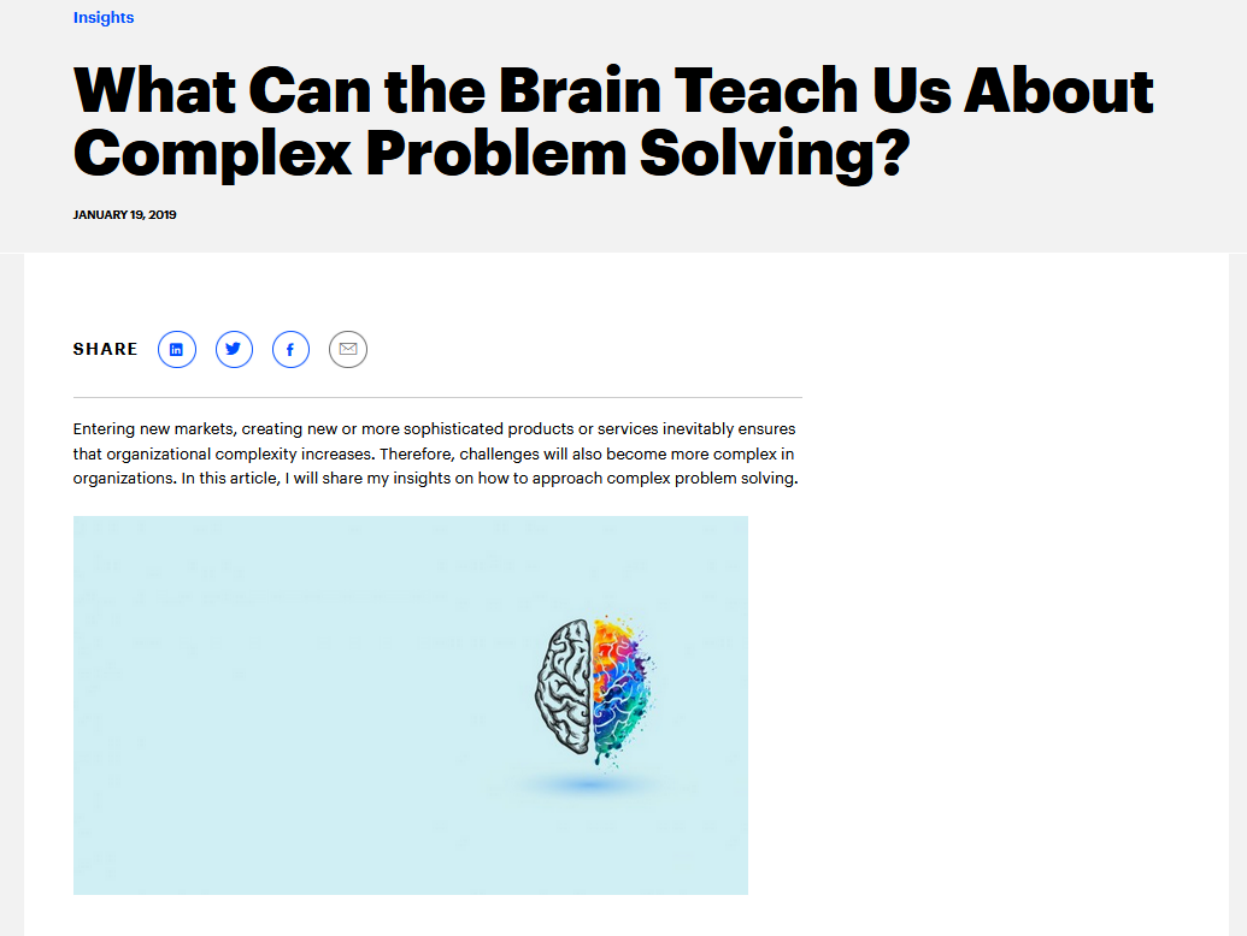

At a TED conference in London 2010, Thomas Thwaites tells his story (https://www.ted.com/talks/thomas_thwaites_how_i_built_a_toaster_from_scratch) about making a bread toaster from scratch. Though his story may be good fun listening to, his experience shows that making a bread toaster is quite a challenge. Would you know how to perform all the activities in the toaster's industry value chain? (how to make plastic? How to make the electric work, wires, coating etc.?). His story illustrates how advanced we have become as a civilization organizing specific tasks in jobs, jobs in organizations that together can produce a bread toaster for just a few bucks.

The digital age (https://www.accenture-insights.nl/article/coding-skill-to-succeed-digital-world) advances the processes of making a toaster even further. Many parts of the activities in the value chain of the toaster are completely automated and monitored carefully by computers. There is more information available than ever, the information is more accessible at a quicker rate and the systems containing the information have become more intertwined, ultimately leading to better insights. However, understanding why and how things are happening becomes increasingly complex.

These complex products we design, along with the processes we work with, make that organizations also face more complex challenges; this complexity can be costly. A Harvard

Business Review from 2015 survey (https://hbr.org/resources/pdfs/comm/sap/19277_HBR_SAP_Report_5.pdf) suggests that forty-three percent of business managers indicate that complexity slows growth, impedes their ability to respond quickly to competitive threats, and interferes with effective decision-making.

> Understanding why and how things are happening is becoming increasingly complex

Therefore, solving the complexity becomes a valuable skill for organizations. Research by the World Economic Forum (http://www3.weforum.org/docs/WEF_Future_of_Jobs.pdf) shows that complex problem solving will be the most important skill for the workforce in 2020. In this article I will share my insights on how to approach the complex problem solving while using the brain as an analogy.

How does Our Brain Solve Complex Problems?

The brain is the most complex organ we know and continuously solves a multitude of complex problems every day. The brain solves problems so smoothly that you don't even notice how complex these problems are. I am referring to how your brain coordinates your movements. Think of typing on your computer, catching a ball or talking with your mouth full; daily general movements you don't have to consciously plan, you just do them. When you try to have robots do our daily general movements, you will get a feeling of the great complexity and see how difficult it is to have robots performing movements with the same smoothness and flexibility as we do.

But why is performing a movement such a complex problem? Performing a movement requires putting together a lot of separate variables or parts. To give you some facts, the body contains around 640 muscles. The brain controls these muscles with 100 billion neurons that transfer signals to the muscles and then back to the brain. Besides the big numbers, all these variables are interconnected, due to the muscles and neurons needing to work together. Furthermore, the brain can perform movements in almost an infinite number of ways and can quickly adjust the movement for unexpected events. The Russian neuroscientist Nikolai Bernstein termed solving this complex problem of performing a movement "The Degrees of Freedom Problem" (Bernstein 1967).

So, how does your brain solve these complex problems of performing movements and what can we learn from it to solve organizational complex problems?

1. Effort on Essentials

My first advice for solving complex problems is to simplify and focus on the essentials to get a satisfactory solution. For example think about learning how to ski. The brain cannot control a lot of separately moving body parts in a new situation or task. This is too much complexity and too many degrees of freedom to handle at once. Therefore, the brain fixates a lot of supporting muscles the first time you go down the hill.

The brain uses the skiing poles you have in your hands as support to not fall down, not for making smooth curves in the snow (yet). Your posture will look cramped, bent and shaky but this allows the brain to focus on the most important muscles needed to not let you fall and make sure you get safe and sound down the hill. When you get the feeling that you have things under control, the brain can include supporting the muscles and attempting to ski more smoothly, fine-tuning the movement you are performing. The further the brain masters the movement, the more muscles can relax and include in the movement making the movement look very smooth and effortless.

For *complex problem solving in organizations* this means setting your priorities to what solves your immediate problem or your immediate customer needs. Narrow your focus down to the essentials that will solve your problem. Afterwards, you can improve your solution by making it more efficient or via additional functionalities. If you think back to the toaster, the initial goal is to toast a sandwich. When that has been achieved you can create a more complex toaster that has several toasting options. You can also choose to make it more energy efficient or more user-friendly. This approach is also seen in newer management styles for new product development like SCRUM (https://en.wikipedia.org/wiki/Scrum_(software_development)) and Agile, these approaches focus on short iterations to quickly test and improve the solution on the go.

2. Divide and Conquer

My second advice is to effectively divide the problem up into parts, and solve these individual parts before you connect them to make a whole. This is how the brain masters a movement most efficiently. Think about how we are taught complex movements like a dance or a difficult move in gymnastics. We divide the whole dance into parts, sub-parts and even micro parts. We start with a few moves and then combine those to a small part of the dance, when these are under control, we are able to add in extra moves and can continue with practicing the next part. After completing all the parts, we can perform the dance in full.

In organizations you can compare this process to making an issue tree. Issue trees are used to solve complex problems by breaking them up into parts. These parts can then be broken down into sub-parts. The parts and sub-parts should be as mutually exclusive and collectively exhaustive as possible meaning that the sub-parts do not interfere with each other (interference is complexity) and cover the whole part of the problem.

The more mutually exclusive parts of the problem are, the more efficiently they can be solved. When parts are mutually exclusive teams can work separately on these parts. There is less need to consult with other teams; instead the team can focus on solving the sub-part.

3. Feedback & Feedforward

Feedback and feedforward control are crucial in bringing a movement to a proper end, resulting in my third advice, use feedback and feedforward in complex problem solving. Feedback will be clear for most, but feedforward might be new. To give an example of both, starting with feedback, a feedback system might notice that the temperature in the house is dropping and thereby turning on the heater. A feedforward system notices that the door has been opened and already turns on the

heater to compensate the expected cold. Movement research shows that a proper designed feedforward / feedback control system will always improve performance over a simple feedback control system (Ben Gurion University 2013). The brain uses feedforward control to adjust movements of body parts and still achieve the goal when other parts in the movement are not meeting expectations. See how Michael Jordan readjusts within milliseconds in mid-air to still get the basket.

In organizational complex problem solving, feedback can be that your designed solution is or is not achieving the expected results, which means that the solution needs to change. Including feedforward in your complex problem solving requires you to develop an understanding of what drives the feasibility of your proposed solution. You can already steer towards the most beneficial solution in the process of creating the solution. You can compare this to lead and lag measures. Lag measures are the feedback and after the effect, you know the solution is or is not working. Lead measures allow you to steer the solution in the right direction. Lead measures predict how feasible the outcome will be.

4. Trial & Error

To gather the most extensive feedback, the brain needs to try the movements as many times and in as many variations as possible. This way the brain learns how to most effectively execute your movements regardless of the circumstances the body is in. Research published in Nature Neuroscience shows that trying the same movements in multiple ways actually facilitates motor learning in humans and improves performance (Wu et al. 2014). This results in my next advice, the more complex the problem becomes, the more trial and error you will need to solve the problem. Expect this and use it to try out creative solutions, they will improve your understanding and performance.

There was an interesting trial and error approach at one of the biggest retail companies in the world, Unilever. In the 1960's, Unilever wanted to design a new nozzle for their detergent production. Liquid detergent is pushed through a nozzle with high pressure in order to spray

the detergent. The detergent dries, falls on the floor and then can be sold. However, the nozzles kept clogging up.

Professor Steve Jones describes how Unilever solved this problem: trial and error, variation and selection. You take a nozzle and you create 10 random variations on the nozzle. You try out all 10; you keep the one that works best. You create 10 variations on that one. You try out all 10. You keep the one that works best. You try out 10 variations on that one. After 45 generations you have a nozzle that works perfectly. They could not explain how it works, but it does.

5. The 10.000-Hour Rule

Solving problems through trial and error takes time. So how much time do you think the brain needs to best solve your degrees of freedom problem for movements? When will you be able to compete with the best? In Ericsson's book (1993) about acquiring expert performance, he states that it takes 10,000 hours, 20 hours for 50 weeks a year for ten years = 10,000, of practice to become an expert in almost anything (Ericsson 1993). It doesn't matter whether we are talking about chess, playing violin, or playing soccer. On the other hand, the learning curve theory, regarding movement learning, supports the 80 / 20 rule. This means that you will be able to perform a movement at about 80% around 20% of the time. I'm not a big fan of cigars, however, look at some nice old research regarding the improvement in performance of cigar rollers in a 10 year period. After 1 year of practicing, the time it takes to roll a cigar was reduced from a mid-20 seconds to less than 10 seconds. Even after 6-7 years there is still improvement, but as expected, it is minimal. My advice here is to know when your solution is at an acceptable level. Then you can focus again on the essentials or when your solution is a competitive key advantage to facilitate learning in order to keep that advantage.

For organizational complex problem solving it is important to consciously decide that a problem is solved to an accepted extent. The organization can then reallocate resources to more pressing complex issues as mentioned in my first paragraph. With limited time, money and resources, solving problems to a reasonable level is acceptable.

Perfection takes too long for this quickly changing society. On the other hand, the learning curve highlights that continues improvements initiatives can be useful for a long period of time. Which can overall improve the solution for organizational problems. The organization does need to facilitate and capture the learning to be able to make these improvements over many years. Toyota's production line is a complex organizational subject and Toyota improved their production line over the years with their famous Kaizen or continues improvement methods.

Find Yourself an Advisor

Learning new movements is more efficient if you have someone to show you and to guide you through the learning process. For some movements it might be quite unsafe to perform them without any supervision. A good coach should actually help you with all the steps mentioned above. Coaches make sure you focus on the essentials first to help you learn the movement as efficiently as possible. They can also help you divide the movement in to parts, provide feedback and motivate you to invest the time necessary to achieve your goals. Coaches should facilitate you in all the previous advices.

For complex problem solving in organizations, you need people who have previously done a similar or related job. They should not be the ones executing the work like an athlete or someone on your team, but should be the coaches or managers pointing people in the right direction and making sure people in teams align or that there is alignment between teams depending on the topic. Furthermore, experts or coaches should direct, quality check and review as much as possible. This ensures that their team members keep working on the priorities, understand the order of activities, improve on their deliverables, and understand and learn the interrelations. This will keep you motivated to achieve your end goal.

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