Design Thinking (for EDP)

What is Design Thinking?

- Design Thinking (DT) is a discipline that uses the designer's sensibility and methods to match people's needs with what is technologically feasible and what a viable business strategy can convert into customer value and market opportunity, according to Tim Brown of IDEO, and thinking like a designer can transform the way one develops products, services, processes, systems and even strategy.

- DT is a methodology that ingrains in the whole gamut of innovation activities a disposition of user-centered or broadly speaking, a human-centered design orientation.

- It is about designing products or services based on close observation of the user's need and expectations or disliking of about the product or the way a product is configured, packaged, marketed, sold, and supported.

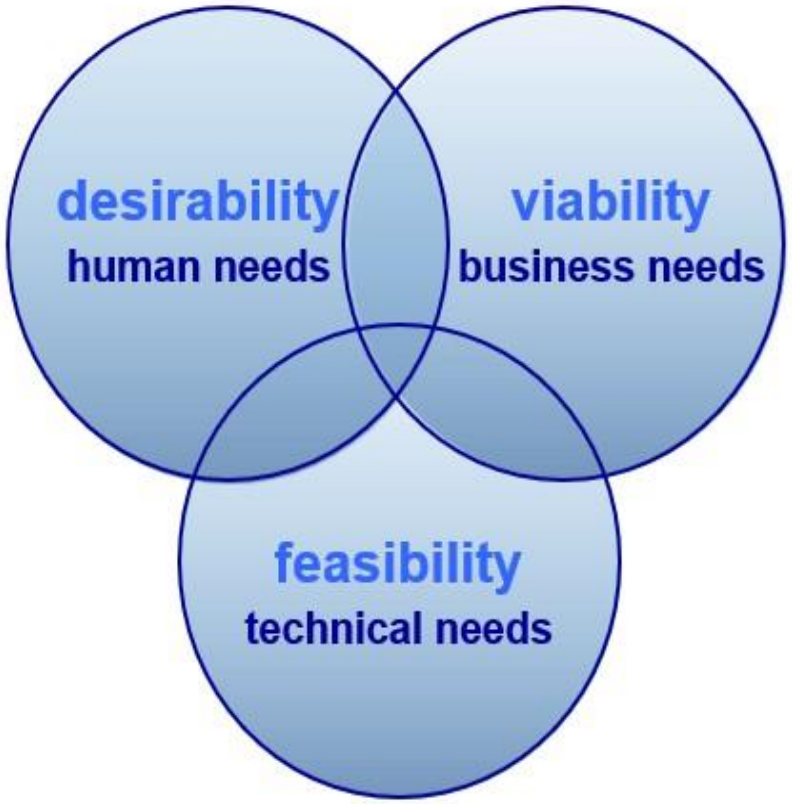
Design Thinking (DT) as a basis for Innovation:

(Elucidation with reference to Stanford d.school's DT Model)

- **Empathize:** Innovation approach is user-centered (human-centered), based on discovery and deep understanding of pain points (problem)/ gains desired.
- **Define:** Innovation would be targeted to solve a problem, based on insight developed.
- **Ideate:** Innovation based on generation , analysis and critical evaluation of ideas, considering the user desirability, technical feasibility and economic viability of the solution.
- **Prototype:** Innovation should be materialized in efficacious transformational terms.
- **Test:** Innovation ought to be verified with user and the solution to be refined.

Design Thinking Principles

- Does the solution engross empathy for end-users?
- Is this the solution simple enough for the intended purpose accomplished?
- Is it useful?
- Is it elegant?



- Is the solution affordable?
- Does it improve profitability?
- Are the proficiency and skills available?
- How much is the ROI?

- **Innovation is at the Intersection.**

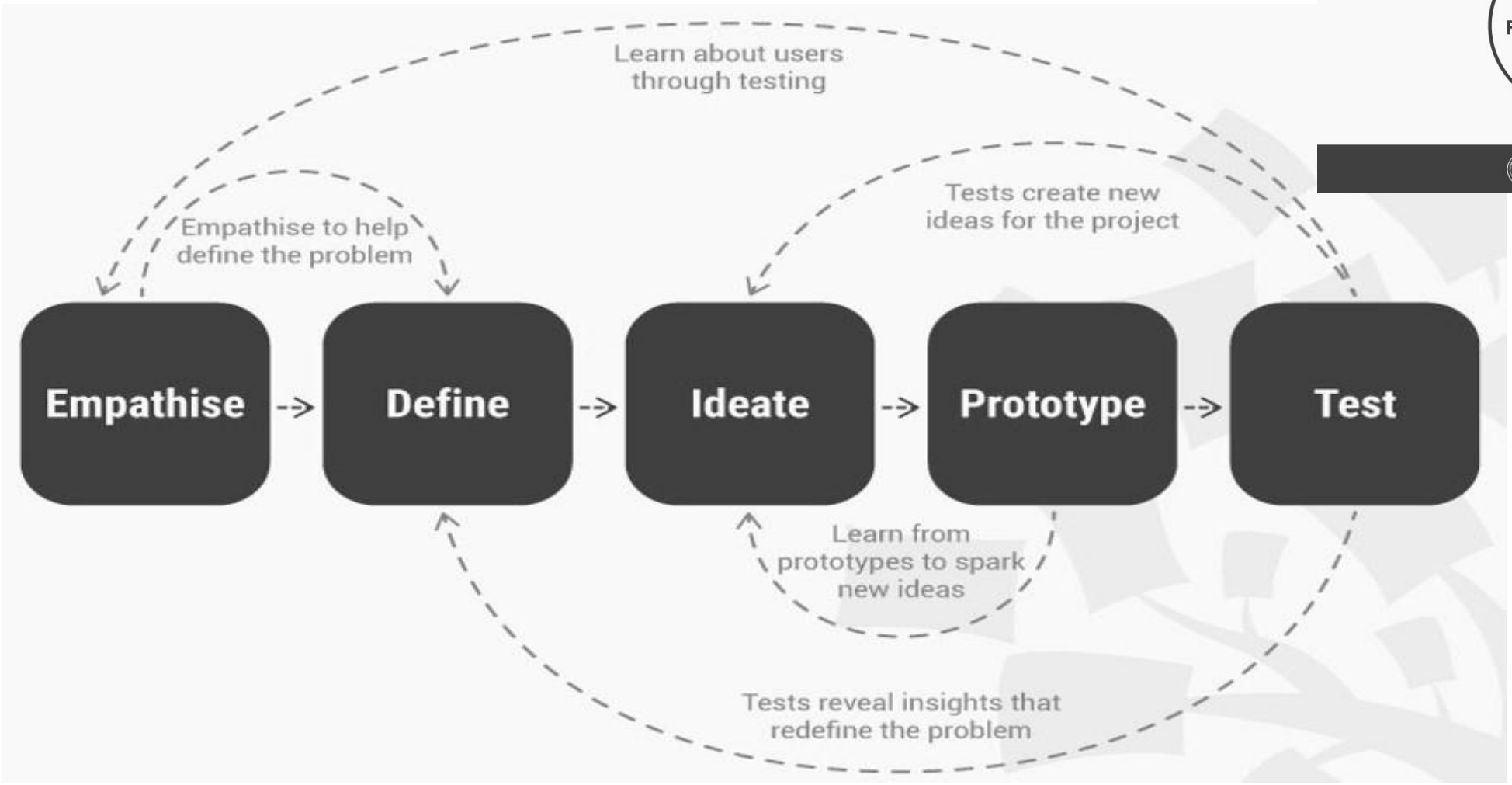
Product creation Phases:

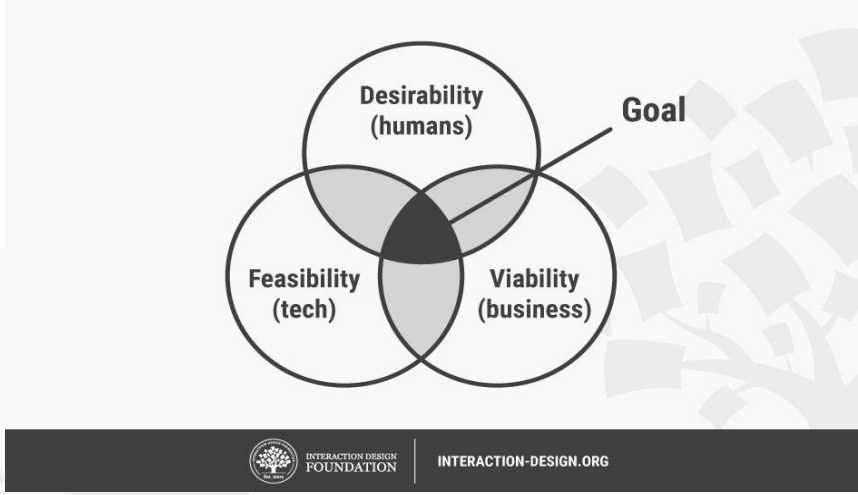
0) Understand/observe
1) Visualize/Realize
2) Evaluating/Refining
3) Implement (detailed engineering)
4) Implement (manufacturing and liaison in vendor operation)

- How quickly can the solution be configured to suit the needs?
- Is the solution maintainable without much hassle?
- Is it consistent with the existing system profile?
- Is the solution conveniently supportable?

Design Thinking: A Non-Linear Process

(Ref: Teo Yu Siang and Interaction Design Foundation, author of the diagram)





Step 1: Empathize

- It is holding back ones opinions, mindset and beliefs, culture, learning and knowledge, purposefully in order to understand other peoples' (users/ customers) experiences of affairs and stuff deeply and meaningfully.

- It necessitates a high degree of ingenuity for imaginativeness to be able to see through another person's view point.

- It is absolutely necessary for absorbing and understanding the first-hand and raw information.

- It is not easy, since people generally are trained, due to grooming the process and acquire knowledge and experience to form judgments and opinions rather than absorbing and understanding the raw information.

Step 2: Define

What is ‘Defining’?

- **Assimilation** of information gathered in the ‘empathy phase’ followed by **analyzing** and **synthesizing** the observation.

  Analysis (analyzing): Breaking down complex concepts and problems into smaller and simpler elements for better understanding and comprehension.

  Synthesis (synthesizing): Creatively putting together research output and analysis data to construct whole ideas. The steps followed respectively are organizing, interpreting and making sense of the data gathered to create a problem statement.

- Leading to creating meaningful and accurate problem statement based on developed insight

Step 3: Ideate

- This stage is aimed to elicit the best of ideas for solving a defined problem, through ***Brainstorming*** and even the wildest idea generation activities.

- *Creativity* and *Innovation* are the fountainheads and impetus behind developing solutions.

- Generation of ideas in good numbers or quantity is the aim, which on screening yields workable concepts, based on the filters of desirability, feasibility and viability.

Step 4: Prototype

What is a prototype?

- An early, inexpensive, and scaled-down version of a product that can be used to obtain the test results.

- It offers product creators the opportunity to bring their ideas to reality, test the practicability of the present design, and conceivably and reasonably investigate as to how the users perceive about a product.

Types of Prototyping:

- **Low-Fidelity Prototyping*:*** It is generally not a very complete version and rather often uses only a few features of the final intended design.

- **High-Fidelity Prototyping*:*** This version more or less resembles and operate as the finished product or closer to it.

Step 5: Test

What is Testing?

- Testing in design thinking refers to and purposed for obtaining feedback from the users about the developed prototype, involving features and functionalities.

- This feedback helps the developer to understand the users more accurately.

Why Testing?

- Collecting feedback is crucial in design thinking and product innovation, and without proper understanding of the users needs the right set iteration in product engineering and development will not take place and the process will fail.

- If the users encounter any problem with the present solution version then the Product engineering team must rethink and design some alternative versions.

Conclusion

- This session addresses a **functional definition** of ‘design thinking’ **for primary understanding** about it.
- Delineates the **inadequacy in practicing ‘Innovation’ in industry**, to help in **gauge the scope and opportunity for the industry**, covering corporate organisations and startups, to explore and embrace **as well as for the professionals** in this domain.
- The discussion covers **principles of design thinking** alongside the **innovation aspects** which is a common element in engineering practices be it a large corporate or a technology startup.
- Consequently, the aspect of **design thinking as a basis for Innovation** has been explicated, and
- Briefly introducing the steps in **design thinking process steps**.

Design Thinking and Product Conceptualization & Development

Concept Covered

- A Perspective on Product Innovation: Design Thinking and Engineering Design and Development
- Intertwining of Design Thinking and Engineering Design Process (Ref: NASA's BEST Engineering Design Model)
- The Steps of the Engineering Design Process (NASA)
- DT's influence on Design Conceptualization

A Perspective on Innovation: Design Thinking and Product Engineering Design and Development

- Design Thinking is an **innovation process inspired by empathy for the user's needs** followed by **ideation and implementation,** particularly **influencing new product design and development** as it is a means **to direct and focus design and development that results into effective commercialization.**

- Design Thinking in **the context of product development** commonly outlines the aspects like, **Empathizing** with users and potential customers**, developing insights** and grasp **user experiences and problems, ideating for problem-solving** in design engineering**, building prototypes, MVP (**minimum viable products) for **feedback** on the product, which is **obtained by testing** with the user and customers.

- It however, can be **perceived that Design Thinking** is immensely efficacious in the **front-end part of engineering development** and that **can yield a great product concept** which can productively be the candidate for high fidelity prototyping.

Design Thinking to be supported through EDP

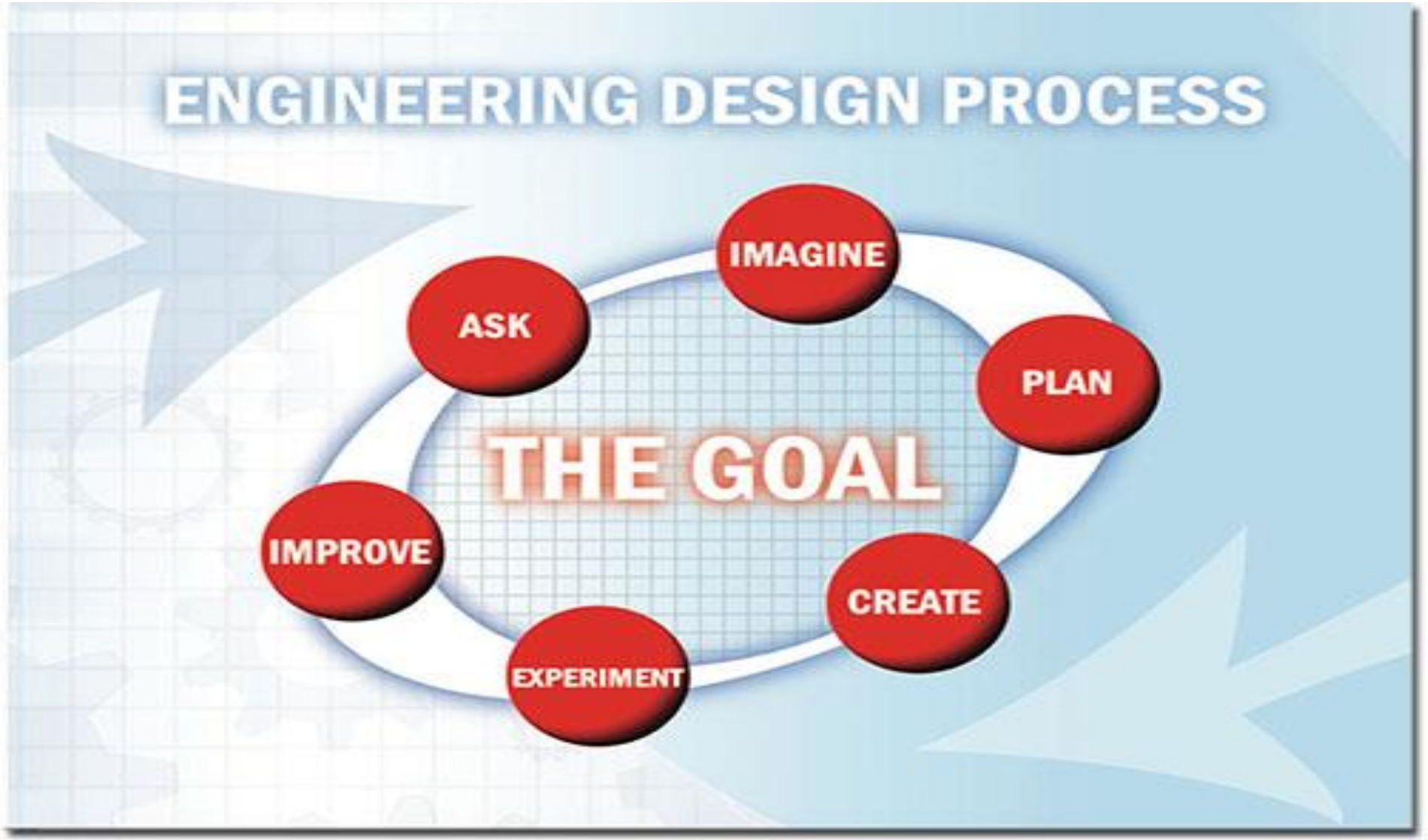
- To **solve engineering problems**, engineers follow a **series of steps** called the "Engineering Design Process (EDP)"

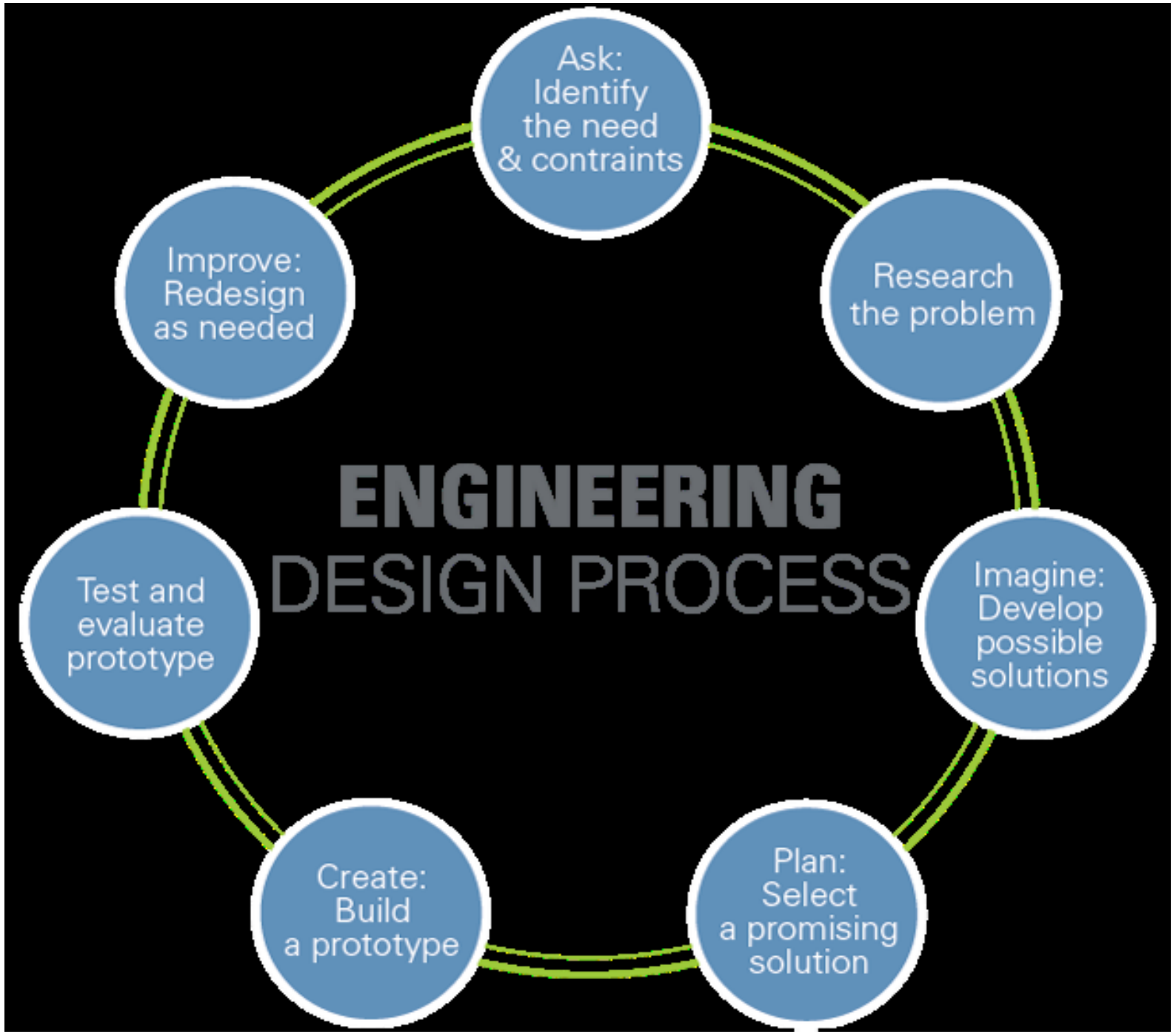
- '**Engineering Design Process (EDP)**' is a decision making process (often iterative) in which the knowledge STEM (Sciences, Technology, Engineering and mathematics) are applied to convert resources optimally to realise a stated objective.

- Among the fundamental elements of the design process are the establishment of objectives and criteria, analysis, synthesis, construction, testing and evaluation
  —Accreditation Board for Engineering and Technology **(**ABET)* in USA

- **EDP** as an **umbrella** covering several aspects, focuses on ideation, research, conceptual design, feasibility assessment, establishing design requirements, embodiment/ system-level design, detailed design, manufacturing planning, tool design, testing, and production piloting. **(Explained with NASA's Model)**

NASA's BEST Engineering Design Model (designed to teach students the EDP)




Ask: Identify the need & contraints
Research the problem
Imagine: Develop possible solutions
Plan: Select a promising solution
Create: Build a prototype
Test and evaluate prototype
Improve: Redesign as needed
ENGINEERING
DESIGN PROCESS

Engineering Design Process (NASA): The steps are described as follows

- **ASK (To identify a need):** Identify the problem, requirements that must be met, and constraints that must be considered.
- **IMAGINE (To develop possible solution ideas):** Brainstorm (think up) problem-solving ideas and research into them; also explore available alternatives.
- **PLAN (To decide the best course or the design concept):** Choose a couple of top ideas from the 'thought up' list and draft possible design solutions, and finally select the most suitable one as the design concept for prototyping.
- **CREATE (To develop a Prototype - a test model of the product):** Build a working model, or prototype, that meets the design requirements, while complying with the design constraints.
- **EXPERIMENT (TEST To evaluate the prototype and Cost-Benefit Analysis):** Evaluate the solution through testing for functionality and quality; collect test data and analyze for determining the fitness and flaws of the design.
- **IMPROVE (To modify and retest the solution):** Carry out improvement iteration on the design by identifying changes to be incorporated, based on the test results.

The alignment of EDP and DT is presented in the following slides

STEP 1- ASK

(Images from Science Photo Library)

'Ask' refers to 'What is the need?'

- Identifying the need or problem or challenge that is being tried to be solved by researching into and properly defining it

  Example of need: To provide prosthetic support/ devices when a person has lost a limb

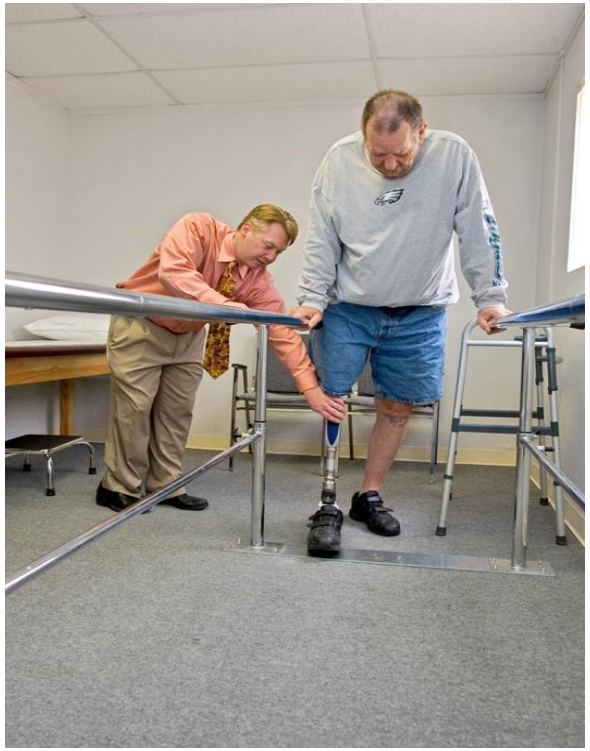
- Using **'Design Thinking'** principles engineers would observe, study and analyze and define:

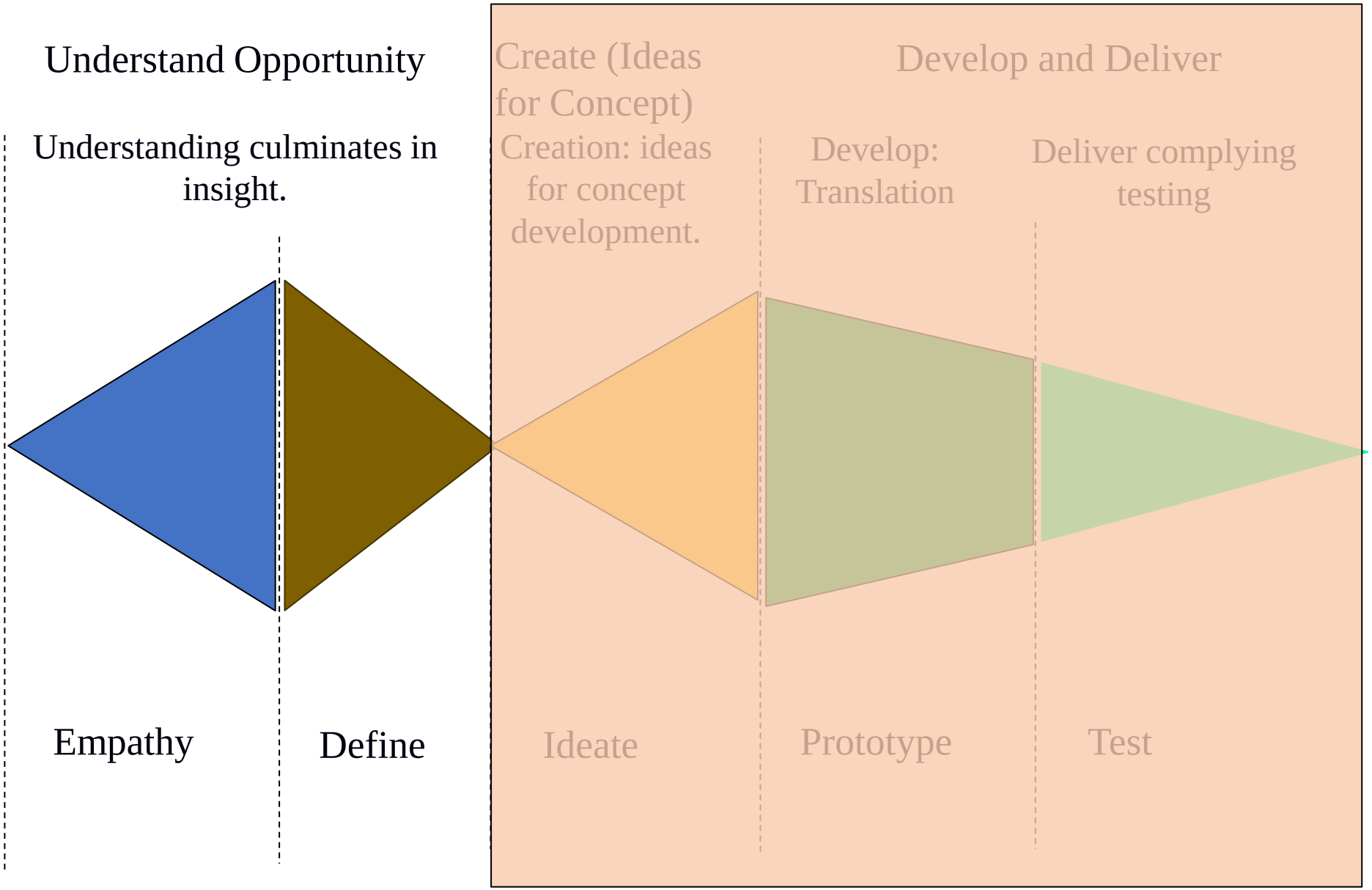
  (i) Precise needs of individual for the specific disability (**Empathy)**

  (iii) Biomechanics concerning the particular case

  (iii) How the available prosthetic devices are not providing comfort or meeting other requirements, and

  (iv) **Define** 'what is exactly to be built', which is based on the tenets of 'Analysis' and 'Synthesis', of the information gathered at Empathy stage in DT




Understand Opportunity
Understanding culminates in insight.
Create (Ideas for Concept)
Develop and Deliver
Creation: ideas for concept development.
Develop: Translation
Deliver complying testing
Empathy
Define
Ideate
Prototype
Test

STEP 2- IMAGINE

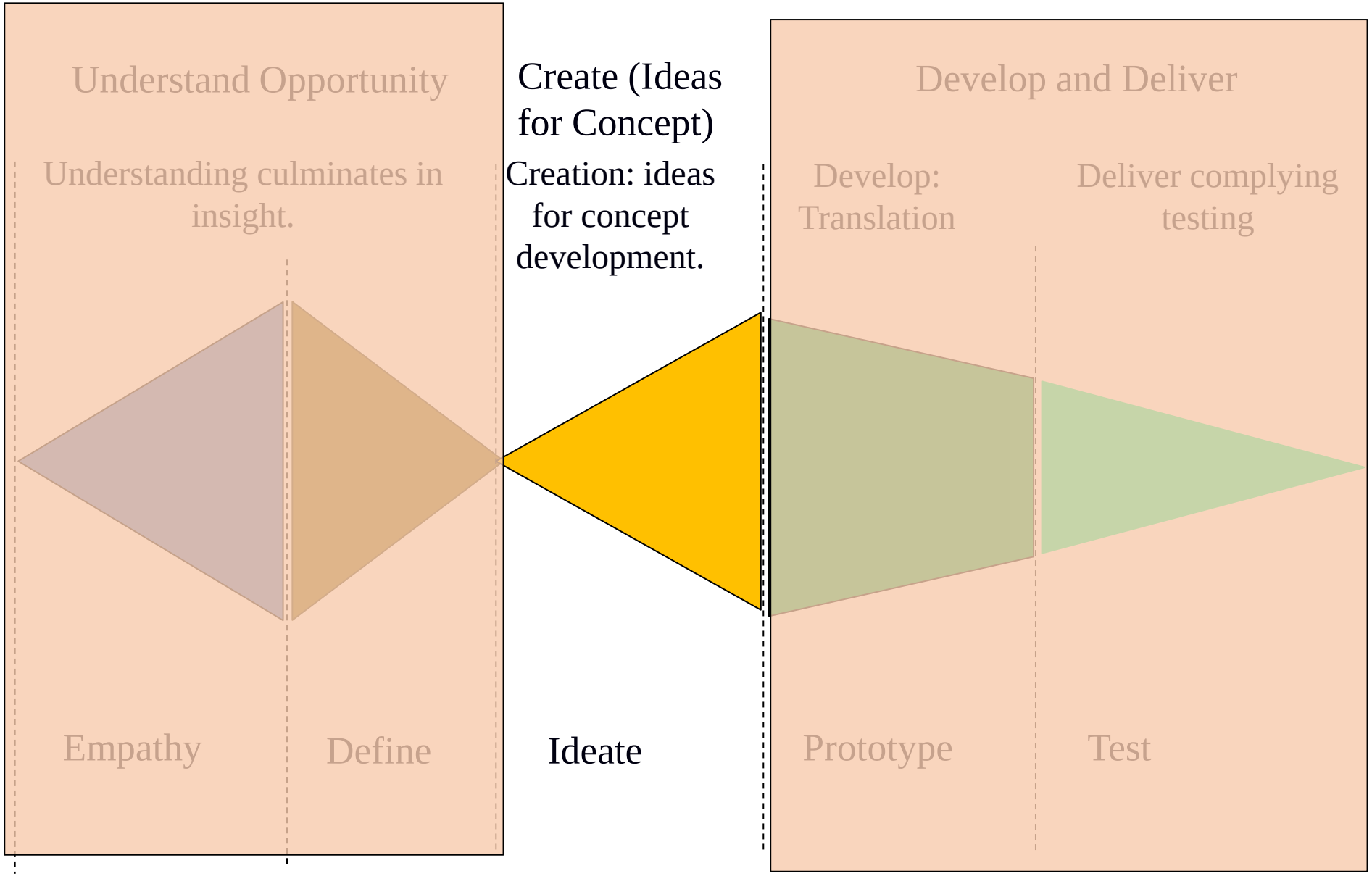
‘Imagine’ refers to ‘Generate Ideas’

- **Brainstorming for problem-solving ideas -** Sharing ideas; so as to build one on another.

Example of Ideation: A prosthetic foot designed copying car springs.

- This, according to Design Thinking’ practice is to **‘Ideate’.** To cultivate the best solution ideas for a defined problem, through Brainstorming, using creativity with Innovation orientation.

- This is required for **(i)** asking the right questions to innovate, **(ii)** enhancing quantity and variety in innovation options, **(iii)** looking beyond the obvious solutions to increase the innovation potential solution, **(iv)** hitting upon the unexpected areas of innovation, as followed in ‘Design Thinking’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STEP 3 - PLAN

‘Plan’ refers to Concept Planning

Evaluation of Ideas and selecting Concepts for prototyping.

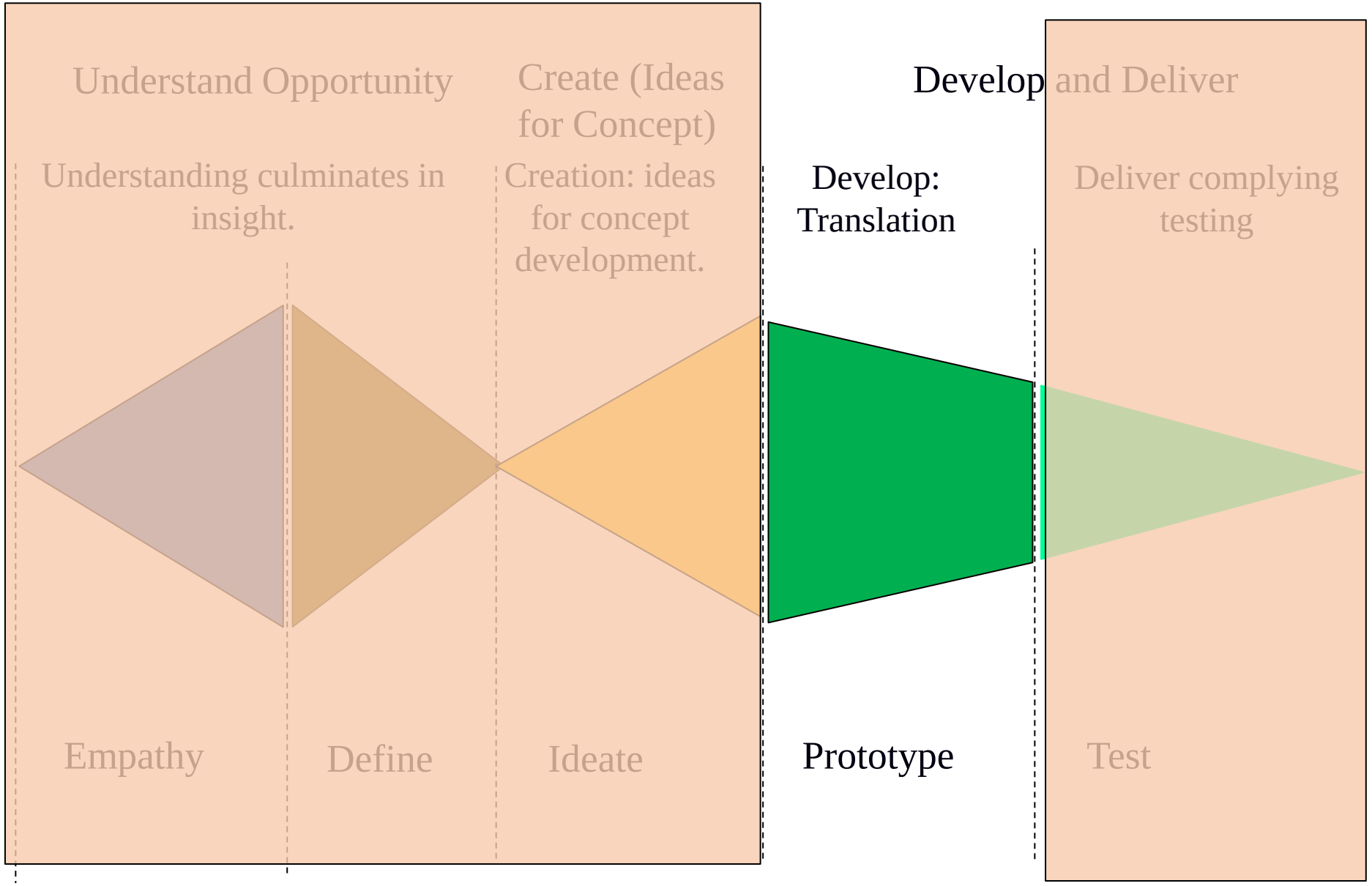
- To **‘Ideate’** in Design Thinking in reality is **‘conceptualization’** in true sense, since ideas are evaluated and the best ones are screened out following the precepts of Design Thinking (DT).

- According to some DT model the innovative concept is considered to be present at the intersection of user desirability, technical feasibility and economic or commercial viability.

STEP 4 - CREATE

‘Create’ refers to ‘Building Prototype’.

- Building a **prototype** (a test model of the intended product) will allow the developer to see if the design works the way it was expected to.
- A physical prototype may, or preferably, follow a ‘digital’ prototype (using CAD/ CAE) for economic and temporal reasons.
- The strategy in ‘Design Thinking’ emphasizes on prototyping for testing with the user rather early to obtain feedback.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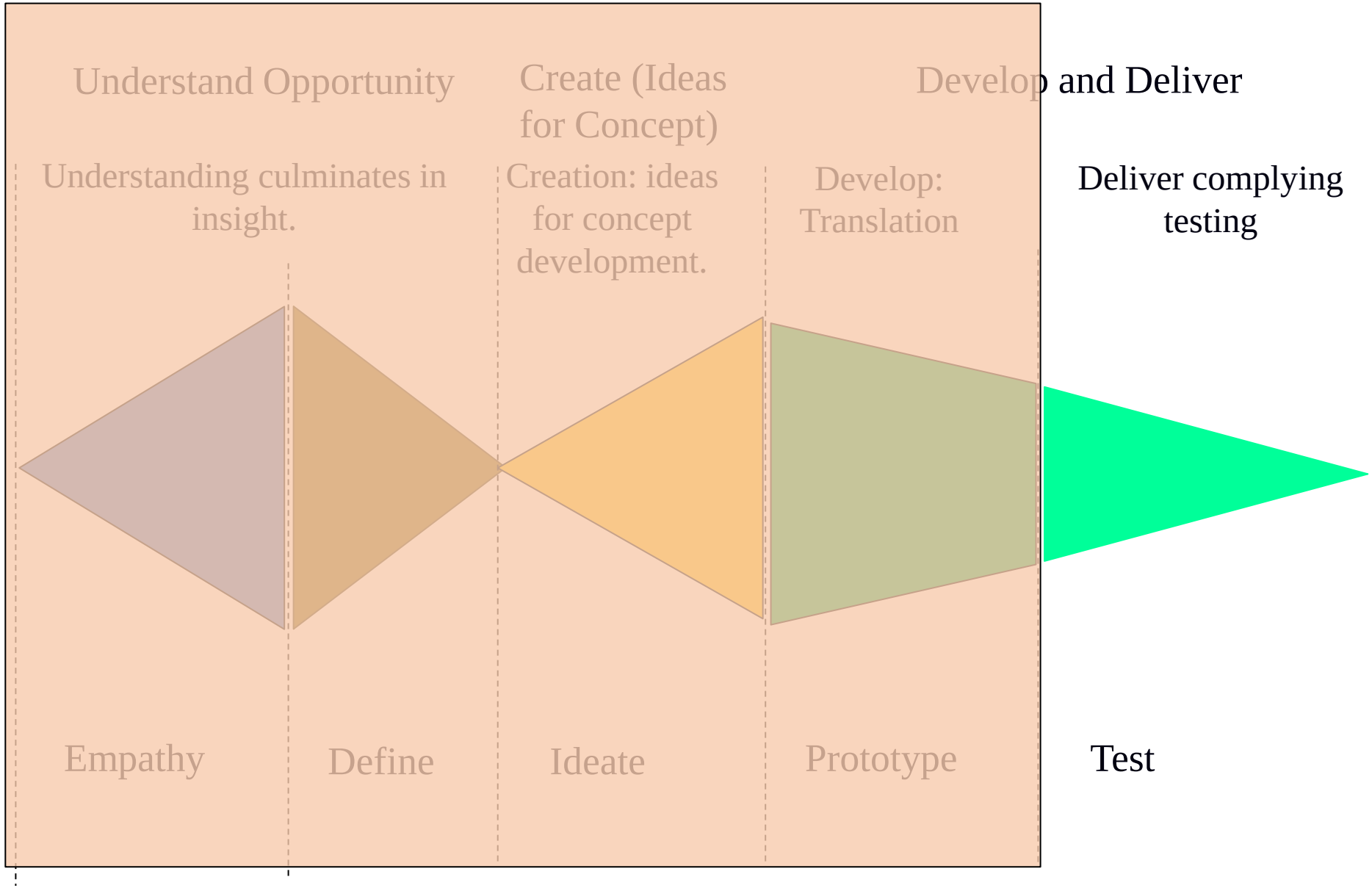
STEP 5- EXPERIMENT (TEST)

‘Experiment/ Test’ refers to evaluating the prototype.

- To insure that the technology/ product/ solution accomplishes the task it was designed for the end user.
- To ascertain what the cost of developing (designing and manufacturing) the new product is worth in terms of benefit **(Cost-Benefit Analysis)**
- Obtaining feedback is crucial in design thinking, which often is an iterative process since development is prone to fail if the ‘need understanding’ is not accomplished using prototypes.
- The experimentation and testing of the prototype through iterations bring the product to its acceptable version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STEP 6- IMPROVE

‘Improve’ refers to modifying and retesting the prototype.

- Till the prototype work successfully, the engineers may prefer to modify it or plan a new solution. Such modification may also be due to alternate uses as requirements generally would also be to scout around for other possible uses for the developed product.

Example: Computerized Tomography (CT) scanning was developed to see internal structures in the body, which is used also for modeling limbs for better fit of prosthetics.

- According to DT paradigm, if the users are facing problems in the present solution then the design team must rethink and develop an useful version.

Understand Opportunity

Create (Ideas for Concept)

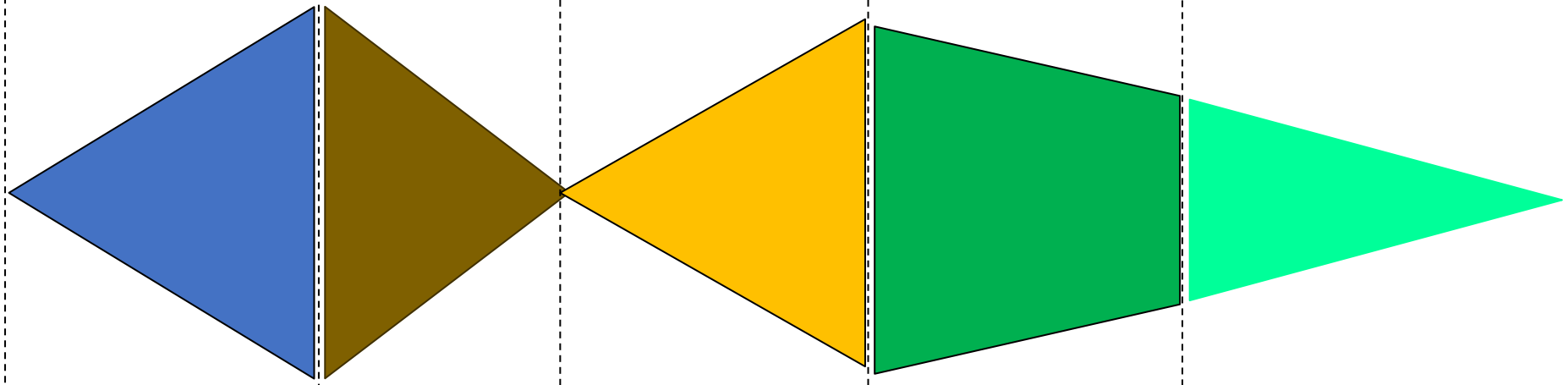
Develop and Deliver

Understanding culminates in insight.

Creation: ideas for concept development.

Develop: Translation

Deliver complying testing



Empathy

Define

Ideate

Prototype

Test

DT’s influence on Design Conceptualization

- It can well be understood that Design Thinking has the intertwining with the Product Engineering Design and Development process.
- It especially influences the front-end of innovation and development and particularly in product design conceptualization.
- Retracing from a DT model for the steps in product conceptualization development corroborates the above as is depicted through the last two diagrams.

Conclusion

A Perspective on Product Innovation blending the Design Thinking paradigm and Engineering Design and Development process is presented in this session with the explication of their Intertwining considering a reference model of Engineering Design developed by NASA. The Steps of the Engineering Design Process are elucidated illustrating DT's alignment with the same and delineating its influence on Design Conceptualization.