LEARNINGS FROM BUILDING A RESEARCH INSTITUTE AS A NEURAL NETWORK

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ABSTRACT

Have you ever tried to walk to work with your eyes shut? You know it is difficult, might even be impossible or at worst deadly dangerous. However, in most organizations the R&D departments, responsible for the future of the entire organization, are doing their work with eyes shut.

In this paper we use stories and historical data and the neural network of humans to explain how the Research Institutes of Sweden (RISE) plays an important role for innovation in Swedish industry.

The collaboration between industry and research institutes is extremely important for both developing new knowledge and securing capability for Swedish industry regarding innovation. Especially, this is important in the front end of innovation. Thus, it is at this point that broad and unfiltered information needs to be gathered and interpreted to secure that the right problem is being pursued.

We conclude in this paper that by explaining the role of RISE using the neural network gives insights on the importance of the role as interpreters, complementing the sensors in industry with new sensors, unbiased networks and signals.

INTRODUCTION

Organizations R&D work are getting more and more complex, and development of new products and services brings new knowledge boundaries, ”which makes managing knowledge integration a key challenge for organizations” (Tell et.al, 2016). Besides this, the digital era puts even more demands on R&D departments. One way to handle this growing complexity is an enhanced collaboration with academia and research institutes. However, this puts new demands to both organize this research and on the organizations supporting this research.

When looking into the human neural network we see a complex but extremely efficient system. Extremely simplified we can explain the human neural system role to 1) collect data from the body and the world around us, 2) analyze this data and 3) give support to decide on how to react. The system responsible for this consists of two parts; the central system (the “processors”; the brain and the spinal) and the peripheral system (the “data collectors and accentuators”; simplified as the sensoric and motoric system).

In biological terms the vision system and audio system is referred to as central senses however to simplify in this article we will see our senses as peripheral. The human brains are formed from biological and cultural input and as a result we also form collective brains for innovation (Muthukrishna & Henrich, 2016), as we also will discuss as a key to innovation.

And, looking at the innovation processes, in a similar simple way, we see an analogous system. If we are to develop something new we need to 1) collect data and information from the world around us, 2) make sense of this information from a human perspective and build models to find opportunities for change and 3) develop and test a new or alternative solution that fit a need in the market. So the way we create innovations is similar to the neural system of a human being.

LITERATURE AND THEORY

In this section we will present the theoretical framework used to explain the importance of R&D collaboration with research institutes and academia.

THE NEURAL ACTIVITIES

Let's start with an example of one of our most important source of information, our eyes. We knows that the brain acquires information from the visual environment one to three times per second (Ware, 2008). This external information becomes the content of our visual working memory. What we need to be aware of is the fact that what our eyes are looking for is anomalies in the surrounding. To be able to facilitate this memory process successfully, external cognitive tools must be developed to compensate for limitations in human memory and information processing at the same time as they take advantage of them (Tversky, 1999). A cognitive tool can be a sketch, a map, a chart, or a poster of some kind. Visual representations relieve the pressure on memory since they externalize memory and reduce processing load by allowing the understanding to be based on external rather than internal representations (Tversky et al., 2007). When working memory is released, new information can be processed and creativity stimulated. On the other hand, representations, pictures, figures, and text affect the memory. As such, a story can easily change direction since the representations generate new ideas (Eriksson, 2009).

If we look into the interpretation of our surroundings we can make clear that each person perceive only what he or she have been adopted to perceive. If we, as humans, perceive reality as something that is constructed in our brains, how can we then know that my reality is the same as your reality? Even though this makes perfect sense to us in this text, we almost always act like we perceive things in the same way.

Our brain is building a reality based on the limited amount of data it receives from our peripheral system, like the visual information in the example above. And it is like this our mind tells the story of our surrounding to us. Each brain, and person, has its own unique model of the world that surrounds us. It is this model that we experience. We don't have a choice. Reality, in this way, becomes what your brain tells you it is. This leads to the fact that we have 7 billion realities on this planet. According to this there are of course "brains" that have more similarities in how they perceive the world, i.e. if we have somewhat the same background, same education, same cultural heritage, same age and same gender. In this way you are more likely to perceive the world more similar. And, of course you may challenge your own reality by feeding it with new more or less radical perspectives but this requires curiosity and a will to change the status quo.

In relation to this we might ask what it is that control our behaviors, right? Most of the time our behaviors is controlled by the autonomous part of our neural system. The rational behind this is that our brain saves energy in this way. But whenever we learn new things it requires energy to change the structure of our brain, the brain is adapting to the new information and updating the brain structures to become autonomous and thus save energy. However, this leads to effects for our conscious, since we perceive things in new ways.

THE INNOVATION ACTIVITIES

In innovative work the most important thing to do is to work on the "right" problem. However, there are still big challenges for industry to define the right problem. The "front end" is of great importance for the success of innovation (Figure 1); it doesn't matter how well the process is managed or the project realized if they are based on wrong assumption regarding the problem (Cooper, 1988).

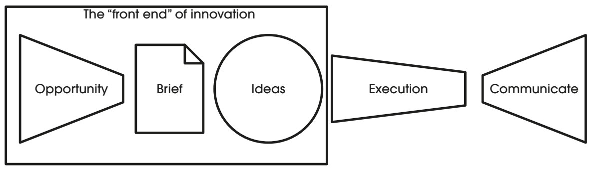

Figure 1: The process of innovation, emphasizing the "front end" of innovation (Wikström 2013)

When developing innovations, any organizations management team faces challenges due to ambiguities in the process and the uncertainty of a successful outcome. Focusing on creating innovative solutions, the use of creativity and design methods is advocated by researchers in the fields of business (Martin, 2009) and innovation (Utterback et al., 2006, Verganti, 2009). There is also significant evidence that the success of innovation depends on directions taken in the early phases of innovation processes, namely in what is called the "front end" (Bacon et al., 1994, Cooper and Kleinschmidt, 1995, Khurana and Rosenthal, 1998, MacCormack et al., 2001, Verganti, 1999).

In an attempt to bring clarity to "the fuzzy front end", Koen et al. (2001) state, "the front end of innovation (FEI) appears to represent the greatest area of weakness in the innovation process". Zhang and Doll (2001) highlight this problem and argue that the "front-end fuzziness is beyond management's control". They describe team vision building and knowledge sharing as making the problems connected with the fuzzy front end more manageable. It is at this front end that opportunities are identified, major constraints are detected, and most of the final outcome is defined. Cross (2008) argues that the design brief (used to frame the opportunity for innovation for the design team) does not always get the attention and priority it needs and deserves in order to stimulate the team to carry out a successful project; if more focus can be put on developing the brief, the design process may have a better outcome. Yet, as Paton and Dorst (2011) explain, there is little research in the specific area of framing the opportunity for innovation except for a few ground-breaking works by Cross (2007), Lawson (2005), and Schön (1991). This is also the case in innovation management research according to Darsö (2001), who explains this phase in the following words:

“What happens before something turns up as a pre-project is rather obscure, in real life as in literature. At best it is described as a chaotic and turbulent phase with certain individuals as central actors who make use of internal networks, intra- and inter-organizationally” (p. 31).

And, with a growing demand on organizations innovation capability, the framing of new projects needs to be understood and supported in any organization.

The capability within organizations regarding innovation is constantly developed. However, there is a need to develop methods to support these activities. And since research have focused on activities after defining a brief, such as idea generation, brainstorming and concept development, methods for defining a problem or even finding a problem is insufficient. This motivates the scope of this research, to share learning’s in how to build an innovation partner to organizations R&D and by this create knowledge of the activities and characteristics of defining projects by understanding it from a human neural network perspective.

THE REFLECTIVE PRACTICE

In 1991 Schön presented his theory of the reflective practitioner”. He framed the professional practice with reflection and learning processes. This new theoretical frame gave insight into how professionals think about doing something while doing it. Schön describes this as reflection-in-action that hinges on the experience of surprise. In designing, this is exemplified by the conversation that the designer has with the sketch. In this conversation time is an important factor in reflection-in-action, and the action-present zone of time that Schön describes could be very small, as in the conversation that designers have with their sketch, but could also stretch over minutes, hours, days, or even weeks or months. The action by design professionals can be transferred into the field of innovation making. Schön (1991) describes design as a reflective conversation with the situation; the designer

“shapes the situation in accordance with his initial appreciation of it, the situation talks back, and he responds to the situation's talk-back” (p. 79).

Schön has developed the theory of the “reflective practitioner” (Schön, 1983). In doing so, he used reflections and learning processes to define the professional practice of design. This new theory provided insight into how professionals think about doing something while actually doing it. Schön describes this as “reflection-in-action”, which is based on the experience of surprise. Wikström and Jackson (2012) explained the reflective practice in a model, visualized in Figure 2.

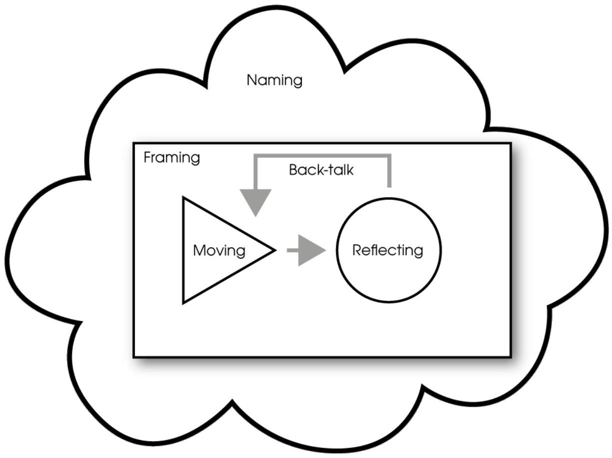

Figure 2, reflective practice model (Wikström, 2012)

Another way of understanding this could be as a type of reframing of the problem space justified by the discovery in the conversation with the situation. When reframing problems, the mindset focus shifts from convergent to divergent thinking as well; this explorative mindset is an important characteristic of design thinking (Howard et al., 2008) and in innovation making (Van de Ven et al., 1999, Rhea, 2003). Rowe (1987) explains this strategy as heuristic reasoning, in which it is impossible to structure the process in advance in steps needed to be completed in order to come up with a solution to a wicked problem, wicked problems being analogical to ill-defined or ill-structured problems. Design practice then, as described by Goel (1995), is

“the process of transforming one set of representations into another set of representations”.

This would mean that we could use design thinking as a way to support the process of framing new and relevant opportunities for innovation in collaboration between organizations R&D departments and research institutes.

THE MEANING MAKING PROCESS

The search for information regarding relevant problems need to be handled with care, like the sensors in our body handle information with care. In our neural system we have 100 billions of neuron cells. Each cell, receives/sends information to other cells through synapsis, and through this process information is analyzed and answers are given on how to react, the result is different depending on experience and culture. This process could be seen as a meaning making process that occurs either autonomously or consciously. One important part of the early phases of innovation is to use the information we collect and make sense of it, and then in conversation with others make the information meaningful in relation to the situation (Krippendorff, 2006).

"Meaning is a structured space, a network of expected senses, a set of possibilities that enable handling things, other people, even oneself. They guide action much as a map shows all the possible paths from where one stands." (Krippendorff, 2006, p. 56).

Focusing on the interpretation of the information gathered is what constitutes the difference between user-centered design and design-driven innovation where the focus in design driven innovation is on creating radical innovations with a new meaning (Verganti 2009). Verganti describes the use of interpreters. Focusing on the interpretation of the information gathered or being, as Verganti (2009) calls the people involved, interpreters of information, is what constitutes the difference between user-centered design (involving THE user) and design-driven innovation where the focus is on creating radical innovations with a new meaning. The step between "listening to the design discourse" and "interpreting signals" constitutes the frame of understanding and creating new ideas for projects. This "brief", as we might call it, is what drives the process but, most importantly, clarifies the opportunity for innovation, returning to the importance of framing the right problem and formulating a "brief" that takes advantage of the opportunity understood by the information gathered.

SUMMARY OF LITERATURE AND THEORY

We have opened up a space between human neural networks and the fuzzy front of innovation processes to interpret and understand the way a research institute, in this case RISE, can be analogous with a neural system of a human being. We take a standpoint in the making of new projects require a set of approaches that supports innovation from a broad perspective. We use the reflective practice approach in combination with meaning to sharpen the approach needed and will discuss the relevance of this later in the paper. One central point is the framing process of new projects and the impact this have on the innovation capability in an organization.

DATA AND METHODS

In specific we have followed the building of one node of RISE closely over a period of five years, the RISE SICS Västerås node have been used as a case to understand and create learning's from. During this period the node have grown from two employees to over 40. We have analyzed the way the work is carried out and how it complements industrial partners need and compared this with how the neural network of a human being works.

The information gathered is mainly stories on how the work has been performed, focusing on the process of developing new research projects. To combine this story information we have also gathered historical data regarding the success of research applications. Table 1 gives an overview of the stories and the relation between them, while Table 2 gives an overview of the historical data collected.

Table 1, model for analysis.

	Human neural system	**R&D internal approach**	**RISE collaborative approach**
Step 1	Sensing	Talk	Multi-talk
Step 2	Signal	Individual reflection	Sharing & reflecting
Step 3	Spinal	Internal seminar	Interpreters seminar
Step 4	Cortex	Experience	Experience
Step 5	Feeling	Type 1 meaning	Type 2 meaning
Step 6	Action	Application type 1	Application type 2
Step 7	Enforced knowledge	Incremental innovation	Radical innovation

Explaining the table above with a number of stories will give you an understanding of the interpretation of the gathered data and how the analysis have been made.

STORY 1, HUMAN NEURAL SYSTEM

Step 1, imagine that you are about to walk out of your home and when you walk out of the door you feel the sun is warm against your hand and face.

Step 2, a signal is sent from your peripheral sensors that have registered the warmth from the sun via synapsis.

Step 3, the signal from the synapsis is transferred to the spinal.

Step 4, it reaches the cortex and is being processed and meaning is created.

Step 5, the meaning is understood as a feeling - it feels nice and warm with the sun.

Step 6, the feeling is made into action - taking of the jacket!

Step 7, this knowledge is already known and the knowledge is enforced.

STORY 2, R&D INTERNAL APPROACH

Step 1, the sensor system of any R&D department is the individual who gets a "signal" of information that could be interesting for the company.

Step 2, the individual reflects on the information and decides it is important to discuss with colleagues.

Step 3, the spinal of the R&D department is their internal seminar where they are framing problems.

Step 4, the brain of the organization is their common knowledge and experience that makes up their frame of reference. They set a frame to work on.

Step 5, in conversation with others within the company "type 1" meaning is created with internal input and common "company" understanding of the problem.

Step 6, they set of to create a communicative concept of their problem to share within the company.

Step 7, as an outcome this often ends up in incremental innovation with a feeling that they know what to do, knowledge is enforced and autonomous process have been confirmed.

STORY 3, RISE COLLABORATIVE APPROACH

Step 1, conversation with companies always include two researchers in order to activate more sensors.

Step 2, sharing and common reflection regarding the meeting takes place shortly after the meeting to secure a deep common understanding.

Step 3, the spinal of RISE is the interpreters' seminar either with internal researchers or external competencies that complement each other, framing of problem.

Step 4, the brain of RISE is the broad knowledge and experience of the researchers, they make a synthesis of the interpreters results and set the frame.

Step 5, in conversation with the interpreters and researchers within RISE "type 2" meaning is created with a broad understanding of the problem.

Step 6, a new application is under development, the process includes several steps of framing and reframing the problem space and understanding of the challenge.

Step 7, as an outcome this often ends up in radical innovation projects with a feeling that they don't know exactly how to do, a lot of energy have been used to create new knowledge.

SUMMARY OF STORIES

These three stories make up the frame for the analysis. A storytelling approach had mainly been used to understand the different approaches used, and the relation to the neural system. When looking at story 1 we can directly understand what would happen if a cloud was on its way to cover the sun and you saw this, you might then consider not taking the jacket of since only seconds later the warm sun would be behind the cloud. So, if R&D departments are without eyes, as we could imagine they are if they only use their internal knowledge, they couldn't understand the entire situation and would create their meaning without important information and knowledge. This would eventually lead to a slow and painful end for the company, since renewal and radical improvement is essential over time for survival and success for any organization.

HISTORICAL DATA

As historical data we use filed applications for new research projects in collaboration with organizations R&D departments. The following data has been collected (Table 2) :

Table 2, project proposal and outcome.

	2013	2014	2015	2016	2017
Filed project applications	3	8	8	21	35
Accepted project applications	3	6	5	12	24
Percentage of application success	100%	75%	63%	57%	69%

EVALUATION OF DATA

In this research we as researchers have been following the entire process of building and developing the RISE SICS Västerås node. The site has been developed organically by phasing real industry challenges, create project teams with different perspectives and when the amount of project approval rises we recruit more people. The focus has however never been to grow in numbers, just to create the best projects that will make a difference for the industries in our region. This was successful and we showed numbers far above average on project approvals compared to other RISE nodes. However, when reaching 40 employees we found that the organization was no longer fit for the number of people and we had a dip in the project approvals that may be caused by the fact that the persons with project application writing skills were no longer enough to cover the needs. Again, in comparison to the brain we could compare to a stress situation when to much information is transmitted but the time for analysis and proper decisions for action is not enough and this lead to stress symptoms and a decrease in productivity.

RESULTS

By analyzing the role of RISE from the perspective of a neural network of a human being we can explain the importance of the collaboration between research institutes and companies R&D departments. In specific the collaboration is important since it autonomously creates interpreters with another kind of understanding of the situation. Like sensors on our body, of course we have trouble understanding the world around us if we lack some of our sensorial system. Try to walk through your house with your eyes closed and you will understand.

We can also clearly see the relation to the work by Schön (1991) on reflective practice and the meaning making process described by Krippendorff (2006) and Verganti (2009). In the way the work is set up in story 3 the reflection in and on action becomes essential and in the conversation with others the meaning making is emphasized and becomes a central part in creating a new project application.

DISCUSSION

By using the neural network we are able to explain how RISE have been able to complement R&D departments with new "sensors" enabling new meaning of the information gathered by R&D departments and vice versa. This process constitutes an important part of design driven innovation. Focusing on the interpretation of the information gathered or being, as Verganti (2009) calls the people involved, interpreters of information, is what constitutes the difference between user-centered design (involving THE user) and design-driven innovation where the focus is on creating radical innovations with a new meaning. The step between "listening to the design discourse" and "interpreting signals" constitutes the frame of understanding the opportunity. This opportunity is what drives the process but, most importantly, clarifies the opportunity for innovation, returning to the importance of framing the right problem and formulating a project that takes advantage of the opportunity understood by the information gathered. Where the understanding is based on collaborative processes culminating in a collective brain of knowledge and information where the framing of new projects take place.

Moreover the analogy with the nervous system tells us important details on success factors, such as number of interactions, competence development and the importance of enjoying work (Stieber 2014). We know that the brain build its system of nerve cells similar to roads, and the nerve cells that are most stimulated build motorways while those who are not maintained may shrink and finally disappear. In a research institute we build personal relationships to our partners in the same manner and the more often we interfere the more we understand of our common challenge. As the brain constantly need more stimuli in order to remain productive that goes for a research institute as well, the more we feed the members with new knowledge and information the better the outcome becomes. We also know that there are different hormones makes us feel happy or sad. Dopamine is the wellbeing hormone and is released when we find ourselves in situations we like. It may also be released after a period of stress and confusion if we manage to find a solution. In RISE we can compare dopamine with the importance of seeing and encouraging each other and let everyone find the way of expressing their expertise area in collaboration with others.

Our aim was to share some learning's from building a research institute as a neural network and bring in a new perspective in understanding the early phases of innovation.

- The analogy with neural network is relevant for understanding the cooperation between institutes and industry. Looking at each individual in the node we see a bunch of neurons that processes information and share new insights to other individuals building a network of interpreters that together analyze the information and build knowledge in how to react. Further, the neural system will form better decision if it may gather information from different senses (e.g. vision, sense, sound) and process it based on earlier experience. If we focus on individuals with different experience and culture we increase the quality of possible outcome.

- The analogy explains the importance of the role institutes should have in relation to being an innovation partner to industry. We as humans can function without getting relevant information from our sensory system. We can live and function without being able to see or hear, we refer this to be disabled. So, if the innovation system of industrial organizations requires a fully functional "body" they need to partner up with institutes or other relevant organizations to get information, process and interpret it and find alternative actions to take.

- We can also understand the decreasing number of accepted projects as a result of not using the network in a sufficient way. Our conclusion is that RISE hasn't been able to use their collective sensors, their entire network, in a good way. The reason behind this is that the growth of the organization have built distance between the sensors that, not yet, have find ways to connect and interact. Meaning that it is a lack of synapsis in the RISE set up today. So, the signals are there but the way to transmit these signals into the spinal is dysfunctional.

We believe that this way of analyzing the process of the "fuzzy front end" of innovation brings clarity to strengths and weaknesses in innovation making. By this analogy we open up a new way of quickly tell a story about the fuzzy front end of innovation in any organization and by doing this understand what can be developed and how it might be improved.

By providing organizations with the opportunity to partner up with RISE, as innovation partner, they can handle knowledge boundaries built up by the increasing complexity of innovation and make sense of opportunities arising in the digital era.

ACKNOWLEDGEMENTS

We would like to thank all employees at RISE SICS Västerås for patiently listening and discussing our thoughts about this paper and also helping with telling the stories and collecting historical data.

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