

# Blink – what does Intuition have to do with Safety –

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**ABSTRACT:** In the past 20 years, the fields of neuroscience, management, decision theory, and psychology have made major progress with the recognition and understanding of human Intuition.

This paper provides a survey of scientific findings on Intuition to-date, describes to which extent Intuition forms part of day-to-day Safety Assurance activities, and then explores the potential of Intuition to become further integrated and applied in the processes of Safety Assessment, Safety Engineering, and Safety Management.

The intention of this paper is to liberate this interesting topic from the taboos that surround it, so insights that Intuition may provide can be named, and may be given a chance to further enhance the Safety Assurance process, beyond the limitations that are experienced today.

*The intuitive mind is a sacred gift, and the rational mind is a faithful servant. We have created a society that honors the servant, and has forgotten the gift.*

*- Albert Einstein.*

standing how human intuition functions, and how safety practices could improve by adding focus on human intuition.

## 1 INTRODUCTION

The completion status of a risk analysis is often determined based on a sort of feeling. An early model output is rejected as unrealistic, and the models' assumptions and numeric data are reinvestigated. Some flaws of reasoning or inaccurate data are found and corrected. Once again the output is judged on its credibility, which may lead to another iteration loop, until the output is considered 'proper' and the analysis is concluded. The question is: how was it assessed that the risk model output was 'wrong' at the beginning, and 'correct' at the conclusion?

The search for publications on intuition showed that a vast amount of scientific research has already been performed.

Section 2 of this paper discusses the findings of this study on the topic and qualities of intuition in various research studies in neuroscience, management, decision theory, and cognitive psychology. Section 3 presents models of intuition as part of the human cognitive mind, and how it manifests. In section 4 is discussed how intuition nowadays is part of safety assurance practices, and recommendations are done where improvements of safety assurance are expected to be possible, by training for better under-

## 2 RESEARCH ON INTUITION

Section 2 provides a survey of scientific publications that have been made on the topic of intuition. It also investigates whether intuition can be investigated and described scientifically.

### 2.1 Management and Decision Theory

Sinclair & Ashkanasy (2005) state that, to come to grips with a world of dynamic change and globalization, organizations today are searching for new management tools to perform satisfactorily under such ambiguous conditions. In the area of managerial decision making, one of the approaches being assessed is the use of intuition. Patton (2003): Increasingly, over the past decade, it has become more and more apparent that the results of analytical thinking may arrive too late for the 24h/7d global marketplace. Effective intuitive inputs are more and more essential. Confident decision makers blend logic and intuition (of thought and feeling), the "so-called two wings that allow leaders to soar". Nutt (1999) reported that rational decision-making strategies struggle to reach the 50% success mark. Eisenhard (1989) and Wally and Baum (1994) suggest that organizations have begun to embrace more holistic approaches to non-

programmed decisions. Factors like high decision costs, increased time pressure, inadequate information, fast-paced change, along with other factors triggered by new economic and technological forces since the 1980s have led to question the effectiveness of rational decision making.

## 2.2 *Cognitive Psychology*

Bastick (1982) performed an extensive computer-aided survey for intuition, and grouped the findings around 20 properties, of which the 10 most important are “quick, immediate appearance, emotional involvement, preconscious process, contrast with analytic thought, influenced by experience, understanding by feeling, associations with creativity, associations with egocentricity, intuition need not be correct, subjective certainty of correctness”.

Epstein’s (1985, 1990, 1994) cognitive-experiential self-theory assumes we experience reality through two systems. The rational system operates mostly consciously, uses logic rules, and is fairly slow. This is the symbolic processor that we think of as our rational mind. The experiential system is intuitive. It is a ‘quick and dirty’ way of assessing and responding to reality. It relies on shortcuts and information that is readily available. It functions automatically and quickly. Epstein believes that both systems are always at work, and that they jointly determine behavior. People giving strictly logic responses tends to place them in the rational mode. Responding how they would act in a hypothetical situation tends to place them in the experiential mode. The more emotionally charged a situation is, the more thinking is dominated by the experiential system.

Duggan (2005) presents that new scientific insights by e.g. Klein (2002) show that “analysis and intuition are so intertwined that it is impossible to sort them out”, and that “flashes of insight are at the heart of problem solving and decision making”, and Duggan claims that military commands are formed in the mind “through a mix of strategic analysis, intelligent memory, and expert intuition”. “Good commanders use strategic intuition”; “we have gained enough scientific knowledge on how a commander’s mind works to revise our (US Department of Defense) manuals accordingly”.

Hamm (1988) asked six highway engineers to think aloud while producing formulas that expressed their knowledge of how highway aesthetics, safety, and capacity are determined by sets of relevant factors. Each engineers’ statements were measured with multiple indices of the use of intuitive or analytical cognition, thus producing a moment-by-moment measure. The analysis of change “shows evidence for a pattern of alternating between intuition (I) and analysis (A) (both A-I-A and I-A-I patterns occurred over the length of the session)”. The general pattern

was A-I-A, though there were substantial session differences.

Wierzbicki (1997) distinguishes the following phases in ‘creative or strategic intuitive decision processes’: recognition (often starting with a subconscious feeling of uneasiness), deliberation or analysis, gestation and enlightenment (concentration on the phase of intelligence, design, analysis, preceding the phase of choice, resulting in the eureka effect, emerging from subconscious, non-verbal processing), rationalization (formulate the reasons), and implementation.

## 2.3 *Neuroscience*

Lieberman (2000) suggests that “it may be fruitful to consider intuition as the subjective experience associated with the use of knowledge gained through implicit learning”, which is based on similarity of intuition and implicit learning, as well as through a review of neuropsychological, neuroimaging, neurophysiological, and neuroanatomical data suggesting that the two phenomena rely critically on the basal ganglia.

Lieberman (2004) performed an experiment where participants with high and with low experience in different domains (soccer and acting) made judgments from each domain while their brain was being scanned. An intuition-based self-knowledge system was associated with judgments in high-experience domains and produced activation in a network of neural structures called the X-system, including ventromedial prefrontal cortex, basal ganglia, and amygdala, all involved in automatic social cognition. An evidence-based self-knowledge system was associated with judgments in low-experience domains, and produced activation in a network of neural structures called the C-system, including lateral prefrontal cortex, posterior parietal cortex, and the hippocampus, involved in effortful social cognition and propositional thought. Lieberman was able to generate new insights regarding the affective, slow-changing nature of intuition-based self-knowledge and its potential resistance to external feedback.

# 3 INTUITION

Section 3 provides a number of descriptions of what intuition could be like, and some aspects of intuition that are frequently described as fundamental characteristics.

## 3.1 *Definition of Intuition*

Many definitions of intuition can be found in literature, that widely vary in scope and focus. Bastick (1982) concludes that common to most definitions of intuition is the idea that the answer or solution is

reached, without being aware of the process underlying it. In this paper we will use the following definition: “Intuition is the human quasi-conscious and subconscious information processing process, leading to an answer or solution, without being aware of the process underlying it”. This definition is based on Bastick (1982) and Wierzbicky (1997), and serves the broad purpose of this paper.

### 3.2 What is Intuition?

Patton (2003) states that intuition can be innate (not learned, but inborn, e.g. flight or fight response), general (accumulated) experience, or focused learning (deliberate efforts to develop habits and achieve intuitive reactions to certain situations. Expert intuition is “simply analyses frozen into habit and into the capacity for rapid response through recognition of familiar kinds of situations”.

According to Klein (2002) “an expert’s brain stores up cases from direct experience and the experience of others acquired through learning. Answers then come to the expert in flashes of insight, large and small. Klein followed fire fighters in action and interviewed them on the details of their decisions. At first they said “it was just my intuition”. Klein was able to pull from them the elements they combined from what they saw and what was already in their brains.

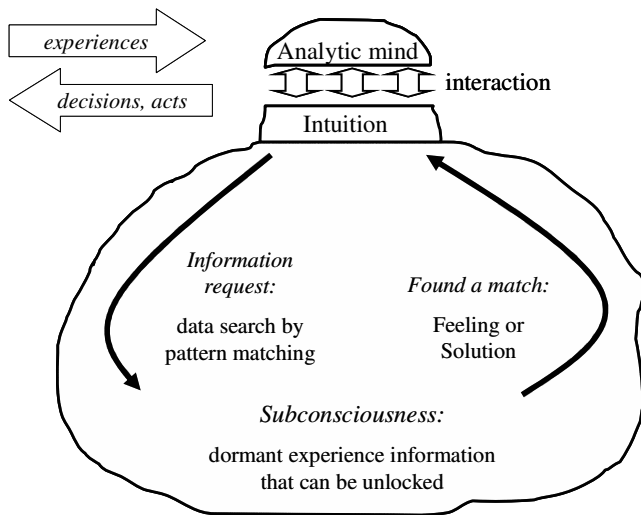


Figure 1. the functioning of human intuition.

The functioning of intuition is depicted in figure 1. Experiences enter the perception via the senses, and are stored in the sub-consciousness for later use. This is a continuous process. Later a new situation occurs, and the mind must make a decision. The analytic mind analyzes what should be done. Simultaneously, intuition searches the sub-consciousness for past memories of similar experiences, by a sort of pattern matching with the stored memories. Combining the results of the analytic and intuitive processes,

the decision is taken, and if necessary appropriate action is started. All this may occur in less than a millisecond.

### 3.3 Speed of Intuition

In “*Blink, the Power of Thinking without Thinking*”, Gladwell (2005) draws specific attention to those moments where we “know” something without really knowing why, and how this ability is one of the most powerful to possess. Gladwell provides ample evidence (Hogarth 2005) that a ‘snap’ judgment made very quickly can actually be far more effective than one made deliberately and cautiously. By blocking out irrelevant information and focusing on narrow slices of experience, it is possible to read a seemingly complex situation literally in the blink of an eye.

Patton (2003) recalls that “people in occupations that involve crises (police officers, fire fighters, paramedics) gain many decision making habits and their ability to respond intuitively to sudden emergency situations, as a result of extensive drill training.”

The pattern matching process of intuition can be much faster than the analytic process in the mind, that can be overloaded or time-consuming. As soon as a pattern is met, intuition has delivered.

### 3.4 Role of Emotion and Feelings

In the current society where ratio and science are ruling, feelings and emotions are often suppressed. Bastick (1982) explains that feelings give intuitive understanding: ‘long before one has realized that the color of the scene has changed, one may feel that the character of the scene has undergone change’. A stimulus creates an experience in the memory if it invokes emotion.

Epstein et al. (1992) proves that the more emotionally charged a situation is, the more thinking is dominated by the (intuitive) experiential system. In Epstein’s view, the experiential system resulted from eons of evolution. It’s invoked when speed is needed (emotionally charged, for instance to avoid danger), but may also be triggered by an intense desire to find the solution (Monsay, 1997).

Decision makers tend to use heuristic processing when in positive mood, which invokes favorable conditions to proceed. Negative mood, on the other hand, evokes the need for careful analysis. Strong emotions can also be cause that the signals of the intuitive process become blocked, e.g. when being absorbed by fear (Sinclair & Ashkanasy, 2005).

Bastick (1982): results from intuition are usually accompanied by a feeling of confidence: ‘exhilaration marks such moments of insight, a glow of elation goes with them, a feeling of adequacy, finality, accomplishment’.

### 3.5 *Intuition can be wrong*

Patton (2003) warns that “it is most important to recognize that the intuition of the emotion-driven leader is very different from the intuition of the expert; the latter’s behavior is a product of learning and experience and is very adaptive; the former’s behavior is a response to more primitive urges and an emotion-narrowed span of attention.”

Myers (2002) warns that intuition can be misleading; for instance one estimates the thickness of a 0,1 mm sheet of paper that is folded a 100 times much less than the actual thickness ( $10^{27}$  km), which roughly equals  $10^{15}$  times the distance from the earth to the sun.

Bastick (1982) states that ‘theory of intuitive thought clearly shows how intuitive perception, intuitive processing, and communicating of intuition are sources of error.’ The combination of emotional sets during the intuitive process transforms the intuitive information according to associations with the person’s past and present experience, and when harmony between these is reached, the intuitive process stops and the content of the emotion, which is the intuition, has to be decoded and communicated. The accuracy of the decoding depends on correct and accurate introspection.

### 3.6 *Intuition accompanied by feeling of certainty*

Intuitions are often incorrect (Bastick, 1982), but at the same time can be accompanied with a (sometimes even strong) subjective feeling that the intuition is correct. ‘Subjective certainty is a hallmark of intuition’. This confidence accompanies all the products of the intuitive process. It is possible that the subjective certainty is a result of the resolution of tensions, anxiety, frustration, or that the subjective certainty arises with the quality of the match with past and present experience.

### 3.7 *Intuition can be educated*

Patton (2003) writes that “the greatest power of intuitive decision making is that the process can be learned and enhanced into an effective management style for quick action. Developing desirable habits, which add to intuition and to better analysis of situations, will improve decision making. For instantaneous reactions where conscious thought is only a small determinant of action, regular drill is the road to habits that reach the “gut-level”. Some leaders can and do deliberately work to improve intuition by constantly learning in their business environments.

The habit to use reminder guideline questions with every significant decision will significantly enhance the intuitive component of decisions.

Wierzbicki (1997) claims that “all training in repetitive activities is actually aimed at delegating them to the quasi-conscious level, ‘automating’

them, by establishing shortened or more easily used connections between synapses, some specialized ‘roads of the brain’”.

Hogarth (2001) describes various ways how intuition might be improved or educated. (Company) culture is critical; learning conditions may vary from kind to wicked. A kind environment in this sense is one where feedback is relevant and tasks are neither too lenient nor too exacting. Intuitions learnt in kind environments are likely to be good, that is dependably predictive within a reasonable range of tolerance. Bad intuitions flow from wicked environments where input is a poor or delayed predictor of output, and when tasks are either too demanding or lacking in challenge.

### 3.8 *Conclusions*

Years of research on intuition have shown that intuition can be defined, that intuition can be well understood, and can be trained and improved. Intuition is a process that closely cooperates with the analytic mind, and derives its information from past experiences in the quasi-conscious or subconscious mind. Because intuition is based on past experience it is domain-specific. When the intuition receives its results from other less relevant domains, intuition can be wrong, although it may be accompanied by a feeling that the intuition is right. Therefore it is important that domain experience is learned with teachers and an environment that give correct answers to questions. In addition the results from intuition should be verified for correctness with colleagues and other information sources, and a self-critical view should be maintained.

## 4 INTUITION CAN IMPROVE SAFETY

This section discusses how intuition forms part of the present-day safety assurance practice, and how intuition could contribute to further elevate the achieved safety.

### 4.1 *Intuition is central in Risk Analysis*

Redmill (2003, 2004) concludes that all aspects of risk analysis, from planning to the interpretation of results, rely on subjectivity. Derivation of values of consequence and probability is based on numerous judgmental decisions. Fault Tree Analysis (FTA), the tool most used for determining cause and effect, was seen to be dependent on human factors for both its construction and its use. Input data for FTA may arrive from disparate sources, of varying pedigree and trustworthiness, so the error in the estimation of probabilities can be large. Qualitative analysis is by definition based on human judgment.

The above quotations make clear that by nature there is a large part of subjectivity (intuition) in the process of risk analysis. To decrease the potential negative effects, peerchecking and design/documentation reviews should be balanced with safety criticality. Better understanding which parts of risk analysis are based on intuition could aid to produce better risk analysis results.

#### 4.2 *Feelings and intuition as valid contributors*

Up to now, feelings and intuitive ‘hunches’ have been more or less taboo as an argument in safety analysis or decisions. The results of risk analyses were often taken for granted and demonstrated the validity of the achieved safety. The hearings on the space shuttle Columbia and Challenger accidents revealed that the engineers were divided about whether the safe limits were exceeded. ‘How many people there understand the effect of intuition and hunch, which are absolutely integral to good engineering, and how the emphasis on numbers suppresses that kind of information in critical situations? People are disempowered from speaking up, by the very norms of the organization. (..) How can you get back in touch with the importance of engineering intuition and hunch in formal decision making?’ (Dr. Vaughan in NASA, 2003A). “Much of the (air traffic) controllers’ ability to identify and correct anomalies rests upon experientially-based human assessment and intuition. Controllers’ tacit knowledge gives them almost a sixth sense about pilots, allowing them to predict and prevent a mistake waiting to happen” (Vaughan, 2004).

In the case of the Columbia, management based their decision on risk analyses, so the decision concerned a working system. NASA now comes back on their procedures. ‘Management must be trained to restore deference to technical experts, empower engineers to get resources they need, and allow safety concerns to be freely aired. Strategies must increase the clarity, strength, and presence of signals that challenge assumptions about risk’ (NASA, 2003B).

An intuitive culture is open for the expression of feelings, emotions, and the individual view, including dissenting opinions. The organizational structure, company values and culture should support that engineering can freely express any (intuitively) felt or (analytically) argued concern, and that these concerns are judged and included in the process of management decision making.

#### 4.3 *Intuition in Safety Decision Making Tools*

Tavana (2002): over the last decades, intuitive models for decision making have been developed, but they lack a structured framework. Similarly, analytical decision models have been developed, but these are not intended to capture intuitive preferences or

model environmental processes. Euclid (Tavana, 2002) uses intuitive and analytical methods to enhance decision qualities evaluating a set of strategic alternatives. Cross (Tavana, 2003) is a multicriteria group-decision-making tool for evaluating and prioritizing advanced-technology projects, that was implemented successfully at Kennedy Space Center at NASA.

The value of decision support tools is often underestimated. This is because management often takes decisions in an intuitive way. Then if a decision tool is applied, the board members propose to change some weighing factors until the result matches the expected result. The tools that include intuitive approaches now put particular emphasis on this type of intuitive tuning, because this is exactly the process that brings the contributions of all of the stakeholders and individual experts in line. This tuning is sometimes repeated at different stages and aspects of the decision process.

#### 4.4 *Man-Machine Interfaces should work Intuitive*

To prevent occurrence of human errors, significant efforts should go to the ergonomic design of the layout of console input devices (e.g. mouse, keyboard, track-ball, emergency buttons) and output devices (e.g. monitors, displays, monitor screen layouts). In 2004, Honeywell received the ‘Bendix trophy’ for aviation safety with the design of the EASy flight deck, which reduced the number of distractions and misunderstandings caused by avionics, and was tested by pilots to ensure that it was ‘truly intuitive’. The result was a reconfigured flight deck that ‘enables the crew to process information faster and to react to changes more expeditiously’.

Many field human errors could be resulting from omitted, misleading or unclear man-machine interface design. To enhance safety to the maximum, ergonomics must be built to provide an intuitive control: the intuitive response to a situation should lead to a safe system state.

#### 4.5 *Innovation and Intuition*

Wierzbicki (1997) mentions that an intuitive decision process, in particular when it is creative, aiming at novel solutions, is actually multi-objective. To support this process analytically, the information should be presented graphically, rich and multidimensional. Early aggregation of objectives into a utility or value function should be avoided, nor should consistency be required. It should support in helping to generate new options, reformulating the problem, organizing the dynamics of the decision process in such a way that it leaves enough time for gestation.

When all related requirements and stakeholders are involved simultaneously, group intuition is

maximally involved, and the novel solution can become as close to the desired product as possible. However upon viewing intermediate results feelings may come up whether or not the correct approach is followed, and desires and requirements may change. To discover necessary changes early, providing models and prototypes, 3D operational simulations, and graphical performance model outputs maximally stimulate the intuitive synergy of the team.

#### 4.6 *Quick-scan Hazard Analysis*

For low-budget projects or early in the project definition phase it is not uncommon to perform a quick-scan hazard analysis (project screening, mapping the major risks, detailing the analysis only as needed for the stage the project is in), that provides early feedback on the necessity for major safety requirements for the design. In the spirit of Gladwell (2005), intuitively thin-slicing a hazard analysis by an experienced analyst can be as productive (or even more) as an extensive analysis, while limiting the resource expenses.

#### 4.7 *'Blink' OS&H Inspections*

Many occupational safety and health (OS&H) plans are written nowadays, but when the (e.g.) construction site is visited several problems are present that are not covered in the analysis, or the proposed measures are not adequate. As an alternative, performing 'blink' inspections (low-effort inspection by walking around the site and discussing which activities are planned), scheduled or not, could be significantly more effective, because of its focus on the actual situations, and stimulating an open and adaptive safety culture.

#### 4.8 *Safety Training to understand Intuition*

Safety managers and engineers can be trained to enhance their intuitive capabilities, see also paragraph 3.7. Hafkamp (1996) names some differences between the 'manager' (role-bound, conservative, conformist, reactive), and the 'master managers' (role-surpassing, creative, visionary, proactive), and elaborates on how this ('master') mental attitude can be improved.

Everybody knows that there are safety analysts that produce extensive documentation, but of which the added value is questioned. And then there is the safety expert, that is able to name the risks in one sheet, and proposes the necessary improvements. What makes the difference between the struggler, the number cruncher, and the 'master'. The insights of intuition could be a drive for the training of safety engineers, managers, engineers, and personnel. Management could receive training to understand and enhance their and their organizations' intuition. Safety

Safety engineers could be trained to utilize intuition to restrict reporting to issues that matter. Personnel could be made aware of the significance of their input to the safety process.

#### 4.9 *Conclusions*

Several topics have been touched that lead to a more effective and intuitive approach to safety assurance. Understanding and training of intuition brings a wider spectrum of insights in hazards, a wider spectrum of solutions, a more effective, human and pragmatic approach, a safety design and operations concept that is more supported in the organization.

## 5 CONCLUSIONS

Many years of research in management, neuroscience, decision theory, and psychology have shown that human intuition can be defined, that the functioning of human intuition can be well understood, and that it can be trained and improved.

Intuition is a process that closely cooperates with the analytic mind, and derives its information from past experiences in the quasi-conscious or subconscious mind. Because intuition is based on past experience it is domain-specific. Intuition from other domains or from faulty experience can be wrong, although it may be accompanied by a feeling that the intuition is right. Therefore it is important that experience is learned with teachers and an environment that give correct answers to questions. Also the results from intuition should be verified for correctness with colleagues and other information sources, and a self-critical view should be maintained.

With respect to its application in the field of safety the following has been found.

Intuition has a central role in the performance and quality of safety risk analysis, albeit not explicit. Better understanding of which parts in the process of risk analysis are influenced by intuition could help to make risk analysis produce better results.

Up until recently feelings and 'hunches' have not been explicitly accepted as an argument in safety risk analysis. The Columbia and Challenger accidents have shown that if management bases its safety decisions on the results of safety analysis only, this may end in a major disaster. The concerns that were present at the engineering level were circulated but not communicated (through the different management levels) to the operations management. Ultimate safety can only be accomplished when the organizational structure company values and culture support that engineering can freely express any (intuitively) felt or (analytically) argued concern, and that these concerns are judged and included at the level of management decision making. An intuitive organiza-

tion culture is open for the expression of feelings, emotions and the individual view, including dissenting opinions.

Decision support tools can document the arguments of a decision, and can prevent that management takes the intuitive shortcut where certain disciplines might be forgotten. Analytic-intuitive tools have been developed that aid to bring in line the values and requirements of stakeholders and environment, by use of techniques such as subjective weighing factors, entropy concepts, and maximize-agreement heuristics.

To enhance safety to the maximum, ergonomic design of man-machine interface console input and output devices must provide intuitive control: the intuitive response to a situation should lead to a safe system state.

Innovation should use all possible means to involve human intuition in the process of creating the optimal solution or design. Intuition can be strengthened by feeding it with visual and tangible information such as scale models, 3D simulations, and graphical data presentations.

Quick-scan hazard analyses could be applied much more frequently. The value of these intuitive assessments is highly underestimated. When exercised by an experienced engineer they may have the same quality output as extensive analysis.

As alternative for tedious and costly occupational safety and health analyses, 'blink' inspections at the worksite may yield a much more responsive and open safety culture.

Safety training at all levels to better understand intuition may lead to better and less documentation, more precise reporting, more organization synergy, and more effective hazard mitigation.

This first investigation to combine research about intuition with the practices of system safety has yielded several opportunities for safety assurance improvement. Understanding and training of intuition brings a wider spectrum of insights in hazards, more effective hazard management.

The world of dynamic change and globalization, high decision costs, increased time pressure, along with new economic and technological forces makes that safety assurance today can no longer afford to do without intuition.

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