# MOBILITY
# Engineer 2030

## COGNITIVE SKILLS FOR FUTURE MOBILITY ENGINEERS

**Introduction**

When I interact with young engineering students, there are three common questions that they raise:

- What new skills do I need to acquire to become industry-ready?
- How can I learn these new skills quickly?
- What competencies do Automotive OEMs look for when they hire fresh engineers?

The skills, that an automotive engineer needs to be successful in the future, are of two broad types – domain skills and cognitive skills [1] (Fig 1).

While it is important to acquire cross-domain engineering skills (cutting across the traditional streams of mechanical engineering, electrical & electronics engineering, computer engineering etc.), it is equally important for the engineers to hone their thinking skills. The mobility engineer's thinking speed has to keep pace with the rapidly growing digital technologies and the disruption caused by their convergence. The new technologies (electric, autonomous, connected) and business models (shared mobility), that have recently entered the automotive industry, have great disruptive potential. hence the mobility engineer needs to think big and think boldly. The mobility engineers of the future are expected to think non-linearly and drive the industry with powerful and disruptive ideas. However, most of us are trained to think linearly and the automotive industry has evolved through a series of incremental ideas over the last two or three decades. If we are keen to contribute

> *A dedicated column for engineering students who aspire to become Mobility Engineers*

to the creation of future mobility technologies, then we need to train ourselves to think differently. We have set out to discuss four important cognitive skills (***DESI***) that could help us to contribute with innovative ideas that would shape the future mobility industry.

**Design Thinking**

A Mobility Engineer needs to understand the articulated and unarticulated needs of the customer and gather insights on customer behaviour and aspirations. He should drive innovation and new product development with a deep customer focus. The ability to understand the customers will help him to design the right products and connect with them. For example, designing a vehicle for the city commute during the workweek is quite different from designing a vehicle for the long drive on a weekend – the design engineer has to understand the specific needs of the customers and optimize the vehicle performance accordingly. Human-centred Design Thinking, which emphasizes the importance of empathizing with the customer, is a very important skill that every automotive engineer should learn and practice.

Design thinking (Fig 2) is best understood from the words of **David Kelly (Founder of IDEO)** ***"A Human-centred approach to innovation that draws from the designer's***

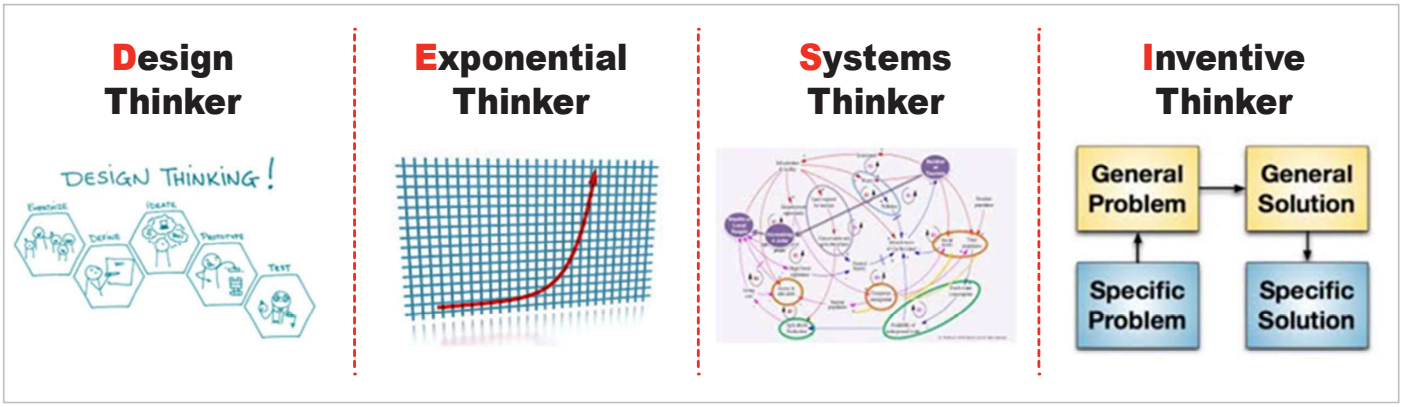


**Figure 1 – Cognitive Skills for Mobility Engineers - DESI**

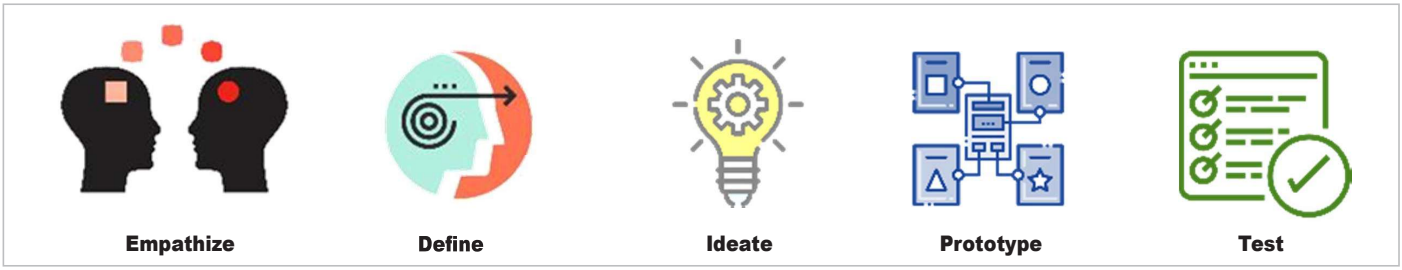


**Figure 2 – Design Thinking – Human Centred Approach**

***toolkit to integrate the needs of people, the possibilities of technology, and the requirements for business success." Thus, the method focuses on the three main elements of a product or solution: people, technology, and business, all of which revolve around the customer."***

The technology leader, as a design thinker, sharpens his customer focus by carefully observing his customers and develops certain unique insights. These customer insights help him not only to precisely define the technical problem but also to segment his solution in such a way that it caters to the critical needs of various customer segments. He understands the unarticulated pain points of his customers and leverages technologies to create a great user experience. The DESI technology leader, just like GE's Inventor Doug Dietz who transformed an MRI scanning experience into a highly engaging entertainment experience for his patient, will use empathy to connect with his customer and go beyond the product to create a rich and meaningful experience [2].

For instance, a DESI Mobility Engineer who is in charge of designing electric cars will study the usage patterns of his customers across various geographies and age groups and then decide on the vehicle specifications - realistic range, modular battery capacity, charging method (and time), differential pricing, etc. He goes beyond the functionality of the product to create a delightful customer experience.

**Exponential Thinking**

A Mobility Engineer has access to a rich platter of technologies to leverage – many of these technologies are exponentially growing in their performance and fast becoming affordable and accessible. These technologies include electrification, energy storage, autonomous driving, omnipresent connectivity, etc. When multiple exponential technologies converge in a product, it is bound to trigger a paradigm shift. When the potential of the technology is growing exponentially, it is important the engineer also thinks exponentially (10x and 100x improvements rather than 2x and 3x). Exponential Thinking is a key enabler for the automotive engineer to set ambitious goals (BHAGs) and leverage technology to achieve the goals.

Peter Diamandis, the founder of X-Prize Foundation and co-founder of Singularity University, introduced the power of exponential technologies through his books Abundance and Bold (New York Times bestsellers)

***"Right now, and for the first time ever, a passionate and committed individual has access to the technology, minds, and capital required to take on any challenge."***
**— Peter H. Diamandis, Bold: How to Go Big, Create Wealth and Impact the World.**

The DESI Mobility Engineer, as an exponential thinker, believes in the exponential growth of digital technologies and their convergence. He has derived his lessons from how the semiconductor technologies followed Moore's law over so many decades and doubled their performance every eighteen months (accompanied by a 50% price reduction too) and how it has, in turn, fuelled the digitization wave across diverse industries beyond ICT. He will actively seek opportunities for digitization in his business. More importantly, he will not be deceived by the initial limited results of his digitization efforts and convince his CEO of their true disruptive potential. He will prepare his business units to respond to the waves of dematerialization and demonetization that follow the disruption. He will anchor his vision on the true aim of disruption – which is democratization. He will have an abundance mindset and will actively apply Peter Diamandis's 6D framework (Fig 3) to steer his business through the turbulent waters. The DESI CTO of an automotive company will even be able to predict the exponential improvement in performance and fall in the

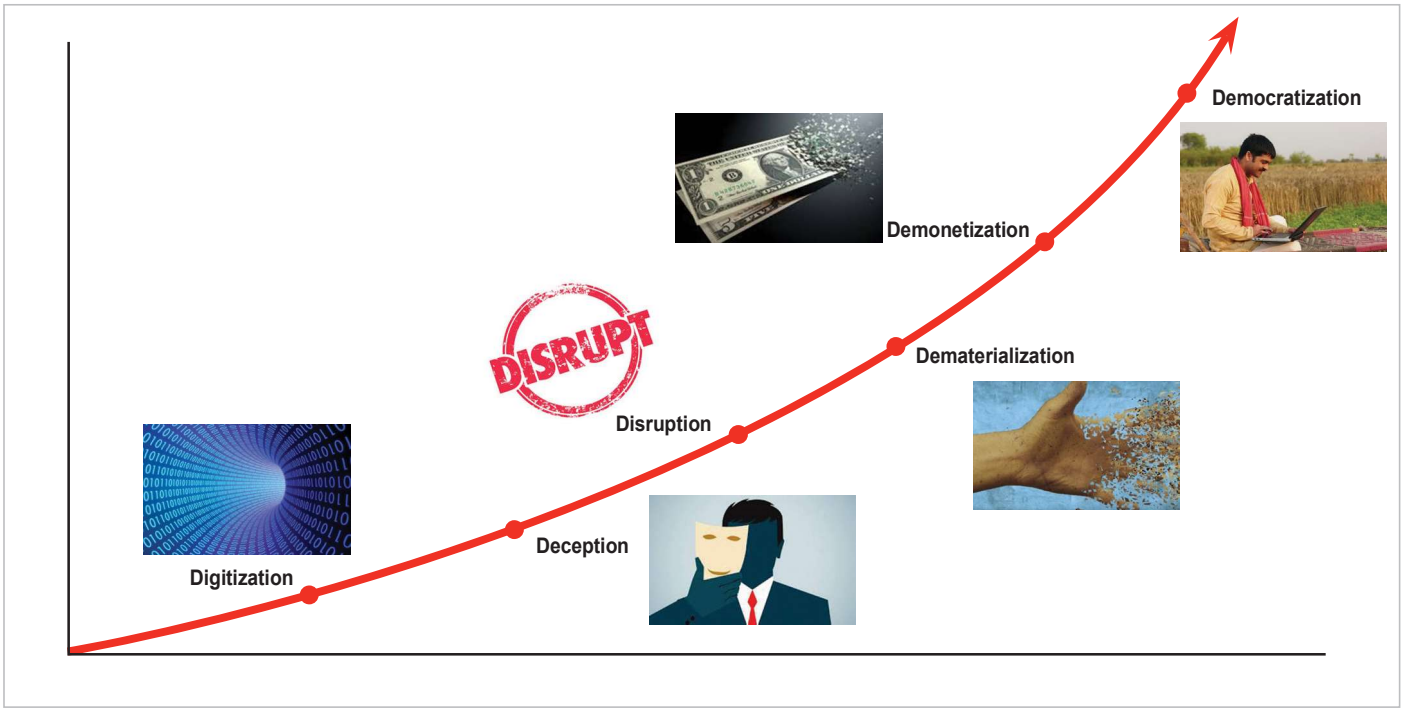


**Figure 3 – Exponential Thinking – 6D Framework**

price of the lithium-ion battery or the LIDAR and put his bets on EVs and AVs at an early stage when many of his colleagues were looking at EVs as lab curiosities and AVs as science fiction [3].

**Systems Thinking**

The emerging concepts such as Mobility as a Service (MAAS) necessitate the automotive engineer to design system-level solutions. The emerging mobility ecosystem includes ICT providers (Information & Communication Technologies), smart power grids, renewable energy sources, charging stations, suppliers of critical materials, etc. The Mobility Engineer has to think beyond the vehicle and look at the entire mobility ecosystem to optimize the performance of his mobility solution. He has to understand the various interdependencies, at the system level, that determine the effectiveness of his mobility solution. Systems Thinking elevates the automotive engineer from his small world of the vehicle to a larger world of the entire mobility ecosystem.

A mobility engineer who is building an electric vehicle needs to visualize the entire electric mobility ecosystem comprising the EV charging infrastructure, the smart power grid, lithium-ion battery manufacturing, mining of critical battery materials, clean energy – renewables for generating electricity, IoT and Cloud, Mobile Internet, Digital Payments, etc (Fig 4). There are many opportunities to grow the automotive business across the entire ecosystem. The electric vehicle will deliver the promised performance only when the ecosystem is fully ready.

Peter Senge, in his seminal book "The Fifth Discipline", describes systems thinking as one of the pillars of a learning organization

***"[...] vision without systems thinking ends up painting lovely pictures of the future with no deep understanding of the forces that must be mastered to move from here to there."*** — **Peter M. Senge, The Fifth Discipline: The Art & Practice of The Learning Organization.**

The DESI Mobility Engineer, as a systems thinker, studies the relationships across the entire ecosystem and carefully makes his technology decisions based on the readiness of the ecosystem. You may remember how Thomas Edison did not stop with inventing the electric bub but went on to explore the generation and distribution of electricity. Edison knew that he cannot expand his customers for the electric bulb without making safe and affordable electricity available to all.

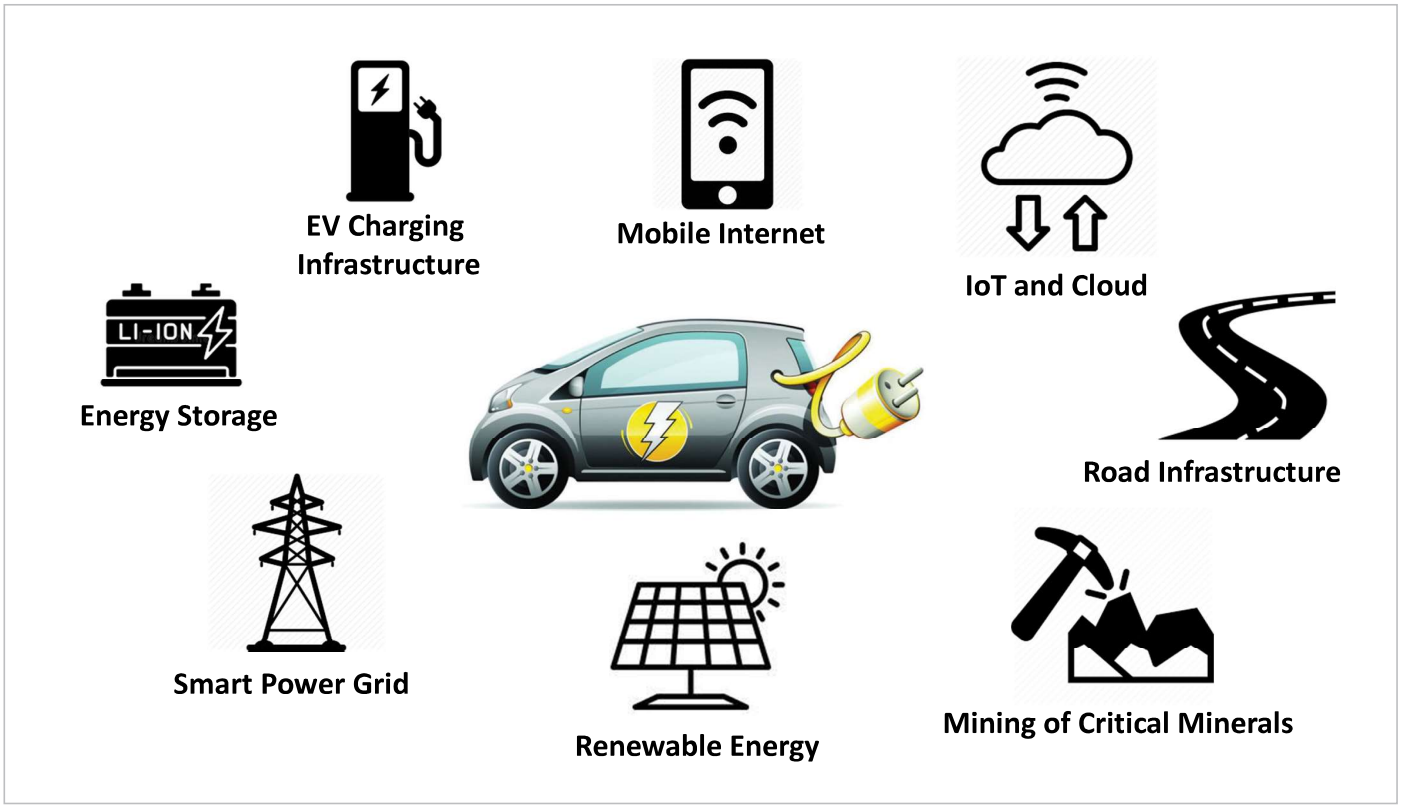


**Figure 4 – Systems Thinking - The Electric Mobility Ecosystem**

A DESI Mobility Engineer in an automotive company will not look at EVs in isolation but look at the co-evolution of fast-charging infrastructure, wireless charging technology, renewables powering the grid, battery storage technology, etc. She would also track the development of emission regulation policies for EVs and legal and insurance policies for AVs. She uses the systems thinking approach to make the right architectural decisions and pick the right technologies. Her technology roadmaps are not limited to the evolution of the product (EV) but the evolution of the entire ecosystem. For instance, she would study the global trade patterns and future demand vs supply dynamics of critical metals (lithium, cobalt) to decide the right battery chemistry for his EV. She would also think across the entire lifecycle of the product and factor at the end of life issues at the early design stage itself.

**Inventive Thinking**

Inventive ideas enable automotive companies to differentiate their products in the market from their competitors. Inventions and Innovations in the automotive manufacturing process help the engineers to maintain the delicate balance of time – cost - performance. Innovations in the business model – like the subscription-based model, servitization model – mobility as a service, shared ownership model, etc have great disruptive potential. The Mobility Engineer has to train herself to pursue innovation at three levels – customer insights, value creation for the customer, and overcoming the barriers encountered on way to the market. Inventive Thinking helps the automotive engineer to shape their ideas into patentable inventions and impactful innovations.

Inventive thinking offers a systematic approach to creating inventions that solve critical problems. Innovators like Steve Jobs have often talked about the importance of “connecting the dots” – creatively connecting diverse ideas across many domains. One often wonders how lesser mortals can connect the dots as seamlessly as Jobs. Genrich Altshuller, the father of TRIZ, has created an algorithmic approach to inventive problem solving and this methodology has been adopted across industries to create groundbreaking innovative products (Fig 5).

# MOBILITY
# Engineer 2030

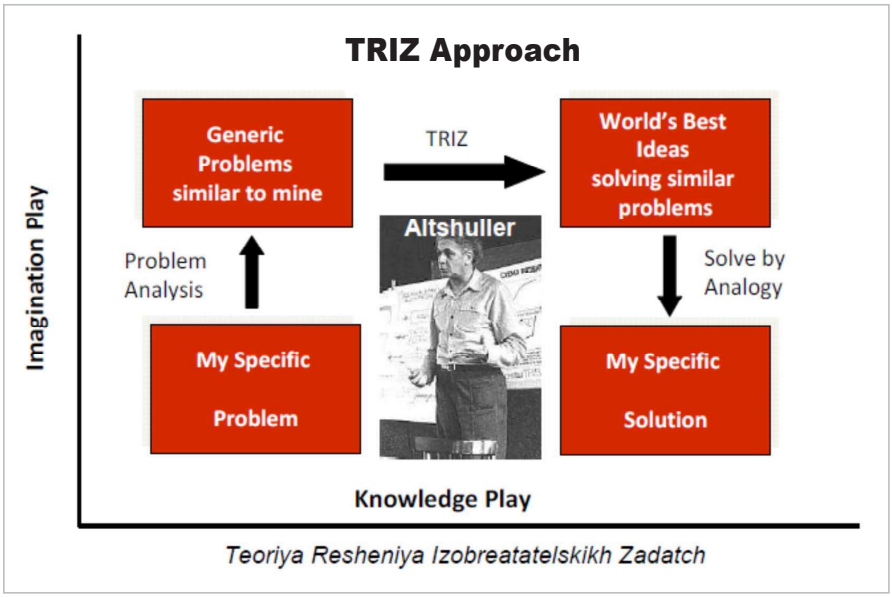


**Figure 5 – Inventive Thinking - TRIZ**

***"Creativity is just connecting things. When you ask creative people how they did something, they feel a little guilty because they didn't really do it, they just saw something. It seemed obvious to them after a while. That's because they were able to connect experiences they've had and synthesize new things."*** — **Steve Jobs.**

The DESI Mobility Engineer, as an inventive thinker, connects ideas from many domains and diverse experiences to synthesize new solutions. When he solves a problem, he identifies the contradictions underlying the problems and resolves them using Inventive Principles. He is not under the illusion that he is the first to try to solve the problem – he actively looks for patterns across industries where inventors have solved similar problems. He brings together inventive ideas across different domains and creatively connects them. He visualizes the ideal solution (IFR), in a constraint-free world, and succeeds in creating innovative solutions that have no trade-offs. He follows the technology evolution trends across various domains to continuously define the next set of problems that he needs to solve. He actively uses TRIZ (Genrich Altshuller's Theory of Inventive Problem Solving) philosophy, tools, and techniques to create inventive solutions [4].

**Summary**

The FISITA white paper titled "Mobility Engineer 2030" clearly emphasized the importance of having an innovative mindset as a key growth enabler for mobility engineers in the future [5]. The mobility engineer can cultivate an innovative mindset by practising the four thinking skills that we have described in our paper – Design Thinking, Exponential Thinking, Systems Thinking, and Inventive Thinking. These cognitive skills will become as important as the engineering domain skills for the mobility engineer of the future. The DESI Mobility Engineer has a great adventurous journey ahead and he has an important role to play in shaping future mobility technologies.

**Dr. Shankar Venugopal,**
Vice President of Technology Innovation and Knowledge Management for Mahindra & Mahindra's Automotive and Farm Business.

He is the Dean of the Mahindra Technical Academy.
He has been recognized as one of the 50 Most Innovative Leaders at the World Innovation Congress (2020).
He holds many Indian and International patents in emerging technology areas.

**References:**

1. Future Skills for Mobility Engineers – Dr Shankar Venugopal – NPTEL Tech Talk - https://www.youtube.com/watch?v=85mqTGrO7Ss
2. Design Thinking - https://challenges.openideo.com/challenge/creative-confidence/inspiration/the-story-of-doug-dietz-creative-confidence-in-the-mri-suite
3. Exponential Thinking – https://singularityhub.com/2016/11/22/the-6-ds-of-tech-disruption-a-guide-to-the-digital-economy/#sm.00001bkluym4xgdgvxtzg5juygxwv
4. Application of TRIZ Inventive Principles in Automotive Engineering – https://triz-journal.com/40-principles-automotive/
5. Mobility Engineer 2030 – FISITA White Paper – https://www.fisita.com/documents/FISITA_White_Paper_Mobility_Engineer_2030.pdf