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IDEAL COMPETENCIES FOR AN INNOVATOR RESOLVING A RIDDLE

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ABSTRACT

Riddle, in general, is – why an engineering brain is not becoming able to create? Despite being a social animal filled with full of energy and enthusiasm, one engineer, surely is able to observe, ideate and many times criticize and generate an idea but not in a position to chase for and innovate to resolve the tough scenario. The present paper examines the constraints in terms of required set of identical needs of competencies an engineer, to become an innovator, must possess and pose challenges that must accomplish in parallel to acquiring while being educated the engineering. It has been observed that though logically sound brain of an engineer while enjoys the creativity, cannot give the advantage of merging the creativity into an engineered result. The paper discusses the concepts of "Key to idea generation" through an "*Innovation Punch*" and ability to be developed as an "*Innovative T-man*" to pursue the idea. Elementary principles and suggestive components of each in the background of the efforts made at the GTU are also deliberated. Prior concluding, the paper also converses on the possible recipe of success and limitations for an engineering graduate in the context of weakened creativity and innovation despite having a huge potential.

Keywords: Design Engineering, Engineer Competencies, Engineering Education, GTU, Idea generation, Innovation in engineering.

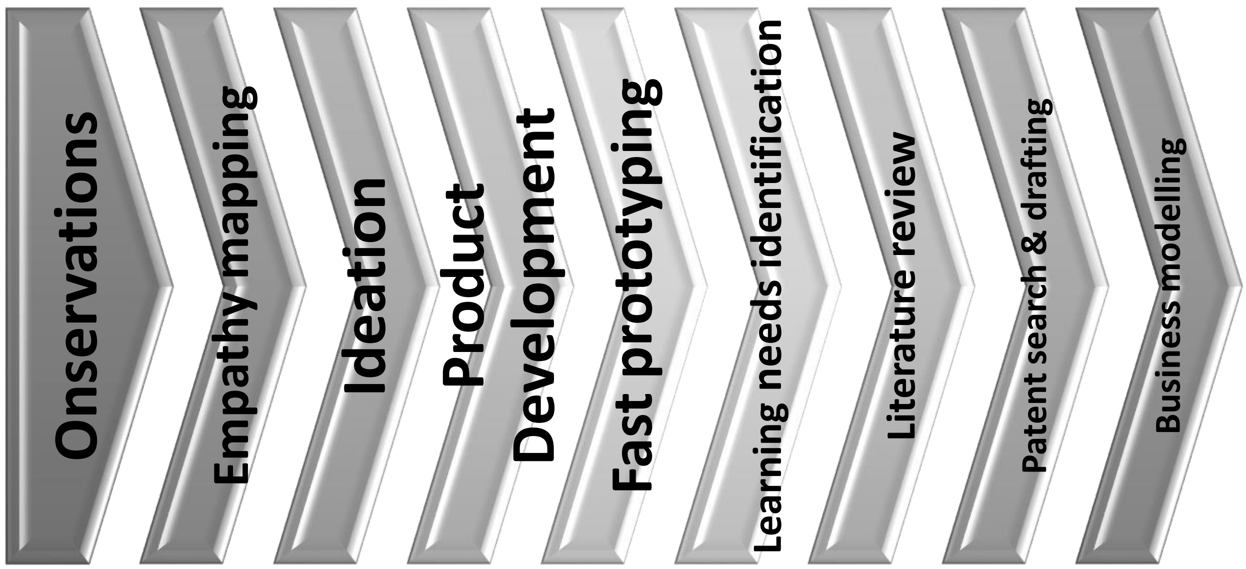
1. BACKGROUND

A large number of subjects are taught to an engineering student in a course of four years filled up with an exhaustive syllabus in each subject. Despite specializing, in many of the cases, the student remains puzzled over where to utilize which of the learned understanding. Young brains get confused when some thought provoking, out of syllabus problem statement is assigned. They seek supportive guidance and once a direction given, step by step they start making a way out. But this approach, many a times result in an academic excursion that leads no welfare of the society and remains excellent academic exercise having not much relevance to the market or societal needs. These students need to be innovators with novel ideas and experimental practices that may bring in the emergence of change. The dictionary of Merriam-Webster defines an innovator as "one who creates or introduces something new" (Thesaurus - Innovator, 2015). The webpage also suggests synonyms to the term innovator as contriver, designer, developer, deviser, formulator, innovator, introducer, originator. An engineer must follow innovative practices in a whatsoever profession one is engaged. Sections from here onward describe briefly the challenging efforts taken up by the Gujarat Technological University (GTU) through introducing a learning approach to innovating through the syllabus. It is envisaged to begin the learning of engineering by igniting curiosity. The course is still under evolution and is envisioned to deliver results in future as the approach taken up is very exciting that covers learning through canvases, learning needs identification, model making, the study of research papers, specific training, intellectual property prospects, business modeling and so on. The spread of the subject is over a duration of three years followed by the first year of learning to become an engineer.

2. EFFORTS THROUGH CURRICULAR AT GTU

Awesome in India, for the first ever time…! The GTU is on its way to explore bringing in innovation based on a human-centric approach where the end results are originated and evolved through an observation and analysis of the society. Something brought from space is not useful to people who are not habituated hence, the primary principle to innovate is to make an idea generated based on improving existing difficulties or incorporating ease of use by some means. Cost is another giant constraint to deal with, that any time can put vigorous and sincere efforts made so far to a state of abandoned. The process adopted at GTU under the subject of design engineering (Gujarat Technological University, 2014) progresses as shown in figure below:

Figure 1 GTU Design engineering process



The above process remains the same across all the branches however, it has been observed that research involving material sciences are difficult to be driven on human-centric approach through observations and empathy. Ambitiously, it is presumed that over a period of time, this limitation will also be overcome by the stakeholders. Apart from pedagogical changes in the engineering learning structure, an individual needs certain quality to develop and evolve around newer technology. These qualities are necessary for an innovative punch – the first step for an innovation process that is discussed further in the following section.

3. THE INNOVATION PUNCH

The concept of "innovation punch" is a self-ignited motivation for developing something new or working out on practicing something which save resources or may deliver a different experience. It may get derived at any stages as mentioned in Figure-1 and drive the innovative design ahead. Encompassing around GTU adopted five principles, the Innovation punch can be visualized to have a five finger aspect setup within the mindset of an innovator. If any aspect of it as discussed further in the section, is among the missing links, it may lead to a process breakdown resulting in an unavoidable delay. One must think of each aspect once, if any criteria thereof is not applicable, one may put it aside, however, such criteria may come up important at later stages.

Innovative strategies are among an apt needs of the organizations to keep doing business and grow. An article in the Harvard Business Review discusses the needs of an innovation strategy. It elaborates over the difficulties to build and maintain the capacity to innovate and suggest to have a strategy for innovation so as to ensure assured results. Pisano also defines an "*innovation system* as a coherent set of interdependent processes and structures that dictates how the company searches for novel problems and solutions, synthesizes ideas into a business concept and product designs, and selects which projects get funded. Individual best practices involve trade-offs" (Pisano, 2015). Avoiding someone else's practices is among the core ideas that GTU also is following by developing a design engineering spine.

An example in figure-2 discusses a glass manufacturer, Corning. It explains about firm connections between business strategy and innovation that can well establish a long-term innovation leadership in a sector. The company ages about 160 years and since inception Corning has kept on transforming its business by bringing in innovative technology in new markets. However, Pisano judged the approach of Corning, outdated while comparing against best practices also, he reviewed the approach as strategically among the best ones. The company keeps focusing on inventing in the key components only that improve the performance of several products. Supporting other components are dealt by other manufacturers that enables through the complimentary process needed for application of material for solving industrial problems.

GTU also assumes that students of different branches develop innovative concepts, product ideas, processes and so on pertaining to their specific branch and further supportive act will be offered by a relevant branch of engineering as needed.

The core value proposition at GTU to introduce design engineering spine in the syllabus is, to uplift the technological level of engineers in the region. However, the process of delivering is to the students of the second year of engineering, and hence, it has been kept a bit fun-filled that is criticized by learned senior faculty members as they do not find any opportunity lying within. Sadly, such judgments are commonly drawn without experiencing the approach and communication of similar thoughts to the student, not yet mature enough are losing interest to an extent.

At GTU, it is perceived that every engineer will need to come up with innovative thoughts and practices. Either one begin with a start-up or start working as an employer, innovative practices will certainly play a crucial role in sustaining the healthy business for a longer duration. The university insists on learning the approach and keep learning how to apply the same in different circumstances that bring in innovative solutions to difficulties identified or thought upon for remedy.

A break through the wall and boundary of thoughts is essentially needed. “I can and I must”. The absence of such attitude will lead to absolutely nowhere even if bearing all the qualities. Each of a team member chasing for an innovation must be filled with positive thoughts essentially needed for creativity. Results of an innovation search may not necessarily be promising at first and may ask more, and rigorous efforts for a longer time that one must provide.

Figure 2 Evolution of glass technology at Corning

Corning’s Breakthrough Innovations

During its more than 160 years, Corning has leveraged its expertise in glass and materials science to produce a long list of highly successful products, including the following.

1800s

1879 Glass envelope for Thomas Edison’s lightbulbs

1900s

1912 Glass for railroad lanterns that could withstand extreme temperature changes

1915 Heat-resistant Pyrex glass for cookware and laboratory equipment

1926 Ribbon machine for the mass production of lightbulbs

1932 High-purity fused silica—the foundation of other Corning innovations, such as telescope mirrors and optical fiber

1934 Silicones, a class of materials that are a cross between glass and plastic

1947 Process for mass-producing television picture tubes

1952 Heat- and break-resistant glass-ceramic material used in Corning Ware cookware and missile nose cones

1964 Fusion overflow process for producing flat glass

1970 Low-loss optical fiber used in telecommunications networks

1972 Cellular ceramic substrates used in automotive catalytic converters and today’s diesel engines

1982 Active matrix liquid crystal display (LCD) glass for high-quality flat-panel displays

2000s

2007 Gorilla Glass—thin, lightweight glass with exceptional damage resistance for smartphones, tablets, and other consumer electronics

2012 Ultraslim, flexible, lightweight glass for consumer electronics and architectural and design applications

SOURCE CORNING; GARY P. PISANO
FROM “YOU NEED AN INNOVATION STRATEGY,” JUNE 2015

Figure 3 The punch need to break the box

(Source: dreamstime.com)

Engineers are specifically skilled with logical thinking and practices. They need to think laterally when a chase for innovation is in progress. There may lie many answers to a simple question that have a most obvious answer. An innovator must check all the relatively relevant options and check for absurd connection of thoughts.

4. THE FIVE PRINCIPLES

Design engineering spine in GTU is evolving with five principles of design. These are, ATEEC – Aesthetics, Technicality, Ergonomics, Environment, and Cost. All innovation must check the designs by applying these principles, as applicable. Over a period of time, certain parameters are coming up that address these principles, however, as stated earlier, all processes and material research does not always have applicability of these principles.

Let us discuss over the break-up of these five principles in terms of sub-parameters. The innovator must prepare a checklist and perform a check on applicability and degree of application for each of these sub-parameters. In form of human five-finger concept, assume these fingers to be playing one principle each and these are:

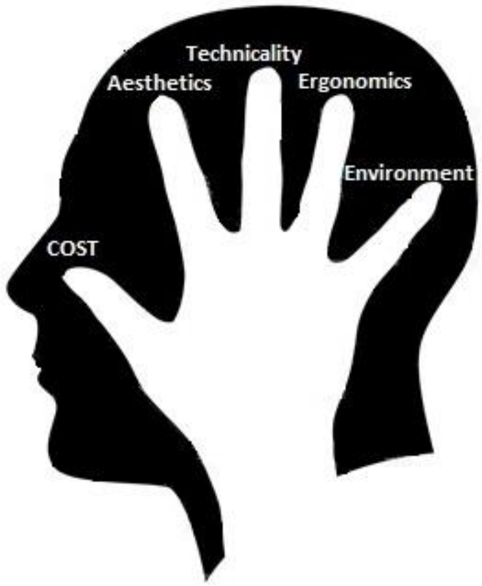
The pointer finger - Aesthetics aspects
→ this must generate a feeling of 'Wow' i.e. feel fantastic in the developed idea/product
Asking 'How to…' and include the sub-parameters of:

- Make an appealing visual appearance/ make it attractive
- Create it unique and versatile
- Make it more Attractive
- Bring in Mesmerizing effects
- Make it different from normal ones
- It can provoke more usage

The middle finger – Ergonomics aspects (Symbolic healing)
→ it must provide ease in usage
Check for possibility to make prototype – working model
How far the design will be adaptive (flexibility for usage)?
Will it be "my size" fit, for all users?
Will it be portable/handy?
Within reach available?

How many comfort will it deliver?
What shall be the best approach to use it?
Which feelings are expected on usage?
Human scale – anatomy interactions

Figure 4 Five principles of Innovation



Source: The Gujarat Technological University – multiple circulars; conceptual representation by the Author.

The ring finger– Technical aspects (Symbolic Prosperity) that ensure successful utilization
← Need a merger of existing knowledge linked with thoughts on innovation to identify requirements related to:
Mathematics, statistics, techniques
Multiple uses possible
Tools and instruments required
Old and new theories
Advanced theories
Testing needs
Applicable standards and guidelines
Extent of absurd connections

The ladyfinger – Environmental aspects
→ One need to ensure that all is safe and utilization of resources will be in a sustainable manner
Consider disturbances in any ecosystems
Pollution to water, land, air
Food, food chains and Green spaces
Electricity and its usage – need
Fuels – fossil and non-conventional
Biotic and abiotic processes involved
Norms and impacts need to be identified
This sub-parameters, if omitted anyways, the product/ project implementation will certainly observe loss of resources and accrue delay.
Thumb – the cost aspects
→ A decision-making criteria – if it allows, begin the experimentation/ application

Think over the Budget available
Procurement needs
How to manage with minimal costs
Maximizing functionalities, features
Optimal design part utilization – cost alternatives
What will be minimum average usage after investment
How much raw materials to cost
Will the waste products / end products / bi-products be sellable?
What will be the management costs / administrative costs and HR costs

Costs are hidden until explored in detail, and may surprisingly re-orient entire line of action. The essential requirement is to have an upfront analysis done well in advance and updating it for changes made by continuing on doing it till the end.

Figure 5 The Five principles of design

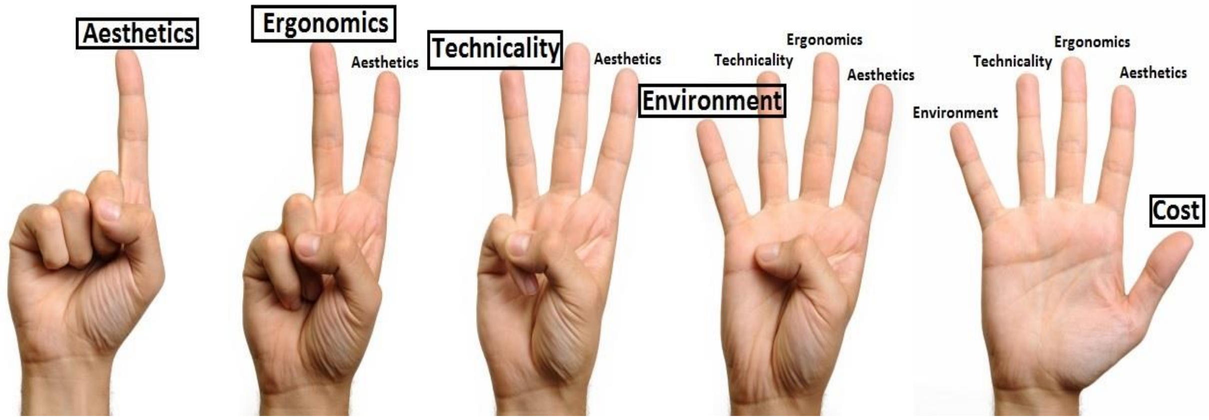


Image source: Author

In another way, the above can be termed or identified as basic five principles of innovation and advanced designs for products of any kind.

5. KEY OF IDEA GENERATION

The idea to innovate is mostly based on a word combination - *User FEE* (as the author defines, it encompasses a visualization or assuming the most probable User Feelings, Experience and of course, Expectations from a product or design). These are the igniting factors. Openfuel.org once developed a canvas called *Ideanut Ideation Canvas* (Saxena, 2014) that help imagine over users, activities, location-context-situations under a selected theme, wherein difficult situations are visualized and props are evolved that help resolving the difficulties. It can be very useful if an innovator works well with it by applying rigorous thinking efforts. All one need is to observe what actually is happening in place after ideation. The canvas is a very powerful tool for generating idea resolving a difficulty of a user in multiple circumstances. Once an idea is in hand, it becomes very important to materialize it, test it and actually implement it. For the same yet another round of efforts is required. However, while putting efforts, an innovator must make sure to have qualities of a T-man as described in the following section.

6. CONCEPT OF AN INNOVATIVE T-MAN (TECHNOCRAT MAN)

Let us assume a human figure as shown in figure-6 below. The head, most important part of a human figure represents the value propositions or the purpose for the innovation drive. It always remains at the top and guide other practices. Amongst moral values for an Innovator, ethical practice is a must. The awareness of what ethics one must follow that shall be among prime requirements. Also, the innovator must have good memory power, if not, one may keep a record of every instance by putting a note in paper or recording a voice. This is required as every human brain has the ability to process a number of thoughts simultaneously and any intervention if likely to be useful, must be noted somewhere else the similar set of though is very rare to generate – exceptionally rare. *An innovator needs to shift thinking from a problem to a project*.

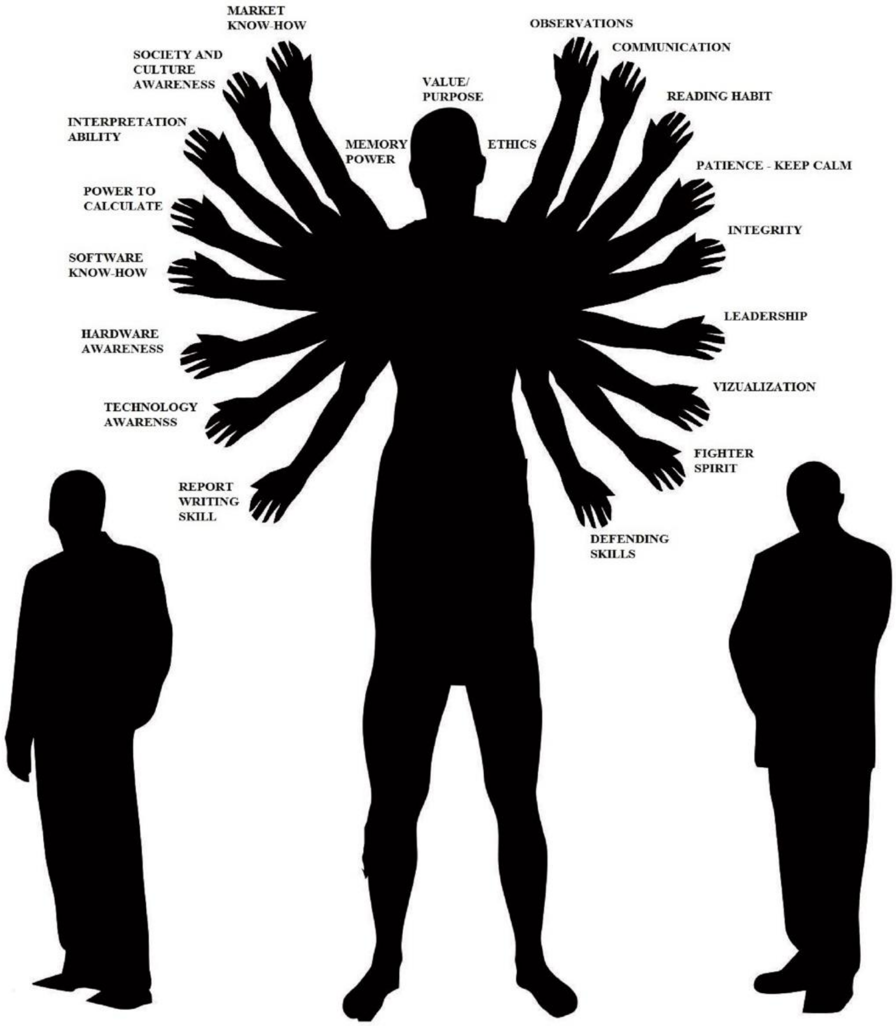
A good idea lies within randomization. *Frans Johansson* asks that randomness defines the part of our lives that we can't control, so how can we rely on it? (Johansson, 2012). However, visualization over randomness and synchronization to make choices can provide an appropriate degree of reliability over randomization. In fact, randomization in a pool of thought enables one to identify all the possibilities – the good and the worse as well. An ability to identify a specific pattern from within randomization is very well possible through a practice over the ideation canvas. Ideation empowers the innovator to have deep diving in a pool of words and thoughts and in no time, one can confront ample opportunities for innovating. All that is needed is to make choices (synchronization) among the alternative opportunities. The result of random thoughts have so far gifted the world with a number of successful and very useful products – for example, Bill Bowerman invented revolutionary sole for running shoes. He could make a connection of waffle iron pattern with a difficulty lying in a running shoe sole. A large number of similar results are available among published – unpublished sources. *Frans* also suggests that the level of random success increase as societal norms around a specific field become looser (Johansson, 2012). It means, there is an apt need to leverage the stringent and purely logical pattern of teaching-learning of engineering and infuse creativity through the infusion of origami or model making with basic engineering principles. A mind mapping exercise helps randomization. Tim Brown urges that the linear thinking is about sequences whereas mind maps are about connections (Brown, 2009). As per Tim, we are in need of new choices – new products that balance the needs of individuals and of society as a whole; new ideas that tackle the global challenges of health, poverty, and education; new strategies that result in differences that matter and a sense of purpose that engages everyone affected by them (Brown, 2009).

Tim recalls that to operate within an interdisciplinary environment, an individual need to have strengths in two dimensions – the T-shaped person as made famous by McKinsey & Company. Originally, it consisted on the vertical axis, every member of the team needs to possess a depth of skill that allow one to make tangible contributions to the outcome (Brown, 2009). Innovator engineer needs to cross the original idea of the T-shaped person and needs to possess a variety of skills and competencies as discussed.

The GTU methodology of engineering can empower the student innovators with skills of observation, communication, understanding on the market to an extent along with basics of economics along with somewhat software-hardware and technological awareness. However, rest of the skills needed are let out over an individual to develop and all these skills play very important role for working out a materialistic or physical innovative product. An innovator needs to be open-ended, open-minded, and iterative. To list out the competencies/ skills essentially an innovator must possess are:

- Ability of observation
- Skill to communicate correctly
- A good reading habit
- To have patience
- Power of integrating all existing relevant knowledge base
- Role-play as a leader
- Ability to do visualization (imagination on drive)
- Fighter spirit to confront the consequences and limitation of resources (constantly remain motivated)
- Skill of defending thoughts

Figure 6 Conceptual T-man standing tall



Source: Author

- Understanding on markets and economics
- Understanding about society and cultural practices
- Ability to interpret
- Skill of performing calculations and analysis
- Software know-how
- Hardware awareness – about alternatives for making a correct choice
- Technology awareness
- Report writing skill – setting up a document for one who know nothing

A deeper understanding gained for the above competencies will ensure better understanding in all aspects. In a human-scale, a person with all the above skills and competencies will be taller among others and will ensure developed potential for innovation. Collaboration among multidisciplinary teams will be the next task to accomplish.

An innovator engineer must understand the system of engineering. The system comprises of rules, standards, specifications, facts, constraints, combinations and guidelines among which some are constant and rest are of varying with time and technological advancement. Results and effects can be predicted to an extent, however, important are who the scenario will be over next ten or twenty years. However, the predictability (as for all normal courses of action) leads to boredom and the boredom leads to the loss of talented people (Brown, 2009). One need to create a harmonious balance among desirability, viability, constraints, and feasibility aspects.

7. RECIPE OF SUCCESS

There is no precise formula for success. Neither it is sheer luck. Frans suggests that success is something one cultivates through hard work and intense focus (Johansson, 2012). Geoff Colvin argues that deliberate practice is the key to success (Colvin, 2008). One need to spend more and more time by doing it again and again and again.

8. CONCLUDING REMARKS

Following a philosophy of design thinking approach, an ambitious effort is taking place at GTU for making the engineering graduates an innovator or able to practice innovation in every possible circumstance. The overall environment is enabling a student to develop one's self however, one needs to develop a number of skills and competencies to accomplish goals set forth. Interventions discussed over idea generation, principles of designs, competencies need and success recipe depicts an apt need for response by an individual. Solely allowing and opportunistic circumstances will not change the conventional practices, efforts are needed to change personalities and mindsets at large. Mechanisms for motivating rising innovators are more than desirable to be in place.

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REFERENCES

Brown, T. (2009). *Change by Design: how design thinking transforms organizations and inspires innovation* (One ed.). New York, USA: Harper Collins Publishers, 10 East 53rd Street, New York, NY 10022.

Colvin, G. (2008). *Talent is Overrated: What Really Separates World-class Performers from Everybody Else.* New York: Penguin Books Ltd, New York, NY 10014, USA.

Gujarat Technological University. (2014, JUNE). *Design Engineering (Subject Code: 2130005).* Retrieved from GTU: http://files.gtu.ac.in/syllabus/DESIGN_ENGG/2130005.pdf

Johansson, F. (2012). *The Click Moment - Seizing Opportunity in an Unpredictable World.* London: Penguin Books Ltd, 80 Strand, London WC2R 0RL, England.

Pisano, G. P. (2015, June 01). *You Need an Innovation Strategy*. Retrieved from Harvard Business Review: https://hbr.org/2015/06/you-need-an-innovation-strategy

Saxena, Y. (2014, November). *Open fuel canvas*. Retrieved from Openfuel.org: www.openfuel.org

Thesaurus - Innovator. (2015, 12 10). Retrieved from Merriam-Webster: http://www.merriam-webster.com/thesaurus/innovator