Recognition-Primed Decision-Making:
Implications for Record-Keeping by Organizations
Owen Ambur, June 12, 2004

In *Sources of Power: How People Make Decisions*, Gary Klein addresses *naturalistic decision making*, which he defines as "how people use their experience to make decisions in field settings." (p. 1) Contrary to conventional wisdom in decision-making theory and training, he argues:

> ... *the sources of power that are needed in natural settings are usually not analytical at all* -- the power of intuition, mental simulation, metaphor, and storytelling... intuition enables us to size up a situation quickly ... mental simulation lets us imagine how a course of action might be carried out... metaphor lets us draw on our experience by suggesting parallels between the current situation and something else we have come across... storytelling helps us consolidate our experiences to make them available in the future, either to ourselves or to others. (p. 3, emphasis added)

Klein summarizes key aspects of his topic, as follows:

> Features that help define a naturalistic decision-making setting are time pressure, high stakes, experienced decision makers, *inadequate information (information that is missing, ambiguous, or erroneous), ill-defined goals, poorly defined procedures*, cue learning, context (e.g., higher-level goals, stress), dynamic conditions, and team coordination ... (p. 4, emphasis added)

He likes to study people under *time pressure*, such as fireground commanders, who he says make around 80 percent of their decisions in less than a minute. Furthermore, he notes that naturalistic decision making is concerned with *high stakes*, situations in which lives can be lost. Thus, he is "interested in *experienced decision makers*, since only those who know something about the domain would usually be making high-stakes choices." (p. 4)

Klein wants to know "how people carry on even when faced with uncertainty because of *inadequate information* that may be missing, ambiguous, or unreliable -- either because of errors in transmission or deception by an adversary." He is also interested in tasks where the *goals are unclear* and he notes, "***Most of the time when we have to make difficult choices, we do not fully understand what we want to accomplish***."[1] (emphasis added) In addition, he says, "Naturalistic

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[1] The notion that we often do not know what we want to accomplish takes on an ominous hue in the context of military actions such as the Viet Nam war and the invasion of Iraq, for which critics argue not only that objectives are unclear but also that exit strategies may be lacking. Klein's focus is on situations where we have no choice but to act upon inadequate information. However, history suggests that decisions of war and peace must not be taken lightly, without long and serious rational analyses of the very best and most complete information available.

decision making is concerned with *poorly defined procedures*. (p. 5) Finally, he points out, "*Dynamic conditions* (that is, a changing situation) are an important feature of naturalistic decision making. ***New information may be received, or old information invalidated, and the goals can become radically transformed.***" (p. 6, emphasis added)

Establishing some of the background for his research, Klein notes: "the U.S. Government had spent millions of dollars in the 1970s and early 1980s finding out how people make decisions, and the army had used these findings to build very expensive decision aids for battle commanders in the field. Unfortunately, most of the aids were disappointing. No on would use them." (p. 7) He points out that the classical decision analysis method, which he calls *rational choice strategy*, involves five steps in which the decision-maker:

- Identifies the set of options.
- Identifies the ways of evaluating these options.
- Weights each evaluation dimension.
- Does the rating.
- Picks the option with the highest score. (p. 10)

Klein cites research in which Peer Solberg trained his students to use rational methods, yet they failed to do so even when called upon to make a rational and important choice. Instead, they *rationalized* their choices after-the-fact by attempting to demonstrate that they were better than the alternatives. As Klein explains, "Once they had shown this to their satisfaction (even if it meant fudging a little or finding ways to beef up their favorite), then they would announce as their decision the gut favorite that Soelberg had identified much earlier. ***They were not actually making a decision; they were constructing a justification***." (p. 11, emphasis added)

Such behavior is enabled, as well as justified, by the lack of information that makes the relevant factors explicit in advance. In turn, it is easier to justify our behavior after the fact if records are lacking to expose the degree to which we may be "fudging" reality to conform to what we have decided and done. Thus, ***the failure to document our intents and actions becomes both cause and effect of "naturalistic decision-making."*** That is not to suggest there are not many instances in which there is no other rational choice but to engage in such decision-making. Indeed, those are the very instances of interest to Klein. However, it does imply a disincentive for us to create, maintain, and readily share reliable records, since doing so reduces our ability to "fudge" and to "construct justifications" (rationalizations) for our actions after-the-fact.

Indeed, taking this line of reasoning a step further, Charles Ford asserts, "lying is part of the interface between a person's internal and external worlds." He observes, "there is an internal world composed of beliefs, fantasies, and perceived realities, and there is an external world of shared beliefs, or 'reality'." In addition, Ford notes that ego defense mechanisms serve to protect us from information that exceeds our personal capacities to accept failure, which Dietrich Dorner says we "court in predictable ways." In fact, without using the term "naturalistic decision making," Dorner essential refers to it in observing: "... real-world decision-making processes are rarely well documented, and it is hard, if not impossible, to reconstruct them. Reports on real

processes ... are often unintentionally distorted or even intentionally falsified."[2] Indeed, the difficulty in "reconstructing" real-world decision-making processes as they actually occurred is a source of power to those who are in a position to reconstruct such processes in any way they see fit, by telling the story as it best suits their own purposes in retrospect.

In fact, Klein's own study methodology relies upon story telling, which Robyn Dawes says leads inevitably to irrationality, because it leaves out relevant facts.[3] However, Klein makes no apologies for his method while merely explaining: "The study did not just consist of people telling us stories. It is important to select the right incident to study. To define what we want to learn from the stories, we plan strategy, sometimes with checklists of items to cover so that if they do not emerge during the story, we can ask about them." (p. 13) Presumably, Dawes might argue Klein's method of "selecting the right incidents" inherently biases his studies, but be that as it may, Klein further explains his intents, along with the results of one of his studies:

> We sought to explain two puzzles: how the [firefighter] commanders could reliably identify good options and how they could evaluate an option without comparing it to any others. Our results turned out to be fairly clear. ***It was not that the commanders were refusing to compare options; rather they did not have to compare options... the commanders could come up with a good course of action from the start... Even when faced with a complex situation, the commanders could see it as familiar and know how to react***. (p. 17)

This finding is consistent with Donald Norman's assertion that precise information is not required for acceptable results in many circumstances. Norman says precise behavior can emerge from imprecise knowledge for four reasons:

> 1. Much of the information a person needs to do a task can reside in the world...

> 2. *Great precision is not required*... Perfect behavior will result if the knowledge describes the information or behavior sufficiently to distinguish the correct choice from all others.

> 3. *Natural constraints are present*...

> 5. *Cultural constraints are present*.[4]

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[2] For more on Ford's views on the psychology of deceit, see http://ambur.net/Lies.htm. Dorner's thoughts on the logic of failure are discussed at http://ambur.net/failure.pdf.

[3] For more information on Dawes' views on everyday irrationality, see http://ambur.net/irrationality.htm.

[4] For more information on Norman's thoughts on the psychology of everydaythings (POETS), see http://ambur.net/6thGenKM.htm.

While it is doubtful that Klein would call the behavior of his research subjects "perfect," his observations clearly build upon Norman's second point with respect to the ability to act on the basis of less than complete information. For example, based upon the findings of his study of the effectiveness of highly experienced fireground commanders, Klein wrote: "[Their] secret was that their experience let them see a situation, even a nonroutine one, as an example of a prototype, so they knew the typical course of action right away. Their ***experience let them identify a reasonable reaction as the first one they considered, so they did not bother thinking of others***... We now call this strategy ***recognition-primed decision making***." (p. 17, emphasis added)

Klein calls this strategy "a *singular evaluation approach*," to distinguish it from comparative evaluation, and he further explains: "Singular evaluation means evaluating each option on its own merits, even if we cycle through several possibilities... The difference between singular and comparative evaluation is linked to the research of Herbert Simon [who] identified a decision strategy he calls satisficing: selecting the first option that works. Satisficing is different from optimizing, which means trying to come up with the best strategy. Optimizing is hard, and it takes a long time. Satisficing is more efficient. The singular evaluation strategy is based on satisficing." (p. 20)

However, the singular evaluation approach alone could not fully account for the behavior reported by Klein's research subjects. He notes there was a second puzzle to be solved as well; namely, how *did* his subjects evaluate the options? Answering his own question, he says his subjects relied upon "the power of mental simulation, running the action through in their minds." While he acknowledges such a strategy is not foolproof, he asserts, "it is usually better than anything else they can do." (pp. 20-21)

Klein acknowledges, "there are times for deliberating about options. Usually these are times when experience is inadequate and logical thinking is a substitute for recognizing a situation as typical... Deliberating about options makes a lot of sense for novices, who have to think their way through the decision." (p. 23) However, the focus of his attention is on experienced decision-makers and the *recognition-primed decision (RPD) model*, which Klein says "fuses two processes: the way decision makers size up the situation to recognize which course of action makes sense, and the way they evaluate that course of action ***by imagining*** it." (p. 24, emphasis added) In such circumstances, he says decision makers recognize the situation as typical and familiar and, thus, they understand:

- what types of *goals* make sense (so the priorities are set),

- which *cues* are important (so there is not an overload of information),

- what to *expect* next (so they can prepare themselves and notice surprises), and

- the *typical ways of responding* in a given situation.

"By recognizing a situation as typical," Klein suggests decision makers "also recognize a *course*

of action likely to succeed. The recognition of goals, cues, expectancies, and actions is part of what it means to recognize a situation." (p. 24)

In some cases, Klein allows: "situations are more complex ... when the decision maker may have to devote more attention to *diagnosing* the situation, since the information may not clearly match a typical case or may map onto more than one typical case. ***The decision maker may need to gather more information*** in order to make a diagnosis. Another complication is that ***the decision maker may have misinterpreted the situation but does not realize it*** until some*expectancies* have been violated. At these times, decision makers will respond to the anomaly or ambiguity by checking which interpretation best matches the features of the situation. ***They may try to build a story to account for some of the inconsistencies***." (p. 26, emphases added)

In such instances, obviously, it would be better if good and complete records were available to prevent the decision maker from misinterpreting the available information and/or being motivated to develop a "story" that may or may not comport with reality. However, as a practical matter, ***we may prefer to satisfice with the stories we "imagine" and make up ourselves, rather than being stressed by rational analysis of reality.*** That may be particularly true if the impact of such misperception of reality and "misoptimization" of collective and cumulative results falls upon others and we do not foresee such impacts rising to the level of creating a negative feedback loop affecting us. (Garrett Hardin called that dynamic the *tragedy of the commons*.)[5]

Klein notes the most widely recognized models of the classical approach to decision-making arose from the work of Janis and Mann, who "warned that people try to avoid making decisions because of the stress of carrying out the analysis." If Janis and Mann were right, avoidance of stress is yet another reason the we may prefer not to have good records, since such records may make it more difficult to avoid the stress associated with analyzing not only our actions but also our inactions when perhaps we *should* have acted. Be that as it may, Klein cites several prescriptions Janis and Mann offered for making better decisions:

- Thoroughly canvas a wide range of options.

- Survey a full range of objectives.

- Carefully weigh the costs, risk, and benefits of each option.

- Intensively search for new information in evaluating options.

- Assimilate all new information.

- Reexamine the positive and negative consequences of each option.

- Carefully plan to include contingencies if various risks occur. (p. 28)

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[5] Hardin's paper entitled "Tragedy of the Commons," which was published in1968, is available at http://www.garretthardinsociety.org/articles/art_tragedy_of_the_commons.html.

While allowing that Janis and Mann probably did not mean for these practices to be applied in time-sensitive situations, Klein asserts that "***the RPD model predominates even when time is sufficient for comparative evaluations***." (p. 28, emphasis added) Moreover, he suggests: "The problem is that ***the assumptions of the rational choice strategy are usually too restrictive. Rarely is there the time or the information needed to make this type of strategy work***..." Thus, he asserts we should "***be skeptical of courses in formal methods of decision making. They are teaching methods people seldom use*** [and we should] be sensitive to when you need to compare options and when you do not." (p. 29, emphases added) "Sometimes we may need to use formal methods to look at a wide array of alternatives," he says, but "Other times we may judge that we should rely on our expertise to look in greater depth at a smaller set of alternatives..." (p. 30) Consistent with the latter circumstances, the RPD model assumes that with experienced decision makers:

- The focus is on the way they assess the situation and judge it familiar, not on comparing options.

- Courses of action can be quickly evaluated by imagining how they will be carried out, not by formal analysis and comparison.

- ***Decision makers usually look for the first workable option they can find, not the best option***.

- ***Since the first option they consider is usually workable, they do not have to generate a large set of options to be sure they get a good one.***

- They generate and evaluate options one at a time and do not bother comparing the advantages and disadvantages of alternatives.

- By imagining the option being carried out, they can spot weaknesses and find ways to avoid these, thereby making the option stronger...

- ***The emphasis is on being poised to act rather than being paralyzed until all the evaluations have been completed.*** (p. 30, emphases added)

Turning to the power of intuition, Klein observes that it: "*... depends on the use of experience to recognize key patterns that indicate the dynamics of the situation*. Because patterns can be subtle, people often cannot describe what they noticed, or how they judged a situation as typical or atypical. Therefore, intuition has a strange reputation. Skilled decision makers know that they can depend on their intuition, but at the same time they may feel uncomfortable trusting a source of power that seems so accidental." (p. 31)

Klein says, "one basis for what we call intuition [is] recognizing things without knowing how we do the recognizing..." and he observes "intuition grows out of experience." (p. 33) He notes, "intuition has a bad reputation compared with a judgment that comes from careful analysis of all

the relevant factors and shows each inference drawn and traces the conclusions in a clear line to all of the antecedent conditions." However, he asserts research "shows that ***people do worse at some decision tasks when they are asked to perform analyses of the reasons for their preferences or to evaluate all the attributes of the choices***." (p. 34, emphasis added)

On the other hand, he acknowledges, "Intuition is not infallible. Our experience will sometimes mislead us, and we will make mistakes that add to our experience base." (p. 34) Klein says experienced decision-makers are aware their intuition can mislead them and they "rely on their expectancies as one safeguard. If they read a situation correctly, the expectancies should match the events. If they are wrong, they can quickly use their experience to notice anomalies." (p. 35)

Klein observes that some anomalies are "difficult to articulate" and suggests perhaps that is "because they depend on a deviation from a pattern rather than the recognition of a prototype." (p. 39) ***Human beings are fairly good at recognizing patterns but may prefer to ignore deviations from the norm since stressful analysis of alternatives may be required to understand them***, analysis for which -- as suggested by the RPD model and Klein's research -- time, motivation, and mental capacity may be lacking.

Klein relates a story in which one of his colleagues was conducting research by observing decision-making by a team of forest fire fighters: "The team got to an issue and realized that ***they had already made this decision several days ago, but no one could remember what they decided***... Knowing that he was violating the creed of observers just to watch and never to intervene, [Klein's research colleague] flipped back a few pages in his notebook and read to them what their plan had been. ***Jaws dropped open as the team found out how helpful it is to have someone serving as their official memory***." (p. 41, emphasis added)

In light of the fallibility of human memory -- as reported by Schacter and others, and as experienced by all of us -- the fact the team could not remember what they decided is no surprise.[6] ***What is surprising as well as disappointing is that a group of supposedly experienced decision-makers would be so ignorant of the need for record-keeping. While it is an honest appraisal of the realities of individual behavior and group dynamics, it is also a sad commentary on the sorry state of organizational theory and effectiveness that the need for good records is so routinely ignored by organizational decision-makers. It suggests that powerful elements of human nature inveigh against creating, maintaining, and effectively using such records -- as a threat to our intuition and our mental models of the world as it "should" be, at each instant in time, as determined by a majority vote of the imperial triumvirate of me, myself, and I ... and no one and nothing else!***

Klein's observes, "The part of intuition that involves pattern matching and recognition of familiar and typical cases can be trained," and he suggests, "If you want people to size up situations quickly and accurately, you need to expand their experience base." (p. 42) "Another approach," he notes, "is to develop a training program, perhaps with exercises and realistic

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[6] For a discussion of the seven "sins" of human memory identified by Daniel Schacter, see http://ambur.net/memorysins.pdf.

scenarios, so the person has a chance to size up numerous situations very quickly. *A good simulation can sometimes provide more training value than direct experience. A good simulation lets you stop the action, back up to see what went on, and cram many trials together so a person can develop a sense of typicality. Another training strategy is to compile stories of difficult cases and make these the training materials*." (p. 43)

Another way of stating the latter potential is to document and create records of such cases that can readily be shared for training purposes. In addition, a "simulation" relies upon a model of reality as it *might* be, as documented in records based upon images constructed in someone's mind. A "good" simulation is one that comes as close as possible to replicating factors that could be gleaned from records of actual experience with the behavior of objects in reality. If such records are unavailable, it may be preferable to construct simulations from mental models. However, *the risk is that the modeler's natural proclivity to satisfice themselves with their own imaginations may result in failure to document and maintain records of readily observable facets of reality*, particularly aspects of reality that are complex.

The results of Klein's studies showed his subjects were constructing mental simulations that were not very elaborate, with each relying on just a few factors, generally no more than three. In addition, he noted the simulations seemed to run through about six transition states and usually not many more than that. He suggests that those parameters reflect the limits of our working memory, and as a general principle, he asserts:

> *If you cannot keep track of endless transitions, it is better to make sure that mental simulation can be completed in approximately six steps.* This is *the "parts requirement" for building a mental simulation: a maximum of three moving parts. The design specification is that the mental simulation has to do its job in six steps*. Those are the constraints we work under when we construct mental simulations for solving problems and making decisions. We have to assemble the simulation within these constraints... (p. 52)

On the other hand, Klein notes: "there are ways of avoiding the constraints. If we have a lot of familiarity in the area, we can chunk several transitions into one unit. In addition, we can save memory space by treating a sequence of steps as one unit rather than representing all the steps. We can use our expertise to find the right level of abstraction." (p. 52) However, the most relevant suggestion Klein makes with respect to record-keeping is: "*Another strategy for overcoming memory limits is to write things down and draw diagrams to keep track of the transitions*." (p. 53, emphasis added) Setting aside the context of Klein's discourse, which is decision-making in naturalistic settings, this observation may seem obvious. However, *in many instances that do not involve the constraints of "natural" settings, people forget, fail, lack sufficient time, or simply prefer not to document the relevant factors, much less their own thoughts, intents, and actions*.

Klein observes that mental simulations are difficult to construct but suggests that once they have been constructed, they are impressive. Moreover, he says we constantly construct mental simulations in areas about which we are knowledgeable. (p. 57) He posits a generic model that

shows two types of needs -- to explain the past and to project the future. The model, he explains, "shows that we specify the parameters by pinning down the initial state (if we are predicting the future), the terminal state (if we are explaining the past), both initial and terminal states (if we are trying to figure out how the transformation occurred), and the causal factors that drove the transformation." (p. 58)

In attempting to explain an observed behavior, Klein says we simulate in our minds the set of states and transitions that constitutes a plausible *action sequence*. Next we evaluate the action sequence at a surface level to determine whether it is coherent, applicable, and complete. ***Generally, he suggests such mental simulations pass our internal evaluations and constitute acceptable explanations. However, he cautions that does not mean they are correct****.*(p. 61) In short, mental simulation may satisfice within the constraints of the natural setting but that does not make it the ideal when more rational analyses are possible, based upon high-quality information (records).

Klein notes that mental simulations can run from the past into the present or the present into the future, and that they can "help us infer a missing cause, a missing effect, or a bridge between the two." However, he also cautions, "They can also mislead us... ***The biggest danger of using mental simulation is that you can imagine any contradictory evidence away***." In other words, he says, "The power of mental simulation can be used against itself... We can ask what evidence you would need to give up your explanation. Sadly, the answer is that if you are determined enough, you might never give it up. You can continually save the explanation by making it more comprehensive and complicated." (p. 65) Supporting this dynamic are what have been called *de minimus* explanations, which aim to minimize the inconsistencies, as their practitioners simply explain away contrary evidence. (p. 66)

However, in a *de minimus* explanation of his own, Klein does not view as a weakness the fact that **mental simulations** are sometimes wrong. He suggests they are fairly accurate most of the time. "Besides," he argues, "they ***are a means of generating explanations, not for generating proofs***." (p. 68, emphasis added) Accordingly, mental simulations should be used appropriately, when it does not matter greatly whether the conclusion is "right" or merely good enough to avoid serious, avoidable repercussions. The danger is, as Klein cautions: "I do count it as a weakness of mental simulations that we become too confident in the ones we construct. ***One reason for problems such as de minimus explanations that discard disconfirming evidence is that once we have built a mental simulation, we tend to fall in love with it.***" (p. 68, emphasis added) Obviously, it is much easier to maintain such love affairs if records are lacking to confront and separate us from our fantasies and "heartfelt" beliefs.

Some of the difficulties Klein does acknowledge include: "Mental simulation takes effort. Using it is different from looking at a situation and knowing what is happening. Mental simulation is needed when you are not sure what is happening so you have to puzzle it out. When you are pressed for time, you may not do as careful a job in building or inspecting the mental simulations you have constructed... A final shortcoming is that we have trouble constructing mental simulations when the pieces of the puzzle get too complicated -- there are too many parts, and these parts interact with each other."

"Despite these limitations," Klein argues, "mental simulation allows us to make decisions skillfully and solve problems under conditions where traditional decision analytic strategies do not apply." (p. 69) Moreover, he notes: "Marvin Cohen (1997) believes that mental simulation is usually self-correcting through a process he has called *snap-back*. Mental simulation can explain away disconfirming evidence, but Cohen has concluded that it is often wise to explain away mild discrepancies since the evidence itself might not be trustworthy. However, there is a point when we have explained away so much that the mental simulation becomes very complicated. At this point we begin to lose faith in the mental simulation and reexamine it. We look at all of the new evidence that had been explained away to see if maybe there is not another simulation that makes more sense. Cohen believes that **until we have an alternate mental simulation, we will keep patching the original one. We will not be motivated to assemble an alternate simulation until there is too much to be explained away**." (p. 69, emphasis added)

That seems an especially likely occurrence if our mental simulations have no representation in the real world, i.e., if their salient features remain undocumented in records that we and others can analyze. As Klein cautions: "The problem is that **we lose track of how much contrary evidence we have explained away so the usual alarms do not go off.** This has also been called *the garden path fallacy*: taking one step that seems very straightforward, and then another, and each step makes so much sense that you do not notice how far you are getting from the main road." (pp. 69-70, emphasis added) Contributing to the problem, people may be over-confident once they have devised a plan of action, particularly if they are not highly experienced. Klein says, "You can ask them to review the plan for flaws, but such an inspection may be halfhearted since the planners really want to believe that the plan lacks flaws." (p. 71) In other words, assessing the relevance and truth of mental simulations requires rational analyses. Such analyses require time that may not be available as well as effort for which will may be lacking.

As one means of overcoming those problems, Klein discusses the strategy of building decision scenarios, which "are like mental models except that they are written down, charted out, and developed to change the way executives think." He suggests, "The problem with forecasts and conventional scenarios is that they try to provide answers. Decision scenarios, in contrast, were built to describe the forces that were operating so the executives could use their own judgment... Typically the decision scenarios featured only a few variables, usually around three, and a few transitions, rarely more than five or six." (p. 72) Klein says "mental simulations can gain force when made explicit" and that, when made explicit, such decision scenarios prompt executives to respond more favorably than they do to forecasts based on statistics. (p. 73) **Writing models down and making mental simulations explicit means to create records that persist and, thus, can be scrutinized and analyzed over time, as often and for as long as necessary to understand their meaning.** If that is done, it is easy to understand why executives might find them more persuasive than sterile statistical forecasts, since their own roles and responsibilities are made more self-evident in decision scenarios than in statistical forecasts.

In an observation highly relevant to many corporate scandals resulting from the actions of executives, Klein cites research evidence appearing to indicate that a subject "distorted data flow in an unconscious attempt to make available evidence fit a preconceived scenario." He also

highlights another instance that "... seemed to be a clear case of expectancy bias, in which a person sees what he is expecting to see, even when it departs from the actual stimulus." (p. 84) Neither of these instances is unusual. To the contrary, they probably are indicative of what commonly occurs when assumptions are not made explicit and when realties are not documented and made clear in persistent records having the attributes outlined in ISO 15489.

With respect to jury trials, which are supposed to be decided solely on the basis of the evidence presented in court, Klein suggests that may not be the way verdicts are actually reached. "Instead of passively listening to the attorneys," he says, "the jurors are actively trying to build their own stories, their own explanations. Then they compare their stories to those presented by the two attorneys, and select the one that more closely matches their own story." (p. 90) Moreover, with reference to physicians and medical diagnoses, he argues, "The ideal we sometimes have of a machine-like diagnostician carefully tagging new data and withholding judgment does not fit the reality of what people do." (p. 91) Instead, he suggests, "Someone who has sized up a situation will be aware of some typical ways of reacting to it" and often "the person just chooses the first action thought of, without deliberating about the little details."

On the other hand, Klein cautions, "***that simple model does not describe the major decisions. Few of us are so impulsive that we always act out the first thing that pops into our heads.***" (p. 92, emphasis added) "Certainly," he allows, "there are times to use a comparative rather than a singular evaluation of options... The RPD model describes how people can make decisions without comparing options, but the RPD model does not describe the only strategy people use in naturalistic settings. ***Even with time pressure, there will be times when you may need to compare different options.***" (p. 93, emphasis added) Thus, ***as a matter of principle and routine practice, the aim should be to ensure, to the greatest degree practical, that decision-makers have access to the very best, most up-to-the-minute information possible*** -- regardless of how little or how much time they may have to consider and act upon it.

Klein notes that the rational choice model has been called a *compensatory strategy*, since a weakness on one evaluation dimension can be offset by strengths on other dimensions. However, he points out that researchers have identified noncompensatory strategies that are simpler to use, and he says studies have demonstrated that decision makers in natural setting use those simpler strategies. For example, he says, "Instead of trying to see if the strengths on one dimension compensate for the weakness on others, we may use methods such as selecting the option that is the best on the dimension that is most important and ignoring the other dimensions." Another simple strategy Klein highlights is *elimination by aspects.* All of the options are evaluated on the most important dimension; those failing to meet a standard are dropped, and the surviving options are evaluated on the next-most-important dimension. Yet another strategy he cites is "a face-off procedure in which one option is compared to a second, and the winner gets compared to a third, and then the winner of that face-off is compared to a fourth, and so on. ... the comparison considers only two options at a time." (p. 94)

Klein observes that people tend to use singular strategies when *time pressure* is greater, when they are more *experienced* in the domain, when conditions are *dynamic*, and when goals are *ill defined*. By contrast, people are more likely to use comparative evaluation when they have

to *justify* their choice, when *conflict resolution* is a factor, when the decision maker is trying to *optimize* (find the best course of action), and when the situation is *computationally complex*. However, "even when decision makers are comparing options and trying to find the best one," Klein asserts, "they may not be using rational choice strategies such as assessing each option on a common set of criteria. The process may be more like running a mental simulation of each course of action and comparing the emotional reactions -- the discomfort or worry or enthusiasm -- that each option produces when it is imagined." (pp. 95 & 96)

Klein says, "we will be more likely to compare options when faced with unfamiliar situations" because "a lack of experience will prevent us from generating reasonable options, or will at least reduce our confidence in the options we do generate." (p. 96) Another, logical and closely related reason is that if a problem has been sufficiently well-clarified and stated, the solution may suggest itself, thereby obviating the need to consider alternatives. Conversely, lacking a clear statement of the problem, we have no logical choice but to consider alternatives that might lead to the differing solutions required by potentially varying requirements posed by as yet unknown aspects of the problem. Thus, it is not merely the experience of the decision-maker that matters but also the definition of the problem. However, based upon his research, Klein has found that people have used recognitional strategies in large percentages of the time, ranging from 46 percent to 96 percent. Only in a small number of instances have he and his colleagues found evidence of comparative evaluation of options. (p. 99)

Klein sums up the strengths and weaknesses of the Recognition Primed Model as follows:

> *... the RPD model is incomplete; it does not cover teams, organizations, issues of managing workload and attention. The RPD model does not describe the strategies people use when they do have to compare options in natural settings. The significance of the RPD model is that: It appears to describe the decision strategy used most frequently by people with experience. It explains how people can use experience to make difficult decisions. It demonstrates that people can make effective decisions without using a rational choice strategy*. (p. 102, emphasis added)

Klein highlights two kinds of implications growing out of the RPD model -- recommendations about training and about designing systems. With respect to training, he notes:

> The standard advice for making better decisions is to identify all the relevant options, define all the important evaluation criteria, weight the importance of each evaluation criterion, evaluate each option on each criterion, tabulate the results, and select the winner. In one form or another, this paradigm finds its way into training programs the world over. Again and again, the message is repeated: careful analysis is good, incomplete analysis is bad. And again and again, the message is ignored; trainees listen dutifully, then go out of the classes and act on the first option they think of. (p. 102 & 103)

Moreover, he suggests the reasons for failure of the rational choice approach are clear:

- The rigorous, analytical approach cannot be used in most natural settings.

- The recognitional strategies that take advantage of experience are generally successful, not as substitute for the analytical methods, but as an improvement on them.

- The analytical methods are not the ideal; they are the fallback for those without enough experience to know that to do. (p. 103)

Klein asserts the key to effective decision making is to build up expertise and, thus, he suggests it is tempting to develop training to teach people to think like experts. However, in most settings, he says that is too time-consuming and expensive. Instead, he suggests that perhaps we can teach people to learn like experts, and he notes a number of ways that experts learn that are common across different fields of endeavor:

- Engage in deliberate practice, so that each opportunity for practice has a goal and evaluation criteria.

- Compile an extensive experience bank.

- Obtain feedback that is accurate, diagnostic, and reasonably timely.

- Enrich experiences by reviewing prior experiences to derive new insights and lessons from mistakes. (p. 104)

In particular, he notes, "The strategy of compiling an extensive experience bank appears important. But the mere accumulation of experiences may not be sufficient. The *experiences need to include feedback that is accurate, diagnostic, and timely*." (p. 104, emphasis added) "In addition to feedback," Klein observes, "expertise may be affected by the opportunity to *reflect on experiences* ... afterward, there is time to *go over the ... record* to look for opportunities that were missed, early signals that were not noticed, or assessments and assumptions that were incorrect. In this way, an experience ... can be recycled and reused." (p. 105, emphases added)

However, Klein cautions: "Reviews generally occur after mistakes, and not as a routine. And when they do occur, they seem to be directed at what happened, whereas the cognitive critiques are aimed at the thought processes of the key decision makers. Moreover, reviews are conducted in a forum that is usually not conducive to reflection. Also, in most settings there are not always enough real incidents to build expertise quickly enough. That is why it is important to make effective use of the incidents that occur." (pp. 106-107) In these assertions, Klein appears to agree with Dawes regarding the need to routinely record actions and results as they occur, rather than merely after-the-fact when problems have become salient. However, Klein's methodology relying upon post-action storytelling may not result in sufficiently detailed, unbiased, and reliable information to reveal and avoid reliving many mistakes -- particularly since, as Dorner observes, we tend to court failure in predictable ways.

Be that as it may, Klein suggests another application of his research is to use decision

requirements for designing software systems. For example, he notes, "When design engineers are given a new project, they are usually told what the system is supposed to accomplish, that is, what it will do if it works the way it is supposed to. Yet they are rarely told what the key decisions are that the system must help the operator make or the types of strategies or rules of thumb that the operator is likely to use." (p. 107) Toward that end, Klein addresses *leverage points* as a focus for initiating insightful problem solving. (p. 113) When evaluating whether a contemplated action will work, he says experienced decision makers can try to improve the action or try to work with a different leverage point. (p. 114)

Another approach he suggests is to try to modify the goals, which in turn may reveal different leverage points. In any event, he notes, "The evaluation process can alter the understanding of the situation itself." (p. 114) He acknowledges that "Leverage points are just possibilities -- pressure points that might lead to something useful, or might go nowhere." Nonetheless, as he understates, "Expertise may be valuable in noticing these leverage points." (p. 116) In some cases he also suggests "a sense of 'creative desperation' [may drive the] search for leverage points, no matter how risky." (p. 117)

Again, acknowledging that the focus of Klein's interest is decision making in natural settings, it seems likely that inappropriate use of RPD when the rational choice model is more applicable may be a cause of the results that lead to "creative desperation." Also, it is unclear how the identification of different leverage points, modifications of goals, and efforts to improve contemplated courses of action differ from the rational choice model -- unless rational choosing is confined to a single point in time and the rational decision-maker is not allowed to learn and change course as experience suggests over the elapse of time. Unless the dynamics Klein cites are completely random, it seems likely that some consideration of alternatives must occur, however minimal such considerations might be.

Klein cites a theme that is repeated in many domains: "***Experts know how the official records are compiled***, whether they are maps, computer manuals, diagnostic tests, or air crew checklists. ***They know when the steps have to be followed and when to make exceptions***." (p. 117, emphases added) Given good will and sufficient expertise, decision makers might be trusted to decide when to make exceptions. However, experience has shown that ***those in positions of power commonly make exceptions that are contrary to the interests of their stakeholders***. Indeed, ***they use their knowledge of how the "official records are compiled" to serve their own short-term interests, often at great longer-term cost to those upon whose trust they rely***.

Klein notes: "Leverage points provide fragmentary action sequences, kernel ideas, and procedures for formulating a solution. Experts seem to have a larger stock of procedures that they can think of to use as starting points in building a new plan or strategy. These can serve as holds to get the process moving, or in combination with other fragmentary actions. Novices, in contrast, are often at a loss about where to begin." In addition, Klein says: "We also need to spot leverage points that can work against us, in order to learn the weaknesses in our plans. These are sometimes called *choke points*... By noticing leverage points that can work against us, we buy ourselves time to take preventive action before the emergency arises." (pp. 117-118) Finally, Klein suggests: "we need to tie the leverage points together into a path in which we can feel

confidence. Once we see how to move ... we have a plan. We also know we will be changing the plan ... as we notice new features. We may have gaps in the plan where we do not see the connection but trust that we will find it when we get that far." (p. 119)

Thus, ***it is especially important to document and maintain good records of the attributes and actions taken around leverage points. Moreover, by definition, experienced decision makers and others in positions of power are themselves "leverage points" so records of their intents and actions are particularly important to create, maintain, and share with stakeholders***.

Klein suggests: "People become problem solvers when they have to find a way to create a new course of action, improvise, notice difficulties way in advance, or figure out what is causing a difficulty... [P]roblem solving ... is constructive in the sense that solutions can be built up from the leverage points and that the very nature of the goal can be clarified while the problem solver is trying to develop a solution." (p. 121) In addition, Klein asserts: "To solve ill-defined problems, we need to add to our understanding of the goal at the same time we generate courses of action to accomplish it. When we use mental simulation to evaluate the course of action and find it inadequate, we learn more about the goal we are pursuing. ***Failures, when properly analyzed, are sources of new understanding about the goal***." (p. 122, emphasis added)

Colloquially, that dynamic is known as "flying by the seat of our pants." However, Dorner and Dawes argue that ***failure to adequately document the routine, when neither success nor failure are particularly salient, leaves us without the necessary information to determine the factors that contribute to failure***, including failure that may be catastrophic.[7] Naturally, failure to adequately document the routine becomes a self-fulfilling justification for the continued use of recognition-primed decision making (singular evaluation) rather than rational decision making when anomalies occur. Because we have failed to create and maintain such documentation, we have no rational choice but to continue to rely upon our "expert" intuition. Conveniently, it also means we are enabled to recreate history as suits our current purposes.

Klein observes that problem solving can be viewed as consisting of four processes: problem detection, problem representation, option generation, and evaluation. (p. 122) He says, "Constructing a course of action is the component most people think of as the output of problem solving: generating a plan for achieving a goal." However, "regardless of how the option is generated, it will need to be evaluated, often using mental simulation... The goals affect the way we evaluate courses of action, and the evaluation can help us learn to set better goals. The goals determine how we assess the situation, and the things we learn about the situation change the nature of the goals. Goals define the barriers and leverage point we search for, and the discovery of barriers and leverage points alters the goals themselves." (p. 123)

Klein sums up the *problem detection process* as follows: "Something happens, something anomalous, and we may notice it." Turning to the *problem representation function*, he says it

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[7] For a discussion of Dorner's views on the logic of failure, see http://ambur.net/failure.pdf. Dawes' thoughts on everyday irrationality are aired at http://ambur.net/irrationality.htm.

encompasses the way we identify and represent the problem. He views leverage points as part of the representation of the problem and he notes that we try to determine the leverage points that can be turned into solutions, as well as the choke points that can become impediments. "When a gap or opportunity is identified," he says, "often we will try to *diagnose* it. This is the mental simulation function in which we try to weave together the causes that might have led to the current situation." Moreover, he suggests: "We may also want to project trends based on the diagnosis, to see how the situation may change. This is the forecasting process. In many situations, the primary need is to build a reliable forecast in order to determine whether the difficulty will disappear on its own, or will get worse and require action. The problem representation and diagnosis processes are linked to forecasting, which usually requires mental simulation." (pp 123 & 124)

Klein notes that most natural goals are ill defined. (p. 128) "Because it is so systematic," he says, "we are attracted to the standard advice of following the stages from problem definition to option generation and evaluation. Yet in dealing with an ill-defined goal, the advice is sure to fail. The first step, define the goal, can never be completed if the goal is ill defined, and that means the problem solver is not supposed to go further." Thus, he argues, ***The standard method for solving problems is worse than useless [because] it can interfere when people try to solve ill-defined problems***." (p. 129, emphasis added)

Klein observes that problems can be unstructured in multiple ways, not merely because the goals are vague. For example, he points out "a problem can be ill structured if the initial state is not defined, the terminal state is undefined, or the procedure for transforming the initial state into the terminal state is undefined." Thus, he says, "For some problems, clarifying the initial state is the most important outcome [because] the focus of problem solving can be very different depending on the nature of the problem." (pp. 129 & 130)

Klein notes that computers are very good at rapidly searching through masses of information and that a primary approach of artificial intelligence is to spread out the alternatives exhaustively and filter through them efficiently. He observes the same strategy used in analytical approaches to decision making, which call for the generation of many options in order to be reasonably sure that the set includes a good one. The options are then supposed to be filtered to weed out those that are inadequate while identify one that is likely to succeed. Finally, since computational approaches try to reduce thinking to searching, he suggests they show their greatest promise with tasks that can be transformed into searches. (p. 133)

Klein's point is that human thought is not like artificial intelligence and that such intelligence is not well suited for application in natural decision-making situations. However, it is doubtful that he intends to argue computers and various forms of artificial intelligence do not have great contributions to make when time and circumstances allow for their effective usage, e.g., when large amounts of highly accurate and reliable information can be generated and made available for analyses.

In order to define problems and generate novel courses of action, Klein says we draw on experience to make judgments about:

- Reasonable goals and their attributes.
- The appearance of an anomaly.
- The urgency of solving a problem (whether to take anomalies seriously or treat them as transients that will go away).
- What constitutes an opportunity worth pursuing.
- Which analogues best fir the situation, and how to apply them.
- The solvability of a problem.

He suggests each of these judgments is "its own source of power" and that these sources overlap considerably with those required for decision making. Indeed, he suggests there are two primary sources of power for individual decision making as well as for problem solving -- pattern matching (the power of intuition) and mental simulation. Klein says pattern matching provides a sense of reasonable goals and their attributes, as well as giving us a basis for detecting anomalies and treating them with appropriate seriousness. In addition, he says it helps us notice opportunities and leverage points, discover relevant analogues, and get a sense of how solvable a problem is. Combined with pattern matching, Klein say mental simulation is "the engine for diagnosing the causes of the problem, along with their trends. It plays a role in coalescing fragmentary actions to find a way to put them together. And it is the basis for evaluating courses of action." (pp. 141 & 142)

By contrast, Klein notes rational decision making first requires a determination of what the values of different parameters ought to be. Next the actual values are determined, followed by a determination of when the values changed. "Then," he says, "you find out what else changed around that time, and, presto, you have uncovered the cause of the problem." He suggests, "This approach works as long as you are dealing with well-defined goals and fairly static work settings." Moreover, he allows, "Of course, it is a good idea to try to define the goal as clearly as possible before proceeding." However, he is skeptical about rational problem-solving methods because "they do not prepare you to improvise, act without all of the relevant information, or cope with unreliable data or shifting conditions. They do not prepare you to learn about the goals throughout the problem-solving process." (pp. 142-143) Klein's points are well taken, but an issue that he fails to address is whether the necessary information for rational decision making may be lacking for good cause, or simply because of poor preparation -- particularly poor record-keeping practices and systems.

Klein suggests one application of his research findings is to temper our enthusiasm for creativity programs, including brainstorming, synectics, and permutations of elements.[8] "The permutation of elements," he explains, "involves specifying all the different possibilities for each variable and then combining them to create an assortment of alternatives." And he says, "These procedures seem like desperate attempts to use systematic procedures as a substitute for imagination. *In*

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[8] Synectics is defined by Webster's New Collegiate Dictionary (1975) as "a theory or system of problem-stating and problem-solution based upon creative thinking that involves the free use of metaphor and analogy in informal interchange within a carefully selected small group of individuals of diverse personality and areas of specialization."

most domains, we need not off-the-wall creative options but a clear understanding of the goals. The creativity methods may sometimes look promising for identifying new possibilities, but the cost is having to plow through all the poor ideas. Even *brainstorming, a method that has been around for decades, seems primarily a social activity. If the participants generate their ideas individually, the resulting set of suggestions is usually longer and more varied than when everyone works together*." (p. 143, emphases added)

Klein suggests that another application of the concepts of leverage points and nonlinear problem solving is to gain better understanding of planning, He notes that planning is not a simple, unified activity and that plans differ based upon the functions they serve, including the following:

- Directing and coordinating the actions of team members.
- Developing shared situation awareness.
- Generating expectancies.
- Supporting improvisation.
- Detecting inconsistencies.
- Establishing time horizons.
- Shaping the thinking of the planners. (p. 143 & 144)

He says the latter function, to promote individual and team learning, can overshadow the others. "*Sometimes*," he says, "*planners engage in lengthy, detailed preparations that quickly become obsolete, yet they continue with the same process, again and again; it appears that the function is to help them all learn more about the situation and to calibrate their understanding, rather than to produce plans that will be carried out more successfully*." (pp. 144-145, emphasis added)

Klein says studies of the failure of strategic planning have identified inherent limitations that are "consistent with the naturalistic decision-making perspective to support expertise and to be wary of how *decomposing tasks and performing context-free analyses can degrade intuition*... To solve an ill-defined problem," he notes, "we have to clarify the goal even as we are trying to achieve it, rather than keeping the goal constant... Structuring a problem is using a barrier or leverage point to construct a course of action, not organizing a problem into a space that can be searched efficiently... Problem solving is a constructive process. Computational approaches to problem solving rely on procedures, such as searching through problem spaces, that have little psychological reality." (p. 146, emphasis added)

Whereas novices may be confused by complexity, Klein says experts have an overall sense of what is happening in a situation, together with the ability to judge prototypicality. That enables them to see the big picture and be less likely to fall victim to information overload. When experts describe a situation to someone else, Klein says they may highlight leverage points as the central aspect of the dynamics. Their mental models alert them as to what to expect and help them notice when the expectancies are violated. (p. 152) Moreover, he notes the ability of experts to generate counterfactuals, which are explanations and predictions that are inconsistent with the data. He suggests experts may have such ability because "they have learned not to place too heavy a reliance on data. Novices, in contrast, have difficulty imagining a world different from the one

they are seeing." (p. 154)

"In the RPD model," Klein notes, ***"one pathway in the decision cycle is to seek additional information. This may seem like a routine activity, but it also requires expertise. (A mindless information-gathering strategy is not likely to be useful.) Experienced decision makers appear to be able to spot opportunities where the information that can be helpful can be readily obtained."***(p. 154, emphasis added) The need for expertise is magnified to the degree that information that might have been recorded has not been made readily available in a form that is readily comprehensible to those without particular expertise. The failure to routinely create and maintain records generates the need for expertise that might not otherwise be required. It also leads to satisficing, colloquially known as "muddling along," rather than optimizing results.

Klein says, "Experts perceive a situation as the patterns and relationships that grew out of the past and will grow into the future, not just the cues that exist at the moment. All these are perceived at the same time; all are part of their situation awareness. The ability to see the past and the future rests on an understanding of the primary causes in a domain and the ability to apply these causes to run mental simulations... Another aspect of mental simulation," Klein suggests, "is to be able to decenter, to see the world through the eyes of others." (p. 156) However, it is unclear why experts would *want* to see the world through eyes less capable than their own. It seems more likely their experience and expertise would give confidence that their own perceptions are superior to those of others.

Indeed, even to the degree that any of us, including those of us with higher degrees of expertise, do try to view the world through the eyes of others, we are merely *imagining* how others may be perceiving reality. We cannot truly see through the eyes or others or perceive as others do. We can only create in our own minds the illusion of doing so. In fact, our own mind and our own perceptions are still central to such thoughts. By contrast, records truly do help us "decenter" by moving the focus of our contemplation outside our own minds and the mental images they contain.

Yet another direction that experts can see, Klein suggests, is inward. He says, "They can see inside their own thought processes -- the process of metacognition, which means thinking about thinking... Four components of metacognition seem most important: memory limitations, having the big picture, self-critiques, and strategy selection. ***Experts are often sensitive to their own memory limitations***, including their working memory for holding something ... As a result, they can adopt subtle procedures to avoid the difficulty... Experts are not only better at forming situation awareness and seeing the big picture, ***but they can detect when they are starting to lose the big picture***... Experts can critique themselves. ***Since their performance is less variable than that of novices, they can more easily notice when they do a poor job***, and they can usually figure out why, in order to make corrections." (p. 158, emphases added)

The need for inward focus is magnified to the degree that our thought processes have not been documented in records that can be examined not only by ourselves but others as well. Likewise the limitations on our memories are magnified to the extent that we must rely upon them to make up for the lack of records. Since experts are less likely to make mistakes than novices are, it

would seem they might be more willing to document and expose records of their performance to others. However, for them the risk of doing so is also higher, because weaknesses in their expertise may be revealed not only to others but also to themselves.

Klein notes that "... much perceptual experience is needed to carry out tasks that may seem simple because they can be reduced to rules and procedures. We are often fooled into thinking that the procedures are going to be carried out easily. In fact, procedures often take much experience to interpret. Rules tell you that when a certain condition occurs, initiate a certain action. The trick is knowing when the first condition has occurred." (p. 161)

Moreover, Klein suggests: "... *expertise is learning how to perceive. The knowledge and rules are incidental*." He notes the field of technical training has been dominated by efforts to teach rules, facts, and procedures, particularly during the 1960s and 1970s, when there was a great interest in the United States in systematic approaches to training. Klein says such a strategy makes sense for simple, procedural tasks, especially in high-turnover jobs with minimally educated workers. Allowing that systems approaches to training were an improvement over anarchy, he argues "they were not designed to teach people to gain higher levels of expertise or to make better judgments and decisions." (pp. 168-169, emphasis added) Dorner makes a similar point, as follows:

> What accounts for the greater success of the practitioners? ... I think that the explanation is "operative intelligence," the knowledge that individuals have about the use of their intellectual capabilities and skills. In dealing with complex problems we cannot handle in the same way all the different situations we encounter. Sometimes we must perform detailed analyses; at other times it is better simply to size up a situation. Sometimes we need a comprehensive but rough outline of a situation; at other times we may have to give close attention to details. Sometimes we need to define our goals very clearly and analyze carefully, before we act, exactly what it is we want to achieve; at other times it is better simply to go to work and muddle through. Sometimes we need to think more "holistically," more in pictures, at other times more analytically. Sometimes we need to sit back and see what develops; at other times we have to move very quickly. (p. 192)

Klein observes:

> *As we move to more complex jobs, especially as information technologies place more demands on workers and their supervisors, we have to go beyond the traditional task analyses. In organizations, much of the knowledge is held within the heads of the workers and is never shared. This is tacit knowledge . In most organizations, the culture seems to ignore the expertise that already exists, to take it for granted...* We can form a ... list for knowledge as a resource. *We can identify sources of expertise, assay the quality and value of the knowledge, extract the knowledge, codify it, and apply it as well... Organizations interested in taking advantage of their own expertise could use knowledge engineering to create a culture of expertise*. We can use cognitive task analysis to perform knowledge engineering. (pp. 170-171, emphasis added)

Such organizations could also simply start doing a better job of creating, managing, and sharing records documenting the knowledge, actions, and results achieved by their experts. In particular, they could start measuring the effectiveness with which their employees create, manage, and share such records. The fact that few, if any organizations do so is a telling and powerful indicator of the nature of humanity not to want complete and highly accurate records, much less to be judged by on our performance in creating and maintaining such records. Instead, we tell stories and make up history after-the-fact, as we go along, even as so-called experts like Klein laud high-minded notions like "knowledge engineering" while paying scant attention to the obvious and practical need to do a better job of managing and using reliable records.

Be that as it may, with respect to knowledge engineering, Klein says the first step is to *identify sources of expertise* and the second it to *assay the knowledge*. He notes that cognitive task analysis takes time and effort and he suggests no one would initiate such analysis without a having identified compelling need or benefit. In addition, he suggests **the importance of the knowledge has to be balanced against the costs of extracting it.** (p. 171, emphasis added) The third step is to *extract the knowledge* and Klein notes that methods for doing so include "structured interviews, interviews about actual events that were challenging, interviews about the concepts experts use to think about a task, and simulated tasks that require the expert to think aloud during performance or respond to interview questions after completion." (p. 172)

Another step in the knowledge engineering process is to *codify the knowledge*. Methods Klein cites include diagrams, charts, lists of critical cues, computer simulations of the experts' thought processes, annotated stories, transcripts of interviews, even videotapes of interviews. (p. 172) To "codify" knowledge means not only to make it explicit, by documenting it, but also to classify and index it so as to facilitate retrieval and ready recognition of its relevance at the times and in the circumstances when its application is appropriate. To the degree that knowledge warrants codification, it is best to do so as soon as possible to minimize the effect of Schacter's seven sins of memory.[9] However, that is the rational alternative and Klein's point is that rationality is not a common feature of decision-making in natural settings. Dawes agrees that all of us are prone to irrationality in our everyday lives, and Norman notes that perfect information is not necessary for perfectly acceptable behavior.[10]

Klein observes that we have powerful organizers to frame the visual world into Gestalts, so we naturally group things together that are close to each other. Similarly, he says we link elements of the cognitive world -- ideas, concepts, objects, and relationships -- to each other via stories, which he suggests blend of several ingredients, including: agents, predicament, intentions, actions, objects, causality, context, and surprises. (pp. 177-178) He notes that stories embody lessons and are useful in providing vicarious experience to those who did not witness the incident

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[9] Schacter's seven sins of human memory are documented at http://ambur.net/memorysins.pdf.

[10] Information on Dawes' views on irrationality and Norman's views on things that make us smart is available, respectively, at http://ambur.net/irrationality.htm and http://ambur.net/smart.htm.

being recounted. He also says they help preserve values by demonstrating to newcomers the sort of environment they are entering. In addition, stories aid understanding of situations and relationships.

Klein observes that we like to hear good stories retold and he says, "What is more interesting is our need to *tell* stories, again and again. Each telling helps us understand more about the lessons embedded in the story." (p. 179) While there may be a grain of truth in every story, many good stories also involve a significant amount of deceit, which is abetted by the lack of good, readily accessible records conveying the truth, the whole truth, and nothing but the truth. Indeed, there may be an highly interesting connection between Klein's fascination with our need to tell stories repeatedly and Charles Fords' observation from his study of the psychology of deceit: "... ***the most important lesson we can learn is how we use lies to deceive ourselves*** ..."[11] The bigger the lie, perhaps the more times we need to retell it in order to embed its lessons in our psyches and cultures.

Klein observes, "Drama, empathy, and wisdom are key. Stories are remembered because they are dramatic. They are used because we can identify with one or more of the actors. They are told and retold because of the wisdom they contain -- the lessons that keep emerging with each telling. A good story usually has some element of surprise; that is the dramatic part." (p. 180) However, the implication that stories always convey wisdom is doubtful at best. As oft stated, common knowledge is often neither -- common nor knowledge. Often it is based upon rumor, innuendo, or superstition, and stories support such forms of knowledge very well -- especially if they are not documented and scrutinized by unbiased individuals who are not part of the in-groups with whom stories are commonly shared.

Ideally, Klein suggests a good story is an amalgam of various causal relationships -- relaying the factors that resulted the effects reported. The more complex and subtle the story, the more to be learned from it. However, as Klein acknowledges, a story that gets too confusing fails to convey the significant meanings. To be effective, stories must tie different factors together clearly and memorably and demonstrate their connection. (p. 181) Another way of stating this limitation is that stories are befitting the conveyance of simple truths, but if the truth is complex, stories may actually contribute to misunderstanding and perhaps even to the spread of disinformation.

"In its way," Klein explains, "a story is ... a report of an experiment, linking cause and effect... Sometimes experiments vary three or four things at once, but if the results show a triple order interaction, even the original experimenters have trouble keeping everything straight. Therefore, our experiments study only a few causal factors at a time. As a result, we do not gain a good picture of how the different causes affect each other. Compare this to a story, where the outcome is affected by many important variables or causal factors, each of which needs to be described and to have its influence traced. The story is a package for describing the important causes and allowing the listener to think of other possible causes for the events." (pp. 181-182)

Notwithstanding their strengths, Klein cautions: "***The limitation of a story, which makes it***

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[11] For more on Fords' views on the psychology of deceit, see http://ambur.net/Lies.htm.

nonscientific, is that no one has controlled the conditions. If you hear a story, you do not know if you have given all of the relevant causal factors. You do not know exactly how the causal factors would interact if the conditions were slightly different... We have lost precision, the ability to trace each factor, in order to gain richness, the full set of interacting conditions." (p. 182, emphasis added) Moreover, Klein notes another weakness: "Stories have to have endings, as do experiments. If I describe an experiment I ran and admitted that I had never found the time to analyze the data, you would ask why I bothered running the experiment... ***We have been in many situations where people made complex plans, but handed these off and never learned if they were carried out, or what happened. As a result, the planners never got the feedback to learn how to do better***." (p. 182, emphasis added)

If stories are not documented and compared to those written or dictated by other observers, they are almost certain to be biased and to exclude relevant factors. If oral stories are a predominant means of gathering feedback, it seems likely that lack of adequate analyses is more the rule than the exception. Indeed, reliance on oral stories seems almost antithetical to the entire notion of "planning." Planning is not involved in naturalistic decision-making, as Klein describes it. Planning requires time that may not be available in the kinds of situations of interest to him. However, in the most important instances, when the stakes are high, it would be fool-hardy not to engage in rational decision-making by considering at least a few alternatives.

"Besides drama, empathy, and wisdom," Klein notes, "good stories have a number of more mundane but still necessary features: Plausibility... Consistency... Economy... Uniqueness..." These criteria are similar to those for mental simulation and Klein suggests there is a definite overlap between stories and mental simulation. In particular, he say, "Both are causal chains. Both share the same need for plausibility, consistency, economy, and uniqueness. The major difference," he notes, "is that mental simulations are stories we run inside our head, where there is less room for complexity. Therefore, we cannot have as many agents or transformations." Also, he observes, "we are making up the mental simulation, whereas the stories we tell are usually about events that really happened, so it is easier to add details and elaborations." (pp. 182 & 183)

Besides the overlaps between good stories and good mental simulations, it is noteworthy that good lies embody many the very same characteristics. It is unclear whether Klein believes it is acceptable to add to stories details and elaborations that are, if not lies, at least "made up," as mental simulations are. However, he does point out that "Mental simulations are constructed in working memory, so they have to be streamlined. Another difference is that stories are about people and their intentions, whereas mental simulations can address sequences of events for inanimate objects as well as for people." (p.183) Even as stories are about people and their intentions, it seems likely the intentions of the *story-teller* and the *listeners* may have as much or more to do with the understandings conveyed and received than the details of what actually happened in the series of events being described.

Indeed, Klein acknowledges as much in describing the way people make sense of legal evidence presented during a trial. He says, "decision makers try to assemble the evidence into a story. The task of jurors, to hold all the evidence in their heads, is too difficult. By organizing the evidence

into a story, the task of recalling and understanding the evidence becomes easier. A juror who has built a story compares it to the stories presented by the prosecutor and the defense attorney. ... jurors ... accepted the claim that more closely matched the story they themselves had constructed." (p. 184) In short, the evidence per se is not what is most important. What really counts are, first, the limitations on the capacity of human memory and, second, what already "exists" in our memory in terms of personal beliefs, feelings, and understandings about how people conduct themselves and how reality normally evolves.

In another example, Klein notes, "Political debate can be seen as a struggle for the defining metaphors... Metaphor ... structures our thinking. It conditions our sympathies and emotional reactions. It helps us achieve situation awareness. It governs the evidence we consider salient and the outcomes we elect to pursue." (p. 199) In politics, as in life, perception is reality for each of us. Thus, it is in the interests of politicians to shape perception in support of the "party line." Stories are a great way to do so, since they enable the story-teller to capture the imagination of listeners while leaving out important aspects that may favor the other side of the political debate. To the degree the story-teller captures our sympathies and emotions, the facts of the matter become largely irrelevant. The end of being in harmony with the sympathetic figure in the story justifies the means of ignoring reality, particularly if no one has taken the time and trouble to document the facts and consider alternative explanations when not only the causes of the results are unclear but the goals themselves may be ill-defined as well.

With respect to the solution of ill-defined problems, Klein highlights two strategies: One is to try to reach a goal while simultaneously trying to define the goal, using failures to specify the goal more clearly. The other is to find an analogy that suggested features of the goal. (p. 201) He suggests. "If we can find an analogy with which we feel comfortable, we can use it because it reflects the full set of causal factors, even the ones we cannot yet identify. The analogy also reflects the interactions between causal factors, interactions we cannot specify, so it lets us make a prediction that reflects factors whose existence we do not know and whose properties we do not know. That is the power of analogical reasoning." (p. 204)

However, he cautions, "***There is a delicate balance to using analogues. If we know a great amount, we do not need the analogues; we can just figure out the formulas. If we know very little, analogical reasoning may be as likely to get us into trouble as to help us. Analogical reasoning seems to help most when we are in between: we know something about the area but not enough for a satisfactory analysis...*** In the hands of experienced engineers, predictions made from analogies [match] up fairly well with the actual data... [However] *the method of using analogues uses so much subjective estimation that it needs to be grounded in hard data. If we make up the data that we then adjust, the accuracy drops.*" (pp. 206 - 207, emphases added)

"Hard data" can be taken to mean records having the attributes outlined in ISO 15489. ***The fact that Klein feels the need to explain that data that is "made up" may become less accurate when it is "adjusted" would be laughable if not for the fact that it is so commonly done.*** Moreover, it should be noted that data without context is meaningless, regardless of whether the data is "hard" or "soft". The most common form in which data is presented in context is the "document" and documents are of varying degrees of trustworthiness, based upon the metadata

associated with them. Just as documents establish the context to make data meaningful, metadata circumscribes the context by which the value and trustworthiness of documents can be assessed.

Turning to the dynamics of teams, Klein notes that communications are placed in context by conveying a general sense of intent in order to supplement more specific directions. "When you communicate intent," Klein says, "you are letting the other team members operate more independently and improvise as necessary. You are giving them a basis for reading your mind more accurately. ***One important function is to increase independence so that team members need less attention and monitoring***... The other primary function of communicating intent is to allow better improvisation... we must accept that few of us can think out all the contingencies in advance, and unless we want to direct every step our teammates take, ***we are going to have to cede responsibilities, including judgments about how and when to carry out critical tasks***." (p. 222 & 223, emphases added) As we do so, we should insist upon good record-keeping so that we can at least assess the quality of such judgments after-the-fact, as a precondition for determining whether and under what circumstances and to whom to continue ceding such responsibilities.

Klein cautions, "***It is easy to say we want to encourage improvisation and initiative*** and to make sure that people understand why they have been given certain assignments. ***In reality, this practice turns out to be difficult, because it means that the people at the higher echelons must give up some of their control.***" (p. 224, emphases added) However, the risk can be significantly mitigated over time and occurrences if good and complete records are kept -- both to ensure accountability for actions by individuals as well as to provide reliable indicators of the ability of those individuals to assume authority and carry out responsibilities efficiently and effectively.

Expounding further on the dynamics of teams, Klein raises the notion of a *team mind*, which, he says, serves the following functions:

- Working memory. ... Applied to a team mind, information is presented and gets some discussion; then the team moves on to another topic and forgets the first one.

- Long-term memory. ... Teams have to store information to retrieve later. ... teams find it helpful to store the information redundantly, so more than one person knows it.

- Limited attention. ... Teams also can discuss only one thing at a time. They have to be careful in directing their attention to make sure that what gets the spotlight is worthwhile.

- Perceptual filters. ... teams do not have direct experience but must depend on secondhand reports, which can introduce inaccuracies.

- Learning. Teams need to learn in many ways, such as acquiring new procedures, discarding inefficient behaviors, and figuring out how to become more effective. (p. 236)

Taken literally, the notion of a "team mind" is nonsensical, conjuring up Frankensteinian images of brains stored in laboratory jars connected by wires. However, even to the degree that we cut Klein slack to speak in the metaphors that are a staple of storytelling, we still owe it to ourselves

and to the good of humankind to consider whether the mythical mind of the team is the best, most efficient and most effective means of serving these functions. If we are to allow ourselves to step out of the naturalistic decision-making mode for just a moment or two to engage in semi-rational analysis, we might come to the conclusion that records may have a strong role to play, particularly with respect to learning and long-term memory but also with respect to focusing attention, filtering perception, and determining the immediate agenda (working memory).

Even as he lauds the "team mind," Klein highlights its "chaotic nature." Among the ways he points out that it is chaotic is that it generates unpredictable ideas. Klein notes, "Unless the leaders of a team deliberately stage a meeting, it is virtually impossible to figure out in advance what ideas are going to be brought forward. ***What gets entered into collective consciousness is only a small part of what all the team members are thinking about. There are many good ideas that never get spoken -- and many good ideas that could be combined into real breakthroughs. None of the team members can know what the others have not said, so the team is unaware of what it misses***." (p. 250, emphasis added)

It is somewhat ironic that Klein makes this point in light of his suggestion that brainstorming is "primarily a social activity" -- because "the resulting set of suggestions is usually longer and more varied" through individual effort "than when everyone works together." (p. 143) However, the obvious way to reconcile the apparent conflict in the two points is for team members to *document* their ideas and share those records with their colleagues.

Another weakness of the "team mind" that Klein acknowledges is an "unpredictable flow of attention." "In most operational settings," he says, "teams are exposed to all sorts of interruptions and distractions." Besides interruptions from the outside, teams makes their own distractions, the most common of which are out-of-context questions. In a process that resembles free association, planning may be diverted to new, unrelated topics for a variety of irrelevant reasons, and after the interruptions are addressed, the team may not return to its original discussion. In one case he cites, the team moved on to a different topic and "The flow of the discussion was driven by random associations people brought up, not by an agenda."

Perhaps we should not be surprised if discussion occurs at random if it is not driven by an agenda that has been documented for all to see. Indeed, Klein suggests, "In immature teams, even an agenda may not be sufficient to keep the discussion on track." (p. 250 & 251) It seems inevitable that operational settings lacking good record-keeping practices may be characterized by self-sustained chaos. Moreover, if members who have tendency to take the team off track are never confronted with explicit records documenting that fact, they may be lacking both evidence as well as incentive to change their behavior for the greater good of the productivity of the team.

Klein says teams are also afflicted with delusion of controlling their own thoughts and actions. He says, "After the fact, team members may describe their interactions as consistent and well directed. Once they know what approaches they arrived at, they can trace how those approaches evolved and make the story seem tidy. However, observers watching them struggle to find any approach ... know about the blind alleys, the stumbling, and the confusion." (pp. 250-251) The

failure to create, maintain, and use good and relatively complete records supports such delusions of control in the imaginary "team mind."

In addition, Klein says, "Afterward, when the team leaders see what they have achieved, they can try to weave an explanation showing how their activities were aimed in this direction all the time. ***Research in neurophysiology has shown that individuals can have the delusion that they are controlling their own thinking when this is not the case****...* If individuals can form a delusion of rational control over their actions, we should not be surprised to find teams doing the same thing." (pp. 251-252, emphasis added) And how do researchers expose such delusions? By recording the actual causative factors and results with scientific rigor, in which good perception, recognition, and record-keeping are implicit. Rather than relying upon "researchers" to establish such factors, good teams and their leaders should strive to do so themselves -- in order to guide their ongoing actions more effectively and avoid, to the greatest degree possible, catastrophic occurrences that may require the attention of "investigators" after-the-fact. In short, not only teams but also each of us as individuals should strive to base our actions on realistic assumptions rather than illusory notions.

Of course, that is not to suggest that we should insist upon entirely rational behavior in every act of our daily, personal, and purely social lives. Indeed, Klein points out: "***Hyperrationality is a mental disturbance in which the victim attempts to handle all decisions and problems on a purely rational basis***, relying on only logical and analytical forms of reasoning. In the initial states, this condition can be mistaken for a healthy development of critical thinking. Only later do we observe an unwillingness to act without a sound, empirically or logically supported basis. ***The final stages degenerate into paralysis by analysis***." (p. 259, emphasis added) Unfortunately, it is not just individuals who may be victimized by this problem. Paralysis by analyses is a common phenomenon plaguing many and perhaps most, if not all large, bureaucratic organizations. Notwithstanding the its weaknesses and risks, Klein notes:

> Rational analysis is a cornerstone of intellectual activities and a very important source of power. We do not want to encourage people to make ill-informed, impulsive decisions... Rational analysis reduces the chance that an important option will be overlooked. It supports the broad search for many options, rather than deep searches of only a few options. It comes closer to error-free decision making than other sources of power. And it allows the decision maker to use declarative knowledge. Without rational analysis, we would not have the exciting growth of science and technology, the miracles of medicine, and so forth. Decision trees and cost-benefit analyses can help us make sense out of complicated choices, but there are some limitations to rational analysis, and that seems to make some people nervous. (p. 260 - 261)

Klein points out that the word "*rational*" comes from the Latin root *ratio*, meaning "to reckon." To think by reckoning, or calculating, he says we need to decompose, decontextualize, calculate, and describe. Moreover, "***All the analyses and representations should be open to public scrutiny***..." He allow that rational thinking is "an important source of power" because it "provides the benefits of orderly and systematic approaches to complex problems." (p. 261, emphasis added) He notes, "***The goal of making the thinking explicit means that a community***

***can arrive at a common perspective and that teams can be set up to work separately on
different parts of a problem with some confidence that their work will fit together at the end."***
(p. 262, emphasis added)[12]

In general, "making thinking explicit" means documenting it in records that can be scrutinized
and reviewed as often as necessary to refresh our memories. ***While it would be unwise to expect
each of us as individual human beings to think and act rationally at all times, conversely, it is
unwise to contemplate action on any other basis at anytime by the <u>organizations</u> we form to
overcome our weaknesses as individuals. Not only should the collective actions we take
through our organizations <u>be</u> rational but they should also be sufficiently well documented so
that we can determine at anytime whether they are rational or not, taking into account our
own personal and as well as our collective interests.*** In particular, we should insist that the
decisions made and actions taken by our leaders are rational. Indeed, by definition, leaders have
relinquished their right as human beings not only to act irrationally but also to do secretively.

However, the ability of leaders to live up to their obligations is called into question by another
weaknesses of rational analyses highlighted by Klein -- the fact that it requires decomposition of
a situation or problem into its constituent parts. He says there are no "primitives" that naturally
exist. Instead, he argues any components defined are arbitrary and depend on *individual* goals
and methods of calculation. To "lead" means to influence, if not to direct the actions and perhaps
also the understandings and beliefs of others. Thus, if there are no universal principles that can be
applied in the best interest of all of the followers, leadership entails a contradiction in terms.

Klein observes that logical atomism, the belief that ideas and concepts can be decomposed into
their natural elements, was popular among philosophers in the 1920s and 1930s. However, he
says it has since been abandoned in philosophy, and in psychology, atomistic schemes have
usually proved arbitrary and unworkable.

In psychology, he says, ***"we usually cannot reduce natural situations to a reliable and valid set
of symbolic units that can be treated with logical operators.*** There is no 'right' way to break
down a task. Different people find different schemes. Even the same person might choose
different schemes depending on the goals being pursued. If we try to predefine the basic
elements, we must either work with an artificial or narrow task, or run the risk of distorting the
situation to make it fit into the so-called basic elements. Alternatively, we can accept the
importance of experience in seeking useful ways to decompose a task within a task. ***Most of the
time we blend the analytical and experiential sources of power to get things done.*** Few of us
fall into the trap of hyperrationality." (p. 262, emphases added)

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[12] Klein's point is similar to the argument made by John Case in his book entitled
Open-Book Management: The Coming Business Revolution: "when the books are open, everyone
can see what's going on. It's harder for managers to fall back on excuses or to point the finger at
someone else. Open-book management gets people involved and helps them take responsibility
rather than shirk it. It's a way by which everyone in the business can hold each other
accountable." For more on Case's views, see http://ambur.net/openbook.htm.

By contrast, emphasizing the opposite end of the continuum, Dawes suggests that we all fall into the trap of irrationality when we could achieve better results by being more rational. Indeed, Klein's argument itself represents an effort to rationalize irrational behavior in natural settings but, of course, the context of his argument -- which is a book -- is not such a setting. It is more like a "laboratory" than, say, a natural, unspoiled field of wild flowers. In nature or in the laboratory, Klein notes that rules and procedures take some variation of the if-then form. He points out that the rules and procedures often sound simple, but in natural circumstances the hard part is figuring out if the antecedent conditions, the "if" part of the rule, has been met. (p. 263) It is particularly difficult to determine whether the conditions have been met if we fail to create and maintain the necessary records capturing the relevant aspects of the reality of the situation.

Indeed, Klein assumes that such records will rarely be available and he may even take that to be a good thing, as he asserts: "Most people are sensitive to how much judgment and interpretation are needed to carry out a rule or an order. We rarely try to plan out every contingency. Instead, we try to make it easy to understand the intent behind the rule or order... Even when we know which rules apply and which to perform, we still have to initialize the equations or arguments. It is usually difficult to make the estimates called for by calculational methods... Formal methods of rational analysis can run into difficulties when they consider a large set of factors (as is found in a natural setting) and try to work out the implications of all the different permutations. As you add more knowledge, the job of searching through connections will increase exponentially." (p. 263) However, Klein observes that we do not routinely face combinatorial explosions in our everyday lives because we are not relying on calculations. Instead, he says, "We use experiential sources of power to frame situations and arrive at manageable representations. Then, if necessary, we bring in the analytical methods to add precision." (p. 264) On the other hand, Klein notes:

> *... consistency is important because of all the errors that can be traced to inconsistencies... If we can detect and eliminate inconsistencies, we can eliminate the errors caused by inconsistencies. Rational analysis is appealing because it is a strategy for reducing or eliminating inconsistencies*. We can try to decompose complex tasks, plans, or beliefs into smaller elements to find any inconsistency. *Unhappily ... we cannot just use a truth table method to make sure our beliefs are consistent* ... (p. 264, emphases added) A belief system containing only 138 logically independent propositions would overwhelm the time resources of this supermachine... In view of this, we cannot expect anyone to maintain a perfectly consistent set of beliefs. *It is easy to trace an error backward and find out inconsistency, but that takes advantage of hindsight*. (pp. 264 & 265, emphasis added)

That's why is it so important to have good and complete records, so that we can be reasonably sure to capture all of the elements that may be relevant to understanding the mistakes of the past and avoiding them in the future. As Klein notes: "*We cannot root out the inconsistencies in advance. Harman examined a type of inconsistency where we continue to hold a belief even when we no longer accept the evidence on which it was based. To stamp out this type of inconsistency, we would have to classify, code, and store in memory all of the evidence on which every belief is based.*" (p. 265, emphasis added)

While it would be unreasonable to expect individuals to be able to perform such feats in their own minds, we should hold to a higher standard the organizations we form to serve those purposes we cannot perform individually for ourselves -- particularly to degree those organizations are already conducting our business by electronic means, in which case automated tools can be used to classify, code, and store current and comprehensive records.

Klein highlights another type of inconsistency, *called memory compartmentalization, in which a person holds inconsistent beliefs but does not make the connection because the beliefs are stored in different contexts in memory*. (p. 265, emphasis added) Again, this is not only a natural limitation for us as individual human beings; it is also an artifact of the bureaucratic structures that comprise our organizations. However, with computers and electronic records it is possible to overcome the disconnection of information in varied contexts.

Klein allows, "Once we see the error or the missed opportunity, we can trace it back to the beliefs that did not get connected." And he asserts, "*It is too much to expect that every piece of information in memory be continually matched against every other piece to catch these connections and draw their implications. It would take exhaustive memory search to find the interesting connections.*" (p. 265, emphasis added) Again, however, that is the very sort of thing at which computers are much better than humans. It is not too much to expect that computers can do the job many orders of magnitude better than the unaided human mind, if only they have the records against which to apply their analytical powers.

Generally speaking, Klein asserts, "it is impossible to free ourselves from inconsistency, belief perseverance, and memory compartmentalization." However, he does allow, "*there is one way to ensure that people find inconsistencies and discover connections: by keeping the number of beliefs small. If we could struggle through life with only a few beliefs, perhaps fewer than ten, then we might have a chance to purge inconsistencies*." (p. 266, emphasis added) In strategic business planning this thought is often expressed in terms of "sticking to the knitting," i.e., not being distracted by potential avenues of pursuit that stray from the organization's core competency. In government, it is reflective of a strict constructionist view of the Constitution, whereby government should not endeavor to do anything that is not expressly authorized.

Klein also points out that "consistency of *function* ... takes more effort, judgment, and insight than consistency of *feature*. It is not sufficient to identify something ... You have to understand how it will be used." (p. 266) Thus, he cautions: "*we should be wary of efforts to ensure consistency at the level of features that do not consider the functions we are trying to perform*. Rigor is not a substitute for imagination. Consistency is not a replacement for insight. Most of the time we would rather have consistency than leave ourselves open to the problems created by inconsistency. It is a goal worth seeking, but attempts to ensure unrealistic levels of consistency are a symptom of hyperrationality." (p. 267, emphasis added)

In addition to sometimes being excessively applied, Klein observes: "Logic is indifferent to truth. The goal of logic is to root out inconsistent beliefs and generate new beliefs consistent with the original set. Logic does not consider whether our beliefs are true. A logical person can be wrong in everything she or he believes and still be consistent." (p. 267) Conversely, an illogical person can sometimes speak the truth, by chance, and thus may not always be wrong merely by "virtue"

of being inconsistent. However, in both instances the only way the truth of beliefs can be assessed is by applying analyses to evidence after it has been faithfully documented in reliable records. Logic may be indifferent to the truth, but at least it holds out the hope of helping to establish the truth, among who care to know it. The alternative is for a belief to be self-justifying and self-sustaining, evidence be damned. The latter requires much less effort but can be quite powerfully applied. For example, suicidal terrorists demonstrate it quite effectively in the very kind of naturalistic settings of interest to Klein. While the terrorists may be achieving their highest aspirations, the outcomes are quite negative for most others.

Klein notes that poor outcomes are different and do not necessarily result from poor decisions. Given the knowledge at hand, the best possible decision may still result in unsatisfactory results. Klein defines a poor decision as one in which we regret the process we used. (Whether successful suicidal terrorists ever come to regret their decisions will never be known, except perhaps through illusion, mental imagery, and story telling by others.) More specifically, he says, "*A person will consider a decision to be poor if the knowledge gained would lead to a different decision if a similar situation arose*. Simply knowing that the outcome was unfavorable should not matter. Knowing what you failed to consider would matter." (p. 271) Klein does not say so, but failing to consider relevant evidence in readily available records is exactly the sort of action (inaction) that is likely to cause one to regret the way a decision was made. Yet another is engaging in a singular evaluation, recognition-primed decision-making when a rational analyses of alternatives may have engendered better results.

Klein notes that "decision makers use a variety of heuristics, simple procedures that usually produce an answer but are not foolproof." However, "***in making judgments, we rely on information that is more readily available*** and appears more representative of the situation." (p. 271, emphasis added) Again, Klein does not say so but one obvious implication is the importance of taking action in advance to make sure the best possible information will be available when needed.

Klein observes that naturalistic decision-making researchers have come to doubt that errors can be neatly identified and attributed to faulty reasoning. Instead, he asserts, "***the operator of a system who is blamed for the error is often the victim of a series of problems of faulty design and practice ... The discovery of an error is the beginning of the inquiry rather than the end.*** The real work is to find out the range of factors that resulted in the undesirable outcome." (p. 273, emphasis added) In many instances, as implied in the work of Dorner and others, errors result from our natural proclivities to "court failure in predictable ways" -- particularly by failing to create, maintain, and use comprehensive and readily comprehensible records. Due to the failure to create and effectively manage records, naturalistic decision-making may prevail when and where less "natural," more rational analysis and decision-making would lead to better outcomes.

Even as Klein suggests discovery of error is a beginning rather than an end, Dawes argues "at best [stories] constitute just a starting point for analysis." (p. 138) Aside from his endorsement of the use of story telling, Klein's use of the word "end" is someone ironic in this context, with reference to the notion that ends should not be taken to justify the use of any means, regardless of

the acceptability of the means themselves. Except in laboratory and artificial learning situations, where injury is unlikely to occur, no one would argue that errors are an end toward which we should strive. However, as Dorner has highlighted, in effect that is exactly what we do as we court failure by neglecting to create, maintain, and effectively use records.

While he does not directly address the records management failures of individuals and organizations, Klein does note that "***decision makers can easily dismiss evidence that is inconvenient, explaining away the early warning signs***... The limitations could lead decision makers to misrepresent the situation, perhaps by explaining away key pieces of information, failing to consider alternate explanations and diagnoses, or leaving decision makers confused by complexity." (p. 275) By "inconvenient" Klein refers to evidence that does not match our preconceived notions but the more literal meaning of the word is equally, if not more applicable. Literally speaking, it is easy to ignore records not only that are not conveniently available but also those that are not conveniently comprehensible. Thus, the failure to create, maintain, and use such records supports our natural inclination to ignore evidence that does not conveniently support our preconceived notions.

Klein observes that poor decisions are often blamed on stress but he does not believe the evidence is convincing. He does not argue that stressors have no effect. His claim is that **"*stress does affect the way we process information, but it does not cause us to make bad decisions based on the information at hand*.** It does not warp our minds into making poor choices." He notes that stressors such as time pressure, noise, and ambiguity, do result in the following effects: ***denial of the opportunity to gather as much information as may be necessary, disruption of our ability to use our working memory*** to sort things out, and ***distraction of our attention*** from the task at hand. "Under time pressure," Klein allows, "we obviously will not be able to sample as many cues." However, he argues, "***if our decisions get worse, it is not because a state of stress clouded our minds but that we did not have the chance to gather all the facts***." Incidentally, he notes, "the data show that ***experienced decision makers adapt to time pressure very well by focusing on the most relevant cues and ignoring the others***." (pp. 275-276, emphases added)

Moreover, Klein suggests: "Stressors should disrupt decision making the most if people use strategies such as a rational choice analysis [whereas] if people rely on recognitional decision strategies, then we would not expect to see much disruption, particularly when the decision makers were reasonably experienced." (p. 276) Klein notes that ***one definition of uncertainty is "doubt that threatens to block action." In such cases, significant elements of information may be missing, unreliable, ambiguous, inconsistent, or too complex to interpret, and as a result a decision maker will be reluctant to act.*** (p. 276, emphasis added)

Klein cites four sources of uncertainty: 1) Missing information -- Information is unavailable. It has not been received or has been received but cannot be located when needed. 2) Unreliable information -- The credibility of the source is low, or is perceived to be low even if the information is highly accurate. 3) Ambiguous or conflicting information -- There is more than one reasonable way to interpret the information. 4) Complex information -- It is difficult to integrate the different facets of the data. (p. 277) He also notes there are several different levels

of uncertainty -- level of data; level of knowledge, in which inferences are drawn about the data; and level of understanding, in which the inferences are synthesized into projections of the future, into diagnoses and explanations of events. (p. 277)

With respect to whether uncertainty is inevitable, Klein observes: "Clearly **the technology available in the future will dramatically increase the information available, yet we cannot be optimistic that increasing information will necessarily reduce uncertainty**. It is more likely that the information age will change the challenges posed by uncertainty. For one thing, **decision makers will still be plagued with missing information**. Previously information was missing because no one had collected it; **in the future, information will be missing because no one can find it."** (pp. 277 & 279, emphases added) However, it is possible to dramatically reduce uncertainty about what has happened in the past, including the very recent (instantaneous) past -- by creating, maintaining, and effectively using electronic records. Klein's comment on the retrievability of information reflects a fairly pessimistic view of the potential of technology to assist with the classification, storage, and subsequent "discovery" of information when needed. While recall and precision will never be perfect, it is possible to achieve a far higher standard than Klein appears to appreciate.

However, Klein does make an important point with respect to time pressures on decision-makers. In particular, he notes that planning cycles will be expedited. He suggests that means plans will be made with the same level of uncertainty as in the past. Moreover, he notes that communication technology means that clients expect faster decisions -- without the time allowed in the past for thoughtful reflection. (p. 279) In that regard, his concern is similar to Norman's lament with respect to the inclination of human beings to favor experiential cognition over reflective cognition. However, Norman observes that perfectly acceptable behavior can be achieved with less than complete information, and Klein asserts that experience and expertise can offset the lack of information in naturalistic decision-making circumstances. Thus, to the degree to which Norman and Klein are correct, the lack of time for thoughtful reflection may not be a matter of serious concern in many instances. However, Klein cautions that:

> **Expertise can [also] get us in trouble. It can lead us to view problems in stereotyped ways**. The sense of typicality can be so strong that we miss subtle signs of trouble. Or we may know so much that we can explain away those signs ... In general, these shortcomings seem a small price to pay; however, there may be times when a fresh set of eyes proves helpful. I am more troubled by the difficulty of learning from experience. We cannot often see a clear link between cause and effect. Too many variables intervene, and time delays create their own complications... **We can learn the wrong lessons from experience. Each time we compile a story about an experience, we run the risk of getting it wrong and stamping in the wrong strategy**. (p. 280, emphases added)

As examples of circumstances where experience may not lead to expertise, Klein cites the Dirty Thirties and lawmaking by politicians. Specifically, he argues:

> The Great Depression was an event of major importance in our history that has received enormous scrutiny, and we still do not know if Roosevelt's actions were effective in

bringing about economic recovery. Because of the difficulty of interpreting cause-and-effect relationships, lawmakers cannot achieve high levels of expertise. They can certainly master the procedures of being politicians, for example, getting on the most influential committees, forging ties with lobbyists, doing favors for the right people. Nevertheless, they cannot learn the long-term impacts of the legislation that they consider. They cannot learn the causal dynamics between a piece of legislation and eventual social changes. Their mental models are not flexible or rich. ***When politicians ask to be reelected because of their experience, they are referring to the efficiency with which they do their job, not their growing wisdom in judging which laws to propose and support.*** (pp. 280-281, emphasis added)

Efficient politicians are dictators; in a democracy politics and efficiency have little or nothing in common. Moreover, the fact that we do not know whether the Roosevelt's Great Society programs were effective or not does not mean that it is impossible to assess the results of such policies; it merely means that we have failed to create, maintain, and analyze sufficient data (records) to render such judgments. It may have been difficult or impossible to do so in Roosevelt's time. However, with rapid advancements in information technology and considering the fact that most commerce is now conducted electronically, continued failure to create and use such records to determine and assess the results of our actions, including the actions of politicians, suggests that perhaps we don't really care to know.

Certainly, there are many political and economic pundits who have a vested interest in keeping others ignorant, so as to maintain their own status as highly valued and highly compensated experts. Likewise, politicians themselves, fund raisers who bankroll their campaigns, consultants who mold their messages, and advertisers who profit from their media buys have little apparent incentive to let the record speak for itself. While it is doubtful he would do so, taken to extreme, the implication of Klein's argument is that such dynamics are fine and dandy. However, it is worth noting that, through passage of the Government Performance and Results Act of 1993 (GPRA), Congress has at least paid lip service to understanding the connection between the actions they authorize and require versus the outcomes achieved. More than a decade after enactment of GPRA, it remains to be seen whether Congress, much less individual politicians, truly cares about anything other than reelection, but if Congress accepted Klein's argument, they would not have bothered to pass the act at all nor would have the President signed it into law.

Without taking his argument to the extreme that factual records matter not at all, Klein does point out that superstitions are commonly considered to be characteristic of primitive cultures that have not sufficiently matured to understand cause-and-effect relationships. While modern cultures are thought to have moved beyond such unfounded beliefs, Klein observes: "***we follow rituals all the time without any evidence that they work... our lives are just as governed by superstitions as those of less advanced cultures. The content of the superstitions has changed but not the degree to which they control us. The reason is that for many important aspects of out lives, we cannot pin down the casual relationships. We must act on faith, rumor, and precedent***. (p. 281, emphasis added) Thus, regardless of whether he considers that reality to be fine and dandy or not, Klein does suggest that we have no other rational choice but to accept irrationality in many instances. However, it would seem that at least we ought to try to limit those instances to

decisions and actions in which "truth" doesn't really matter much in terms of impacts upon ourselves or others.

In his treatise on "everyday irrationality," Dawes essentially agrees with Klein on this point. For example, Dawes notes, "even the most brilliant human being is subject to irrational conclusions before attempting to clarify the reasoning leading to them and sharing this reasoning with others ..." (p. 204) Ironically, Klein seems to have given up on the notion that it might be possible to apply the very principles he espouses to build expertise in the power of rationality and logical thinking -- most particularly by documenting and sharing with others the essential aspects of our thoughts, actions, and the results they engender. At least he seems to have adopted a defeatist point of view and waived the flag of surrender. Granting his point that time and circumstances do not allow rational decision-making in many "natural" settings, we should guard against the self-fulfilling prophesy of repeatedly and needlessly limiting our options to "natural" decision-making methods by failing time and time again to document information on decisions, actions, and results and then making those records readily available to enable rational analyses in the future.

With that very thought in mind, Dawes is far less willing than Klein to accept irrationality as an inevitable fact of life. Instead, he prescribes an "outsiders view," in which he says its practitioners "attempt a statistical or logical analysis of the problem per se and the important outcomes and predictors and then later subject this analysis and our conclusions to expert scrutiny (or even the scrutiny of people with ordinary expertise in statistics and logic who may not be unusually intelligent)." (p 204)

Klein notes that expertise can be gained in activities like fighting fires, caring for hospitalized infants, or flying an airplane. However, in other endeavors, such as selecting stocks, making public policy, or raising a child, he observes that the time delays are long and feedback is uncertain. Factors that reduce prospects for the accumulation of expertise include dynamic circumstances, the need to predict human behavior, minimal opportunities for feedback, lack of sufficient repetition to build a sense of typicality, and fewer trials. Under such conditions, Klein says we should be cautious about assuming that experience translates into expertise. (p. 282)

In such circumstances having good records may be our only hope of improving upon the performance engendered by chance, much less achieving accountability for actions and the results they beget. Records provide feedback and enable predictions. However, even in circumstances where expertise can be built, personal experience is no substitute for having good and complete records -- especially where human life hangs in the balance. Indeed, Klein acknowledges at one extreme of decision-making theory is the work of people like Russo and Shoemaker, which suggests we are all inherently biased and unreliable decision makers. (p. 282) It is only to the degree that our biases are revealed in reliable records that we may become aware of them and subject them to rational analyses in pursuit of better outcomes in the future.

In that respect, Klein observes that accidents may occur even in massively defended systems and, when they do, they will be more difficult to detect. "Since defenses in depth do not seem to work," Klein notes another approach, to "***accept malfunctions and errors, and make their***

existence more visible." He says, "We can try to ***design better human-system interfaces that let the system operators quickly notice that something is going wrong and form diagnoses and reactions***. Instead of trusting the systems (and, by extension, the cleverness of the design engineers) we can ***trust the competence of the operators and make sure they have the tools to maintain situation awareness*** throughout the incident." (p. 283, emphases added)

In other words, we can and we should create the best, most complete records possible and make them available as rapidly as possible to those who may be in a position to act upon them -- so that the recognition for which they are primed is based upon reality rather than merely superstition, supposition and imagination. It is only by creating, maintaining, and making records readily accessible exactly when, where, and in the form needed that we can ensure our decisions are not artificially devoid of information upon which more rational analyses can be based.

Ignorance may be natural, but in the information age, it is neither as necessary nor as desirable as it may have been for effective decision-making in the "prehistoric" past. Certainly, we should strive to minimize the application of ignorance as an enabler of action in instances where either large sums of money and/or human health, life, liberty and the pursuit of happiness may hang in the balance.