nature. Human Ecology looks specifically at the way humans interact with ecological meta-systems as they are a major influence on the systems within nature and can be considered a very special system in which we have special interest. Human Process Studies instead, looks at the set of production processes by which we construct the artificial aspect of our world and sees it ecologically in terms of the relation between different systems of work. It must ask fundamental questions about the nature of production, consumption, inscription and all other aspects of work. It must ask about the relation of Learning and Change to work and ultimately about how new things and processes can come into existence. Human Process Studies must ultimately confront the problem of human creativity and the emergence of the new which is the most significant problem of our cultural system and tradition. The work of scientists and technologists must be seen within the context of engineering and all the other kinds of work that contribute toward the production of our culture by our tradition. Focusing in on Science and Technology development outside of the context of the ecology of human work gives a false impression that all we do is discover new physical laws and new devices that put them to use.



I have spent many years studying the problem of creativity and emergence within an academic context. It is the defining problem of our culture and tradition. In the process of writing my dissertation on the problem of emergence within the domain of philosophy of science, I discovered that there were stages to the process of emergence that were generally agreed upon within our tradition. I found that there were four specific stages which had a particular configuration. I have based my model of the meta-level of learning and change on this discovery of my own within the academic field. Having transitioned to industry and spent years attempting to master Software Engineering as an industrial practice and discipline I have found that the knowledge that I gained studying philosophy of science has helped me understand software. I have attempted to capture those insights I have gained by working in both industry and academia in a series of papers on Software Engineering Foundations that are available for review. I have found that the problems that the philosophers are dealing with in modern philosophy are very relevant to the understanding of what is going on in the industrial context. And I have found that the problems in industry are intellectually challenging and rewarding. So in my opinion, the cross-pollination between Industry and Academia is essential for understanding our tradition and culture in any real depth. So I have hopes that my attempts to articulate the field of Human Process Studies might contribute to our understanding of ourselves to a greater depth than has been possible by keeping academia and industry apart as has been the case for the most part in the past.

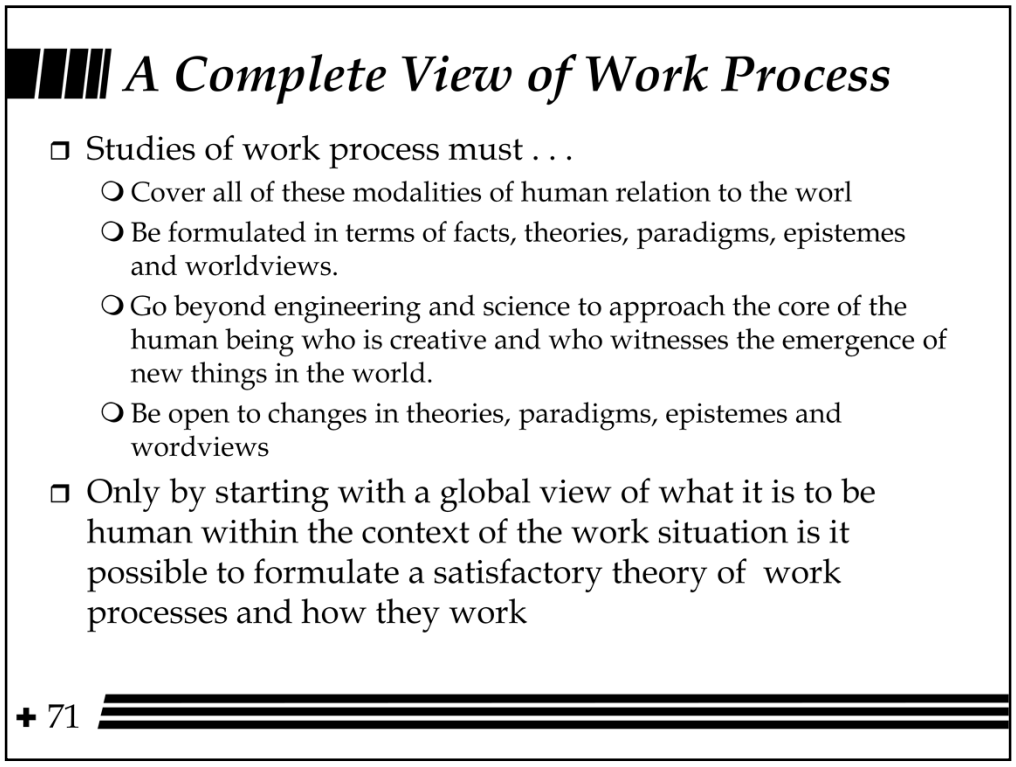
Emergence and Worldview

- The stages of the process of emergence is indicative of structuring of our worldview
- There are different modalities by which we relate to the world, and any genuinely emergent thing must pass through all these modalities to be seen as genuinely new
- There are generally held to be four layers to our handling of things within the world

Pointing	present-at-hand	Frozen Pure Presence	Meta-level 1
Grasping	ready-to-hand	Process Being	Meta-level 2
Bearing	in-hand	Hyper Being	Meta-level 3
Encompassing	out-of-hand	Wild Being	Meta-level 4

- Modern phenomenological ontology studies these modalities of the human relation to his/her world

My studies of emergence link it to the structure of our worldview. There are, in fact, four fairly concrete stages by which any new things come into existence within our world. These stages define the modalities by which we relate to anything within our world. A new thing must establish itself in each of the modalities by which we handle things in our world in order to be recognized as something within the world. Modern ontology studies these modalities of the world and has established their characteristics as they appear to us phenomenologically. There are four layers that have been discovered. These are called kinds of Being. Being was traditionally thought of as being only of one kind, and thus without kind. But modern ontology discovers that there are really many different kinds of Being within the world which reduce to four generic kinds. These kinds are related to each other as a series of meta-levels with a particular modality of human relation to things described by each meta-level. These reduce to very specific psychological components of our experience with things as well. The meta-levels of Learning and Change are based on these meta-levels of Being and act as an operationalization of them. Emergent things come into the world through these stages of Being and continue to function as a productive part of that world by means of the meta-levels of change and learning.



Gregory Bateson says in Mind and Nature that if you study two things at once, then you get higher quality information than if you studied them separately. I have found that this is true in my academic and industrial career. So we must study human processes from both an academic and industrial perspective in order to gain the most insight into these phenomena. So it is necessary to cover all the modalities by which humans relate to the world in our process studies, and we must apply these to all levels of our tradition. If we look at human processes from this broad perspective, then we will be directing our studies toward the phenomenon of emergence of new things and processes. This means we must be open to emergences within our own new discipline as well as being open to the emergence of the discipline itself as a new field of human endeavor. Only by establishing a broad view such as this will it be possible to bring all the resources our tradition and culture have to bear of the studies of Human Process.