DISCOVERY OF KEY PROBLEM CAUSES IN ORGANIZATIONS

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Abstract

Biases and noise distort problem definition and lead astray search of key problem causes in organizations. The author defines bias and noise terms, provides their classification and correction methods, describes an approach to problem definition and discovery of key problem causes in organizations. Limitations of TRIZ and other problem solving methodologies are discussed in the light of Complexity Theory achievements. A way to combine TRIZ and other methodologies is depicted in order to attain synergy and expand their applicability.

Keywords: bias and noise in organizations, key problem causes in organizations, TRIZ limitations, combining TRIZ with other methodologies.

Introduction

Theory of Inventive Problem Solving (TRIZ), since its inception, has shown unparalleled effectiveness in solving many technical problems. However, despite almost two decades of publications by many prominent specialists, TRIZ application for organizational improvement has yet to become mainstream approach like Lean, Six Sigma or Theory of Constraints.

Contemporary achievements and works of some specialists in the fields of management and human behavior sciences are not considered when definition of organizational problems and discovery of their causes is performed according to existing TRIZ practice. In addition, a better understanding of TRIZ limits and synergetic merge of TRIZ with other managerial methodologies are needed for further proliferation as well as theoretical and practical development of such crucial field of Innovation Science as TRIZ.

1. Bias and Noise Affect Comprehension of Organizational Problems

Adequate understanding of a situation and problem definition underpin successful organizational transformation towards a desired ideal state. However, there are ill-defined problems that cannot be defined clearly along with their goal state and means of moving towards the goal state. Solving such "complex problems" requires cognitive processes that differ from simple problem solving processes [1].

External observer, e.g. external consultant, or internal observer, e.g. Business analyst or a manager of any level, perceive current situation via various strong or "weak" signals [2] that are hidden in the noise [3]. In addition, as Nassim Taleb noted, "our reactions, our mode of thinking, our intuitions, depend on the context", in which the matter in question is presented [4]. Peter Drucker, one of the most influential thinkers on management, said [5], "When a change in perception takes place, the facts do not change. Their meaning does."

Daniel Kahneman defines bias as a systematic error that recurs predictably in particular circumstances and views noise as the chance variability of judgments[6]. He explains the distinction between bias and noise in the following example of a bathroom scale [7], "We would say that the scale is biased if its readings are generally either too high or too low. If your weight appears to depend on where you happen to place your feet, the scale is noisy. A scale that consistently underestimates true weight by exactly four pounds is seriously biased but free of noise. A scale that gives two different readings when you step on it twice is noisy."

Figure 1 illustrates the distinction between bias and noise.

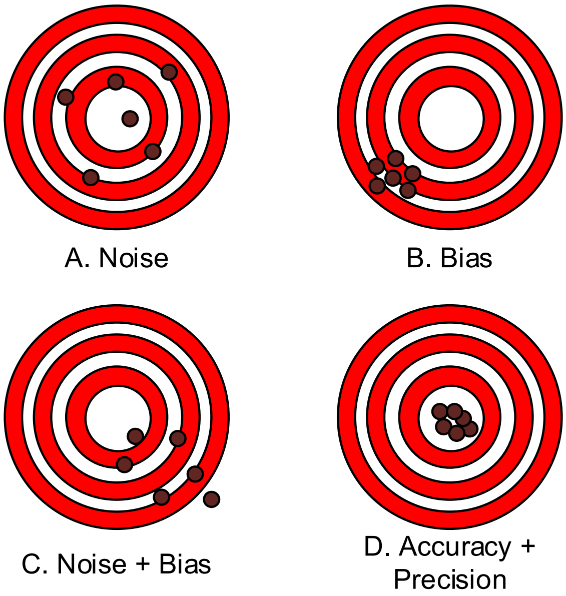

Fig. 1. Distinction between bias and noise

To reduce negative effects of noise that manifests variability across occasions Daniel Kahneman proposes to replace human judgement with algorithms or use checklists that encourage a consistent approach to decisions. In case of demonstrated variability across individuals, in addition, he proposes frequent monitoring individuals' decisions and running roundtables to explore and resolve differences. Increase of a specialist qualification level decreases noise, reducing it almost to none at the highest skill levels [7].

Another way to reduce noise that demonstrates variability across individuals is to "calibrate specialists" by using method proposed by Douglas Hubbard. The method has demonstrated solid results for the last several decades and have been used successfully in various industries [8].

Signal about undesirable effect in an organization is distorted by the signal source, i.e. human or system, and disguised by the "organizational noise". An observer, i.e. any employee or an external consultant, distorts the received signal that is disguised as well by the external environment noise. Diagram in Figure 2 demonstrates how bias and noise affect signal processing in an organization.

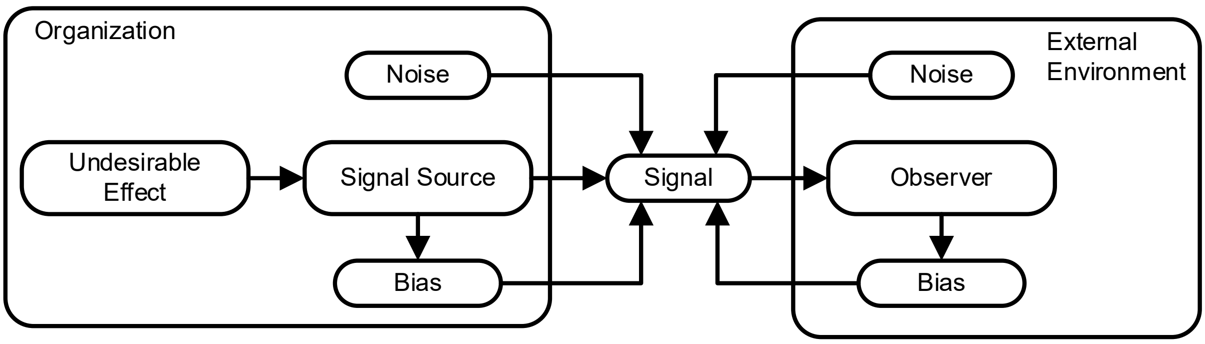

Fig. 2. Bias and noise impact on signal processing in an organization

From the Cognitive Psychology point of view, McKinsey specialists grouped all types of biases in 5 categories: Action-oriented biases driving us to take action less thoughtfully than we should; Interest biases that arise in the presence of conflicting incentives, including nonmonetary and even purely emotional ones; Pattern-recognition biases leading us to recognize patterns even where there are none; Stability biases creating a tendency toward inertia in the presence of uncertainty; Social biases arising from the preference for harmony over conflict [9]. This classification sum ups nicely main bias types described by Daniel Kahneman in his book "Thinking Fast and Slow" [6].

Biases classified and discussed by McKinsey specialists stem from mechanics of our brainwork. There are some other sources of biases besides the abovementioned ones:

1. Motivation. For instance, fear is a powerful stimulus for bias.
2. Organizational systems, first of all information systems, that people build bear biases imposed by their creators and processed data. For instance, information retrieval software learns to make decisions that reflect biased data [10]. Algorithms created for automated systems, including machine learning, can create and perpetuate biases that last for a long time if not corrected promptly. Formalized "AI audit" procedures, "involving assessments of accuracy, fairness, interpretability, and robustness of all consequential algorithmic decisions" should be conducted by a team of trained internal or outside experts instead of alone specialist, thereby correcting and minimizing biases created by information systems [11].
3. Cultural background may breed biases and affect the way people reason causally about certain events [12]. Based on research conducted over prolonged period of time, Geert Hofstede identified five dimensions of cultural difference. Their understanding may enable us to avoid or minimize misunderstandings and conflict, hence maximizing the chances of successful organizational outcomes. Therefore, cultural differences should be considered when correcting biases and noise or defining problems and determining their key causes.
4. Inadequate qualification of managers or employees may lead to biases caused by measurement of wrong performance parameters in an organization or by incorrect interpretation of data. Daniel Kahneman in his book [6] provides a good example of failure to recognize the effect of Regression to the mean that is manifested by any system. Such failure begets harmful biases and occurs due to lack of knowledge and misunderstanding statistical process control.

Kahneman demonstrated that biases can be and should be corrected [7].

Table 1. Bias corrective actions proposed by Daniel Kahneman [7]

Type of Bias	**Corrective Actions**
General	• Continual monitoring of decisions • Guidelines and targets for the frequency of certain outcomes (such as loan approvals) • Eliminating incentives that favor biases
Social	• Monitoring statistics for different groups • Blinding of applications • Objective and quantifiable metrics • Open channels for complaints • Guidelines and training
Cognitive	• Training employees to detect situations in which biases are likely to occur • Critiques of important decisions, focused on likely biases

Based on some real life examples, Alex Miller shows that "algorithms deliver more-efficient and more-equitable outcomes" [14].

McKinsey specialists propose certain corrective actions for each type of biases described in their paper [9].

Table2. Bias corrective actions proposed by McKinsey specialists

Type of Bias	**Corrective Actions**
Action-oriented biases	Promoting the recognition of uncertainty (make a clear and explicit distinction between decision meetings, where leaders should embrace uncertainty while encouraging dissent, and implementation meetings, where it is time for executives to move forward together; scenario planning, decision trees; "premortem"; selection of right metrics to be monitored to highlight necessary course corrections)
Interest biases	Making biases explicit (formulating precisely the criteria that will and will not be used to evaluate a decision, before the time of that decision; populating meetings or teams with participants whose interests clash)
Pattern-recognition biases	• Changing the angle of vision by encouraging participants to see facts in a different light and testing alternative hypotheses to explain those facts (field and customer visits; reframing or role reversal during meetings; competitive war games) • Articulating the experiences influencing a decision maker • Making the angle of vision wider
Stability biases	Shaking things up (establishing stretch targets that are impossible to achieve through "business as usual"; reducing each reporting unit's budget by a fixed percentage; challenging budget allocations at a more granular level)
Social biases	Depersonalizing debate (climate of trust; diversity in the backgrounds and personalities of the decision makers; culture in which discussions are depersonalized)

Some authors [15] propose segmentation of decisions, principle 1 in TRIZ [16], which, in my opinion, helps to reduce negative effects of noise and biases. By categorizing the type of decision that is being made, it is possible to tailor our decision making accordingly and select certain formalized corrective actions countering noise and biases.

It seems to me that classic system operator of TRIZ [17] or a system operator proposed by Darrell Mann [18] correct biases in a way similar to change of the angle of vision proposed by McKinsey specialists because they force us to consider various perspectives of time, hierarchy or other dimensions. Ideal final result (IFR) of TRIZ [17] shakes up our mind to correct biases that stem from tendencies toward inertia of mind, status quo and stability.

As mentioned before, standardization of procedures reduces noise and biases. Combination of this method with other methods such as visual management, formalized system of effective problem solving based on Genchi Genbutsu, training within industry and workplace training, mentoring and quality circles plays crucial role in functioning of the Toyota Production System [19]. Outcomes brought about by these methods and described by Jeffrey Liker make me to conclude that synergetic effect of combining them significantly reduces organizational noise and biases in comparison with Toyota competitors. Furthermore, application of these methods in the Toyota Production System reflects the concept of Ideal final result (IFR) since the organizational system itself reduces noise and biases.

Indeed, ARIZ [20], TRIZ standards [21] and TRIZ principles [22] are effective tools reducing organizational noise and bias due to standardizing and formal documenting of the innovation process.

I believe that every organization, considering its specifics, should implement an appropriate system correcting noise and biases that in combination with other organizational elements improves capability to discern and identify internal and external signals. Such organizational capability is critical for adequate response to change and adaption being the cornerstone of organizational resilience and sustainable evolution.

2. Problem Definition and Discovery of Key Causes

A problem is a gap between the current and the desired system states that is consciously perceived by a person or a group of persons. Therefore, to define a problem we should describe as precisely as possible the current and the desired system states. Such problem definition reflects General (Superficial) contradiction in TRIZ [23] while the Ideal final result (IFR) can serve as the desired system state definition. For comprehensive problem definition, Dean Gano recommends to state as well when and where the negative effect manifested itself and what the problem significance was [24].

Discovery of key problem causes can be demonstrated on the following example.

A rookie Process Engineer of a manufacturing plant was assigned to determine a cause of high defect rate of 36-38% due to inability to assemble two parts of a module.

By using the Five Whys method, inspecting and checking various variants, the engineer eventually found that a mistake in a tolerance chain made by a rookie Product Design Engineer was the main cause of the problem. Obviously, the mistake reflected in a technical drawing led to erroneous process documentation. After correcting product design and production documentation, defects almost disappeared achieving acceptable level.

The problem was resolved from the standpoint of the Process Engineer, his manager, quality control department and the plant shop manager. After all, was this problem resolved from the point of view of the whole plant?

Let us build Ishikawa diagram, aka fishbone diagram. Essentially, we decompose sequentially standard categories (Manpower, Methods, Machines, Materials, Measurement and Mother Nature) into more detailed subcategories that can depict problem causes [25]. A simplified version of such diagram is depicted in Figure 3.

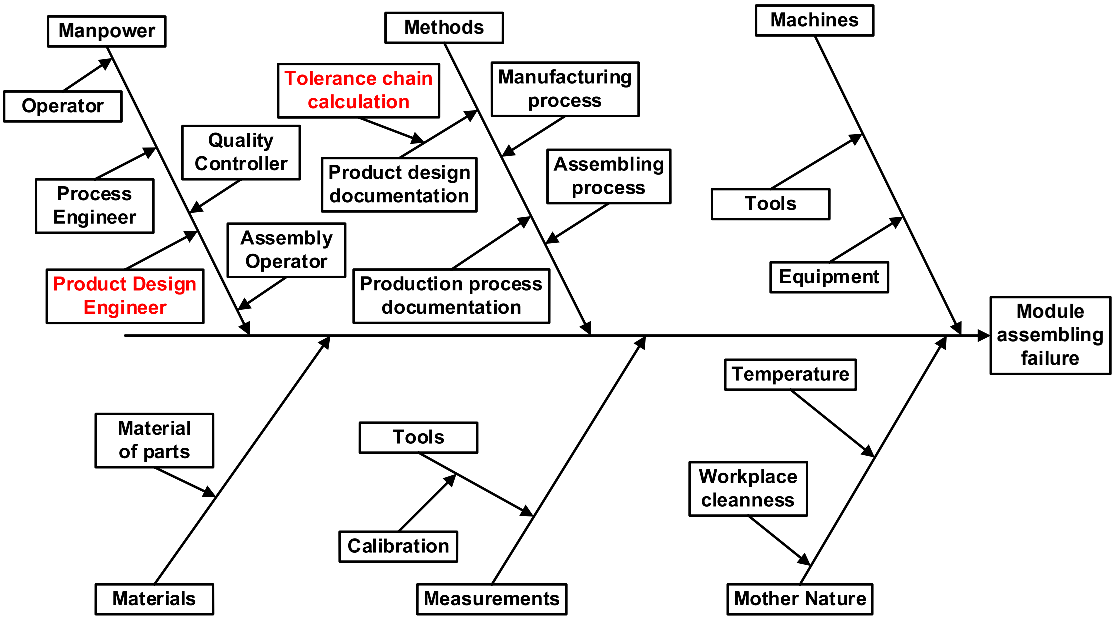

Fig. 3. The Ishikawa diagram example

Thorough analysis of the diagram reveals such problem cause as the insufficient skill level of the rookie Product Design Engineer who made the mistake. However, this cause lies beyond the area of responsibility and concerns of the production process department. Hence, no wonder that the Process Engineer did not indicated this cause. He analyzed situation only from his area of responsibility perspective and his department perspective.

It seems we found the key problem cause. Did we really find the key cause?

Ishikawa diagram has some drawbacks [26]:

- Categorization schemes, especially predefined "root cause dictionaries", restrict thinking and result in "tunnel vision".
- Hierarchy of categories and subcategories substitutes true causal relationships. There is no evidence provided to support the causal factors. Different persons will inevitably have different categorization schemes since we each have a different way of perceiving the world.
- The diagram layout does not allow showing all the causal relationships between the primary effect and the root causes. The diagram becomes illegible after adding the forth and higher levels of subcategories. We are running out of room quickly as soon as we try to add subcategories beyond the third level.

Dean Gano introduced four principles for searching key problem causes and building causal diagrams [27]. In addition, RealityCharting software offered in his website streamlines and facilitates creation of causal diagrams.

1. A "cause" and an "effect" are the same thing. A single thing may be both a cause and an effect.
2. Each effect has at least two causes in the form of an Action and Condition.
3. Causes and effects are part of an infinite continuum of causes.
4. An effect exists only if its causes exist in the same space and time frame.

Principles 1, 3 and 4, suggested by Dean Gano, have already been discussed in the TRIZ literature, for instance in some Khomenko's publications dedicated to OTSM-TRIZ [28, 29]. Nevertheless, the Gano's approach stands apart from other methodologies because it acknowledges infinity of causal chains, requires the Action-Condition format for depiction of any cause and relies on documentation of evidence that proves existence of specific causes. S-Field analysis in TRIZ bears some resemblance with the Gano's approach since it essentially demonstrates causal chains in the form of an object (substance), i.e. a condition, and a field (energy), i.e. an action. In addition, S-Field analysis puts forth specific techniques of causal chain transformation that lead to desired results. I suppose that after determining a key problem cause by using the Gano's approach, such cause can be depicted, analyzed and resolved by means of S-Field analysis.

Analyzing the diagram in Figure 4, from the TRIZ standpoint, we can conclude that super-system analysis is needed in order to identify a key problem cause. In a simplified diagram example in Figure 4, such elements of causal chain depiction as conditions, in the form of main objects participating in the causal chain, trace selected causal links and show how the causal path crosses boundaries of some systems an goes on from subsystem to system, then to super-system and further on. The causal path in this specific example leads up. However, in other cases a causal path may lead in any direction of an organizational hierarchy.

The key problem cause of higher order with respect to the production process department is a flawed new hire induction process, including mentoring as its integral part. Organization of workplace training and mentoring during new hire induction affects significantly the future employee performance.

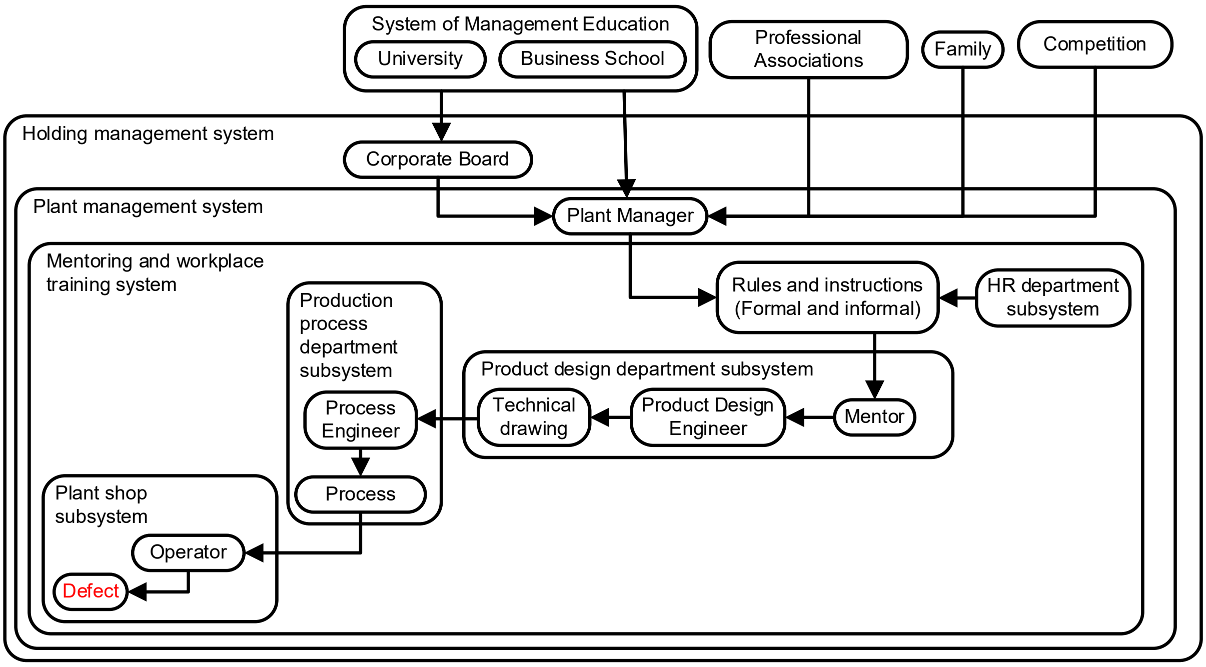

Fig. 4. The example of the causal path in organizational systems

The Plant Shop Manager did not notice a troublesome signal in the described situation of their daily routine. As a matter of fact, the Plant Manager and Human Resource Officer (HRO) should have paid attention to this situation and identified inadequate induction, especially mentoring, of the new hire as a problem. The poor mentoring practice in the product design department and probably in the entire plant as potential causes were manifested by the problem in question. The Process Engineer, his manager, and even the Plant Shop Manager were not accountable for these causes. If we look, further up, at one of the super systems then we may state that the Plant Manager knowledge and skills were the causes of the mentoring system established in the plant. In turn, guiding principles and actions of the Corporate Board were further problem causes, hidden deeply in the system hierarchy.

In order to solve a problem we should recognize a level of abstraction at which a problem solving task or effect analysis to be done. Key problem causes are never recognized at first glance and are usually hidden deeply in the causal structures. Moving along a causal path and sequentially localizing zones of key problem causes, we should distinguish causes that require changes of system parts (subsystems) from causes that require changes of the entire system, e.g. changes of main organizational principles, strategies or a business model.

The John Zachman Framework [30] describes abstraction levels corresponding to certain organizational departments and hierarchy levels. Organizational descriptions change from the most abstract at the highest framework row to the most concrete at the lowest row. A causal path may go through various levels up, down or laterally depending on an observer position relative to the organization in question, Figure 5.

For each level of abstraction and an observer position there are specific corresponding key problem causes that are located near a work area boundary of a particular person in charge or right outside of that work area boundary. Bottom-up and lateral transmission of information and a chain of help in problem solving across the organizational hierarchy should be created in order to facilitate identification of key problem causes situated beyond accountability areas and promote problem analysis and resolution at each system level in the organization.

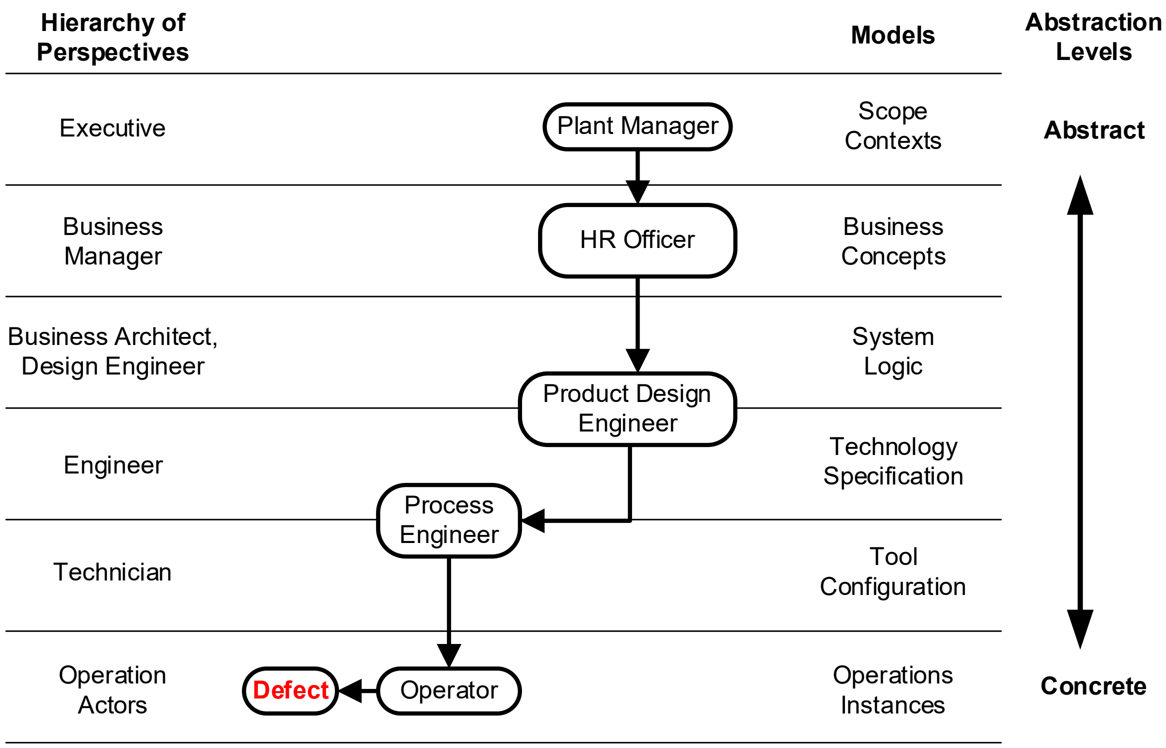

Fig. 5. The causal path through abstraction levels of the John Zachman Framework

Steven Spear and Kent Bowen describe problem solving help and bottom-up relay of pertinent information about problems at Toyota Company [31]. Shigeo Shingo, one of major contributors to the Toyota Production System, defined guiding principles that play crucial role in achievement of organizational excellence [32]. These principles can be attributed to the highest row (level of abstraction) of Zachman's Framework [30]. Therefore, it is utterly important to determine and resolve key problem causes that sit at the highest levels of abstraction, e.g. related to formalized organizational structure, culture, strategy or interaction with external environment, and influence profoundly causal structure of the whole organization, subsystems and outcomes. At the same time, resolution of key problem causes located at the lower levels of organizational abstraction and affecting some organizational subsystems is just a necessary temporary optimization of system parts.

Russell Ackoff presumes that both analysis and synthesis are necessary complements to system thinking and should be combined in order to comprehend interaction of system parts resulting in emergence of a specific system behavior [33]. In regards to organizations, synthesis is the examination of higher abstraction levels of organizations, i.e. organizational super-systems, which is required for adequate comprehension of key problem causes producing undesired system behavior or deviations of system parameters from standard, set-point, values.

3. TRIZ Limits and Synergetic Merge with Other Methodologies

Some specialists acknowledge that TRIZ has certain limits [34]. To shed light on TRIZ limitations let us turn to Cynefin, Theory of Complexity developed by David Snowden [35].

All situations that we come across in our daily life can be divided into two categories: the ordered and unordered world. In Simple (Clear) contexts of the ordered world, cause-and-effect relationships are evident to everyone, repeatable and foreseeable. For example, bookkeeping records are made according to a standardized local or international set of rules. In Complicated contexts of the ordered world, cause-and-effect relationships are discoverable but not immediately apparent to everyone due to their separation in time and/or space. For example, when a business model changes, bookkeeping specialists need an expert consultation in order to understand how to record transactions in order to comply with existing rules. In Complex contexts of the unordered world we can understand why things happen only in retrospect since there is no immediately apparent relationship between cause and effect, whereas, in Chaotic contexts of the unordered world the cause-and-effect relationships exist but they are impossible to determine at all because they shift constantly and no manageable patterns exist. Thus, it is useless to build causal models for situations of the unordered world and define contradictions by using TRIZ techniques. There should be a completely different approach and different management methods for situations of the unordered world, e.g. setting barriers, stimulating attractors, creating "quasi-stability islands".

Agile and Scrum methodologies, based on quick iteration of trials and errors, are examples of problem solving in the unordered world. Inability of rigid linear process to produce a desired result in uncertain situations of the unordered world leads to disposal of the Waterfall approach. Statistical Process Control is the good example of restricting number of potential system states by controlling and forcing system to behave within defined boundaries, control limits. Any random values within control limits are allowed, whereas outliers beyond these limits or specific discernable patterns are investigated. Toyota Company tames high uncertainty and potential chaotic behavior in their supply chain by using several methods that stabilize it to acceptable levels: customer relationship management to control demand; Heijunka to level out the schedule and workload; Kanban to synchronize operations along the extended supply chain, within the organization and for interaction with suppliers.

Allostasis concept suggests that living systems, as complex adaptive systems, do not have constant internal environment. Therefore, parameters of the internal environment always fluctuate around some normal, homeostatic, or set-point value [36]. Similarly, in an organization should be created "quasi-stability islands" where analysis and control of causal relationships, including determination and resolution of contradictions with TRIZ tools, are viable and attainable. Complicated situations of the ordered world should be transformed into the Simple by engaging expert assistance. In Complex situations, experimentation and observation can uncover zones of quasi-stable system states, i.e. Basins of attraction, as well as Attractors. In Chaotic situations, chaotic behavior should be contained first, then reduced by swift decisive actions. Afterwards, the situation can be transformed into the Complex or Complicated, and, potentially, later on in the Simple.

Some authors contemplate necessity of combining TRIZ with other methodologies [37] for better discovery and definition of tasks that can be solved with TRIZ tools. Blitz QFD, methodology of product development devised and propagated by the QFD Institute, thoroughly describes the process of diagnosing and triaging problems that combines several methodologies, including TRIZ [38]. Meanwhile, there is yet to be developed a simple effective approach of organizational diagnosis that could be well structured and thorough enough for determining tasks to be solved by the TRIZ toolset or other methodologies.

By using certain methods, an organization itself should be able to localize problem areas and make signals about undesired effects easily discernable and adequately comprehended. Then, problem definition and discovery of key causes naturally follow as the next steps. After key causes are determined, they should be triaged by using one of prioritization methods, e.g. the Analytic Hierarchy Process (AHP), in order to focus limited organizational resources on the vital few causes and create a roadmap for elimination of discovered causes. Further, key causes that can be resolved with the TRIZ toolset should be determined. Likewise, there should be chosen key causes to be resolved by using other methodologies such as Six Sigma, Theory of Constraints (TOC), Lean or by implementing modern information and communication technologies, see Figure 6.

Time available for problem solving and problem importance determine possibility and necessity of utilizing existing standard solutions or other methodologies, including TRIZ. Art Smalley recommends using different approaches to solving problems depending on their correspondence to each of four categories described in his book [39]. The approaches range from simple, even shallow, problem resolution with certain standard methods up to thorough structured systematic appproaches.

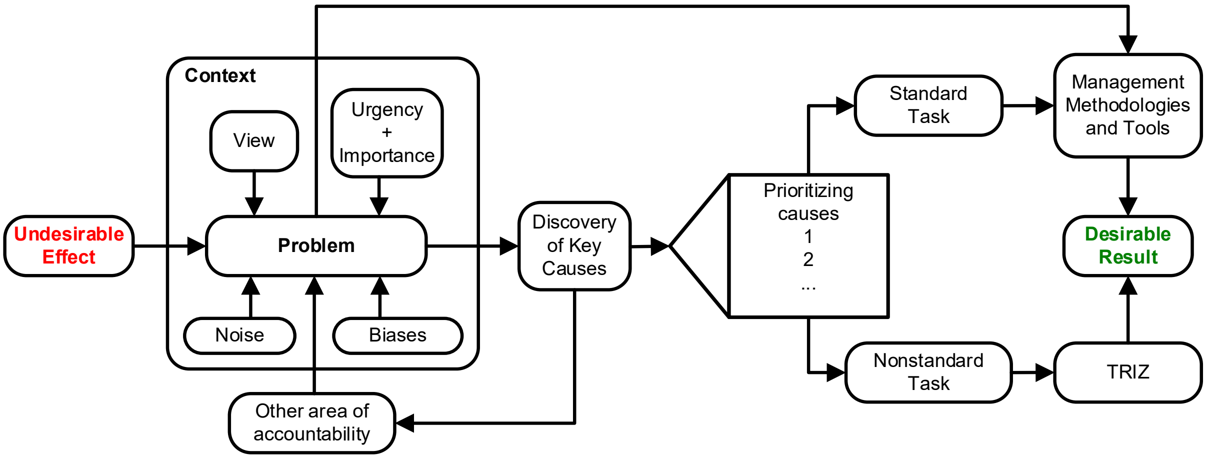

Fig. 6. Blitz discovery and resolution of key problem causes

Improvement of organizational system parts with Six Sigma, TOC, Lean and other methodologies is just local optimization rather than improvement of the organizational system as the whole. Only holistic improvement of systems leads to evolutionary breakthroughs.

Russell Ackoff recommends imagining an ideal organization and its purpose and objectives, likewise IFR concept in TRIZ. The idealized design should be technologically feasible, capable of surviving in the current environment and being improved over time. In addition, a constrained design and an unconstrained design, when availability of resources and capabilities is ignored, should be envisioned. Then, working back from that idealized design to where the organization is now, from destination to origin, we should describe every interim state and the ideal state of the present. Afterwards, by comparing the real and ideal states in the present, working forward and likewise comparing projected interim ideal and real states, we determine potential gaps and actions to be undertaken in order to attain the approximate ideal organizational state [40]. Organizational objectives can be defined for each organizational level in the same way as Toyota Company does by using the strategy deployment method called Hoshin Kanri. Encountered contradictions can be resolved by applying combination of methodologies, including TRIZ.

To build a self-developing organization that effectively adapts to rapid unpredictable changes there should be established natural combination of slow and fast processes: periodic rethinking and fundamental rebuilding of the whole organization along with the daily systematic process of optimizing organizational parts, i.e. parts of the whole system.

Conclusion

Organizational evolution or involution depends on organizational capability to discern adequately and timely strong and weak signals of internal or external nature and to respond effectively to them thereby building more adaptive, innovative and resilient organizations. An ideal organizational system should itself make these signals visible and intelligible, reveal hidden key causes of undesired effects and facilitate optimal decisions. A combination of various methodologies and branches of knowledge, including TRIZ, can bring about some approximation of the idealized organizational design. TRIZ, like any other methodology, has certain limitations. Further advancement and propagation of TRIZ rests on understanding of TRIZ limits and possibilities of merging with other methodologies for achieving synergy and expanding applicability boundaries.

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