New Product Development & Inventions

how engineers ideate and invent.

Can we assist them to move from **adaptive** ideation to **innovative ideation**.

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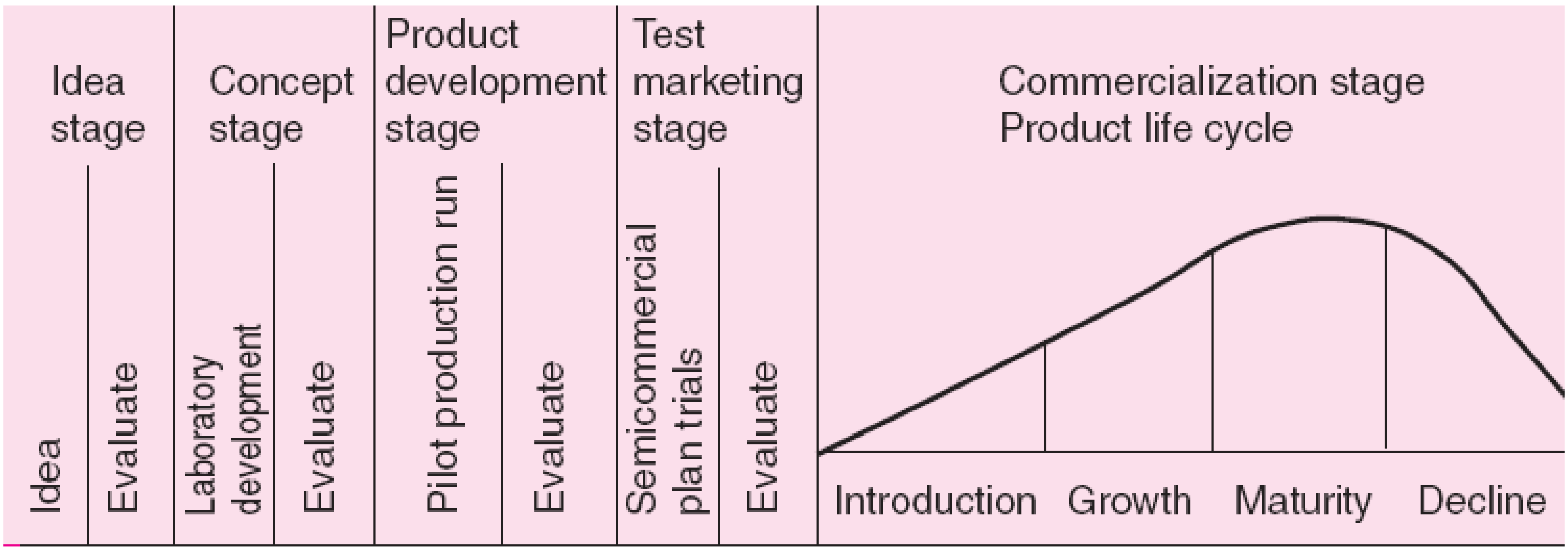
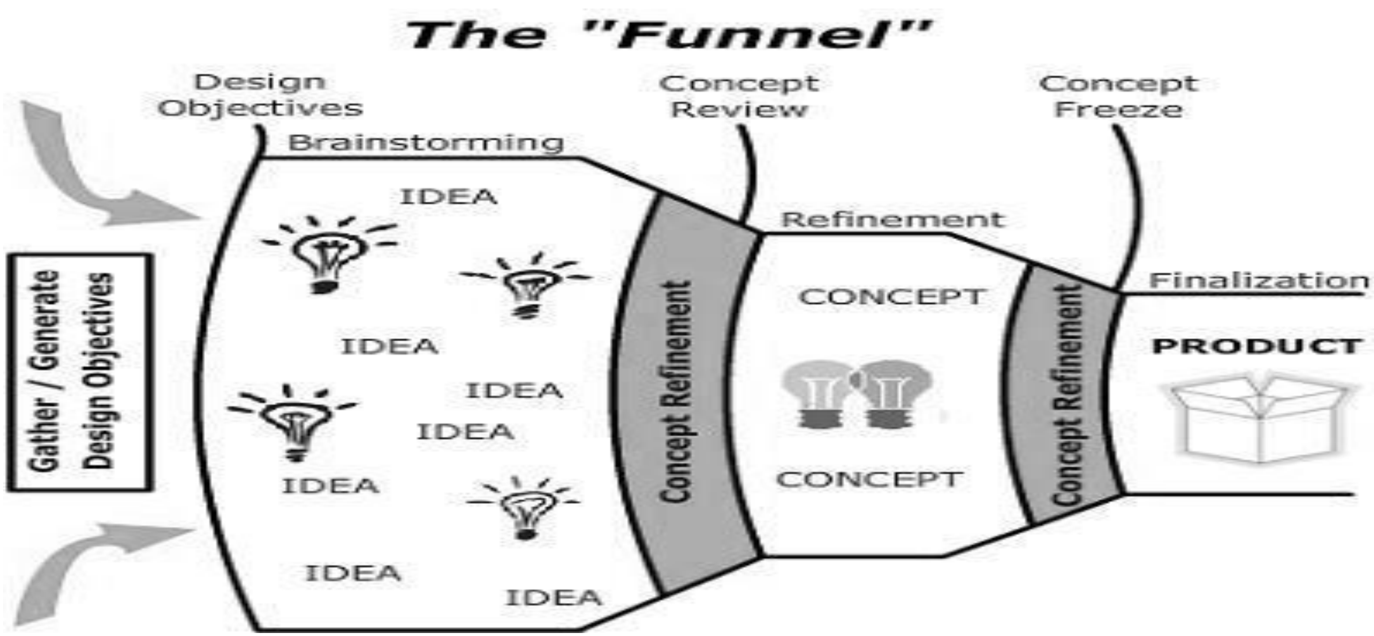
The Product Planning and Development Process



IDEATION IN THE DESIGN PROCESS

- Determines quality of ideas in ‘design process’,
- Drives the quality of the overall design cycle.

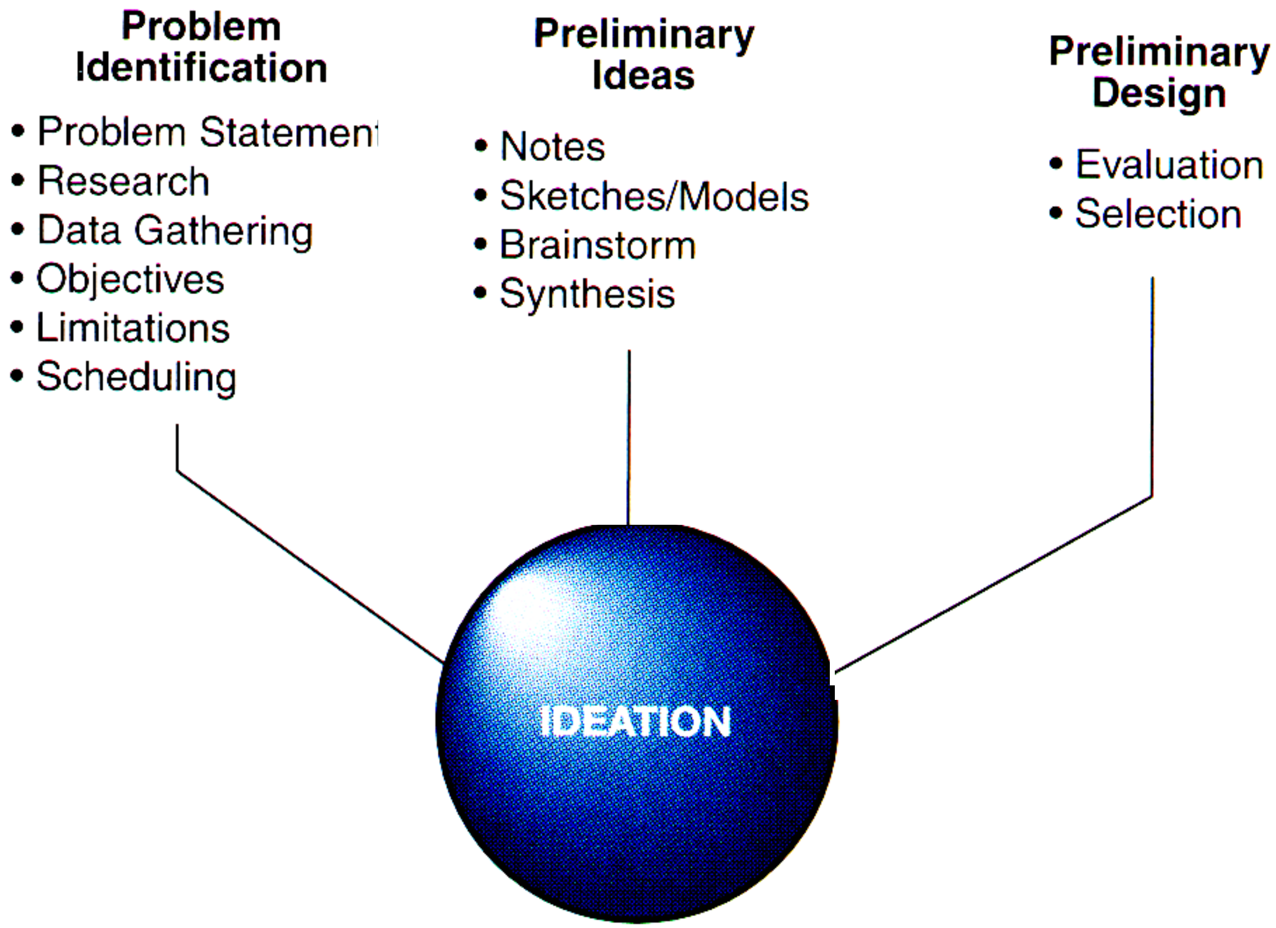


- Diversity of **levels** and **styles** required to solve the **design challenges**

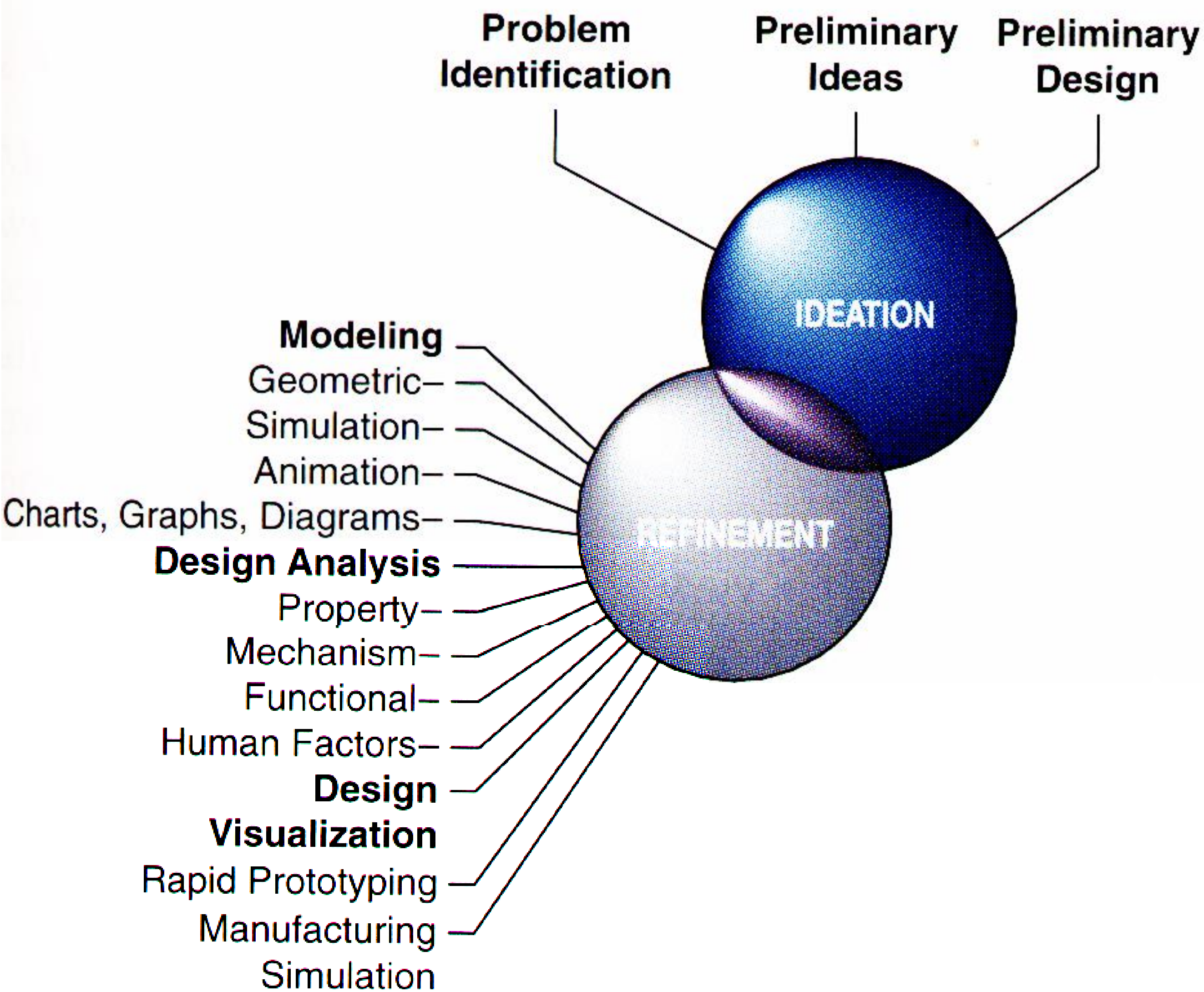
FRAMING DIFFERENCE

- Differences in how individuals respond to different descriptions of the same problem with respect to:
  - Variations in participant expectations
  - Types of goal setting
  - Alternative task instructions
- Generating ideas in teams brings diverse skill sets together.
- Teaming is an effective method for idea generation.

Ideation Process



Refinement Process

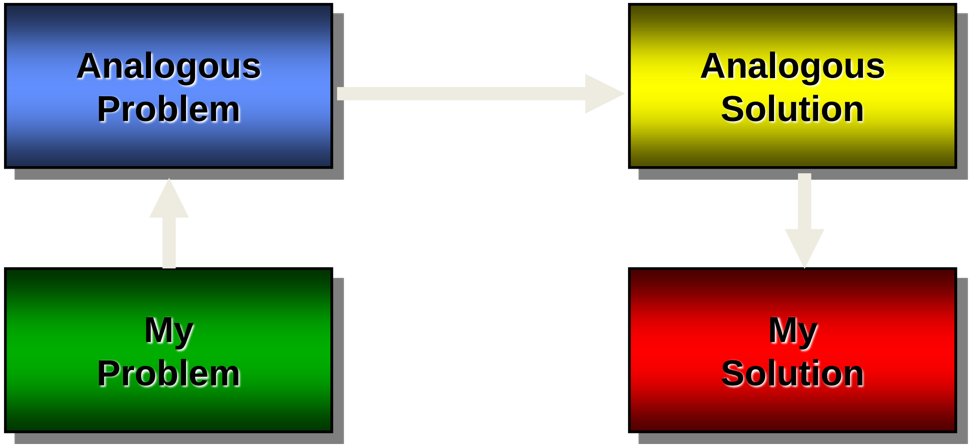


GUIDED REASONING IN INVENTING AND DESIGNING

HOW DO WE INVENT?

Random – Trial & Error!

Which leads to…



"Simply" a matter of finding the previously well-solved problem analogous to the problem at hand

Pattern Breaking

- Thinking differently
  - Metaphoric thinking
  - Outrageous thinking
- Changing your point of view
- Watching for paradigm shift
- Challenging conventional wisdom
- Lateral thinking, provocation (escape, random word)
- Mind stimulation: games, brain-twisters and puzzles

LEVELS OF INVENTIONS

LEVEL 1: Apparent (no invention)

- Established solutions
- Well-known and readily accessible

LEVEL 2: Improvement

- Small improvement of an existing system, usually with some compromise

LEVEL 3: Invention inside paradigm

- Essential improvement of an existing system

LEVEL 4: Invention outside paradigm

- A concept for a new generation of an existing system, based upon changing the principle of performing the primary function

LEVEL 5: Discovery

- Pioneer invention of an essentially new system

The levels of Inventiveness!

Level of inventiveness		%	Source of knowledge	# of explored solutions
1	Apparent solution	32%	Personal knowledge	10
2	Minor improvement	45%	Knowledge within company	100
3	Major improvement	18%	Knowledge within the industry	1000
4	New concept	4%	Knowledge outside the industry	100,000
5	Discovery	1%	All that is knowable	1,000,000

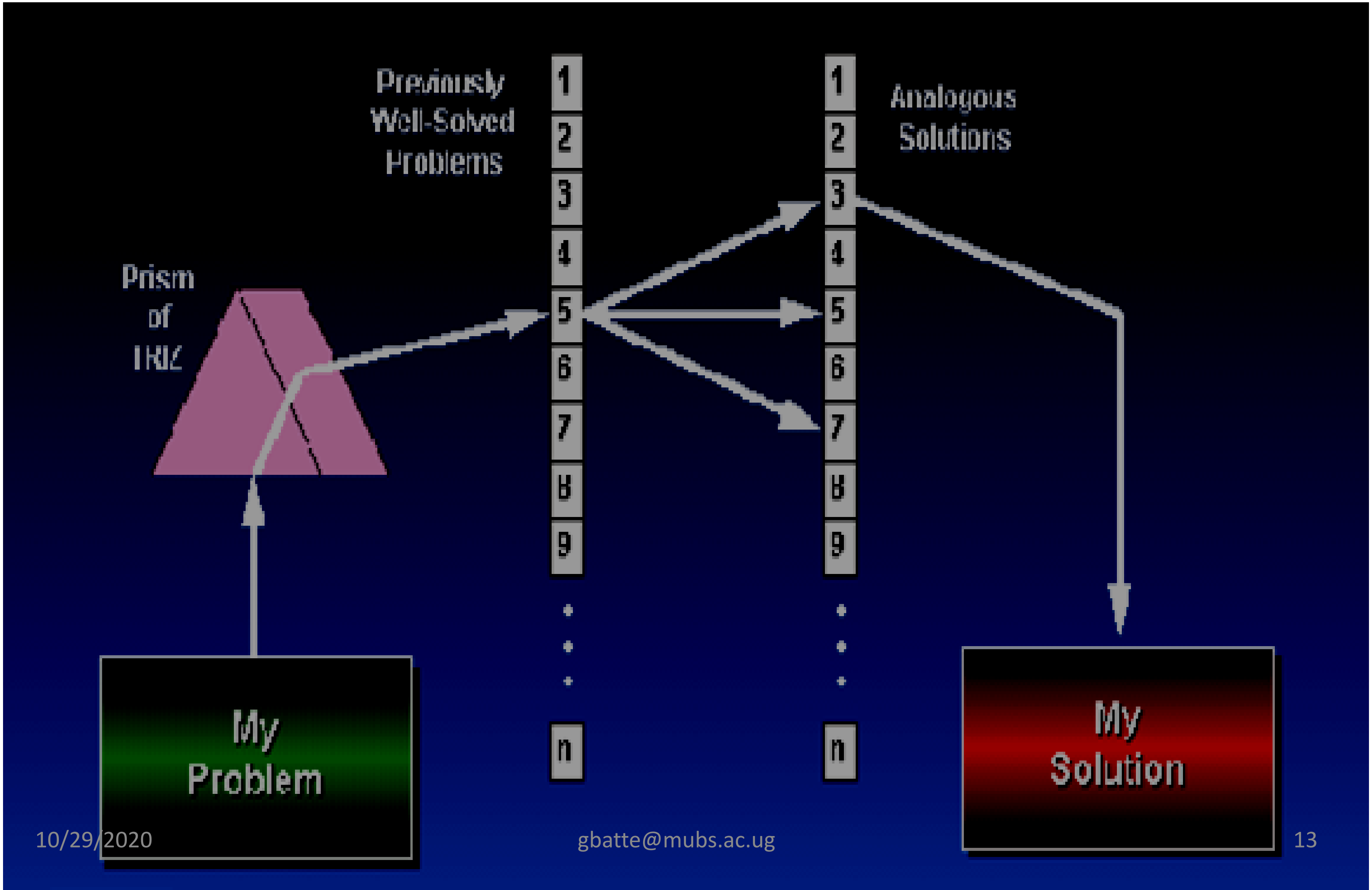
95% of the solutions had been solved before!

TRIZ – Theory of Innovative Problem Solving Principle (Teoriya Resheniya Izobreatatelskikh Zadatch)

Теория Решения Изобретательских Задач

- A systematic step by step procedure.
- Repeatable and reliable process
- Accesses the body of inventive knowledge
- Adds to the body of inventive knowledge
- Is familiar enough to inventors

The TRIZ approach



Ideal Final Result (IFR)

- The I imagined ultimate outcome of the problem solving process.
- Has the following 4 characteristics:
  1. Eliminates deficiencies of the original system
  2. Preserves advantages of the original system
  3. Doesn’t make the system more complicated (uses free or available resources).
  4. Does not introduce new disadvantages

ARIZ - Algorithm for Inventive Problem Solving

- Formulate the problem.
- Transform the problem into a model.
- Analyze the model.
- Resolve physical contradictions.
- Formulate ideal solution.

Inputs That Effect Innovation

Emotional & psychological based creativity methods

- Peer pressure
- Personality conflicts
- Dietary needs
- Energy levels
- Team dynamic
- Communication skills
- Emotional states

TRIZ creativity method

- structured problem definition
- contradiction identification
- Inventive Principles and Separation Principles
- Substance-Field Modeling
- Algorithm for Inventive Problem Solving

39 Characteristics.

- Qualities – Static & In Motion (6*2 > 12)
  - Dimension, area, volume, weight, durability, energy
- Physical Qualities (7)
  - Shape, strength, speed, pressure, force, brightness, temperature, power
- Performance Qualities
  - Stability, reliability, control complexity, system complexity
- Product outcomes (6)
  - Ease of use, ease of repair, harmful side fx, harmful factors, measurement accuracy, manufacturing accuracy
- Wastes (5)
  - Time, effort, material, materials used, information
- Process Characteristics (8)
  - Adaptability, manufacturability, productivity,, automation

40 Inventive Principles

- Organize (6)
  - Segmentation, merge, Abstraction (extract out), Nesting,
  - Counter weight, Asymmetry
- Compose (7)
  - Local Quality, Universality,
  - Homogenity, composites,
  - Spheroids, thin films, Cheap disposables
- Physical (4)
  - Porosity, Additional Dimension,, Thermal Expansion, Colour Changes
- Chemical (4)
  - Oxidate – reduce, inertness,
  - Transform states, Phase transition
- Interactions (5)
  - Reduce Mechanical Movement, Bring Fluidity
  - Equipotence, dynamicity, vibration
- Process (9)
  - Do it in reverse, ++ / --, continued action, repeated action, skip through, negative to positive
  - Prior Cushioning, Prior Actions, Prior Counter Actions
- Service (5)
  - Self service, intermediary, feedback,
  - use and retrieve, cheap copies

DEVELOPING PROTOTYPES - KEY RESOURCES FOR PRODUCT DEVELOPMENT

Prototypes

- A minimum viable product, representing the least amount of effort needed to run an experiment and get feedback.
- Creativity requires cycling lots of ideas. The more you invest in your prototype and the closer to “final” it is, the harder it is to let go of a concept that’s not working.
- Quickly and cheaply made prototypes enable keeping multiple concepts alive longer.
- Commonly used in almost all fields of engineering design
- Expresses how similar it is to the finished interface
- In prototyping, one has to plan to throw away

Prototype Fidelity

- Is an essential property of a prototyping technique.
- Refers to the level of detail
  - Low fidelity - Omits details
  - High fidelity - More like finished product
- Horizontal
  - In breadth implementation (covers most features with limited depth information)
  - Low-fidelity in horizontal might be missing many features
- Vertical
  - In depth implementation (how deeply each feature is actually implemented)
  - Low-fidelity in vertical may mean limited choices

Paper prototyping

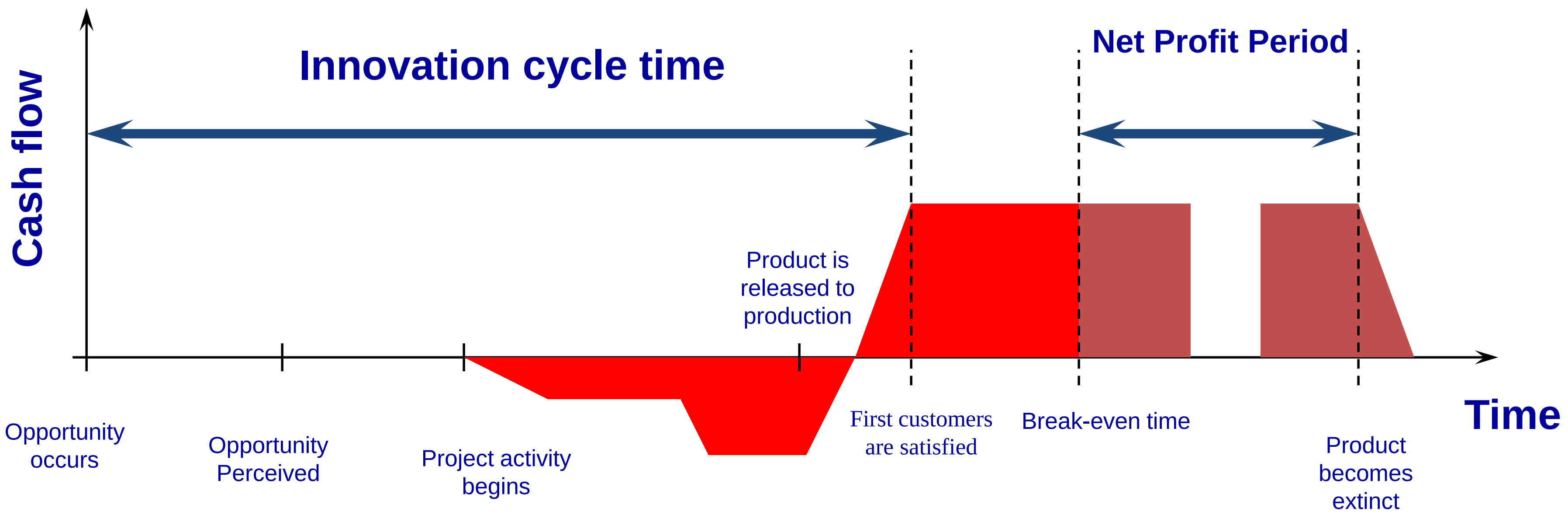
- **E**xcellent choice for early design iterations.
- Advantages
  - Faster to build – hand sketching is faster and easier
  - Easier to change - minimal investment– everything can be thrown away (except the design)
  - Focuses attention on big picture - Designer doesn't waste time on details - Customer makes more creative suggestions
  - Anyone can help - Only nursery skills are required
- What you can learn from it:
  - Conceptual model – whether users understand it.
  - Functionality – whether it does what's needed, Missing features?
  - Navigation & task flow – whether users can find their way around, and whether information preconditions are met
  - Terminology – whether users understand the important labels

Computer prototype

- Interactive software simulation
- High-fidelity in look & feel
- Low-fidelity in depth
  - Paper prototype had a human simulating the backend; computer prototype doesn't
- What you can learn from it:
  - Everything you learn from a paper prototype, plus:
  - Screen layout that is clearer
  - Colors, fonts, icons, other elements
  - Interactive feedback

Physical prototypes

ADMINISTRATIVE CYCLE OF THE PRODUCT



From: Accelerated Innovation by Marvin Patterson

TECHNIQUES FOR NEW PRODUCT DEVELOPMENT

Product development

- Is a learning process - one "gets to know" the product's characteristics during NPD
- A knowledge managing process
- **Development drivers: wish, want, and need**
- Requires a Business possibility/opportunity
  - **The need for speed - shorten development** through the **use more appropriate methods**

Need based product development

- Characterized by detailed plans and rigid methods arising from a control culture.
- Provides well-organized workplace and checklists preferred by most people.
- **Serial/sequential/ relay product development**
  - Different units are responsible for each stage in the process - oldest PD methods.
- **Semi parallel product development**
  - To increase speed, activities are pushed together so that concept development starts before market research is finished.
- **Parallel product development**
  - Simultaneous start and execution of activities in all departments.
  - **Concurrent Engineering** - product design and manufacturing process development occur concurrently in an integrated fashion, using a cross-functional team.
  - **Integrated Product Development, IPD -** integrated teams with members from the four main functions in a company (market, design, production and administration) are used for the development of new products,
  - **Stage-and-gate processes:**

Dynamic Product Development, DPD

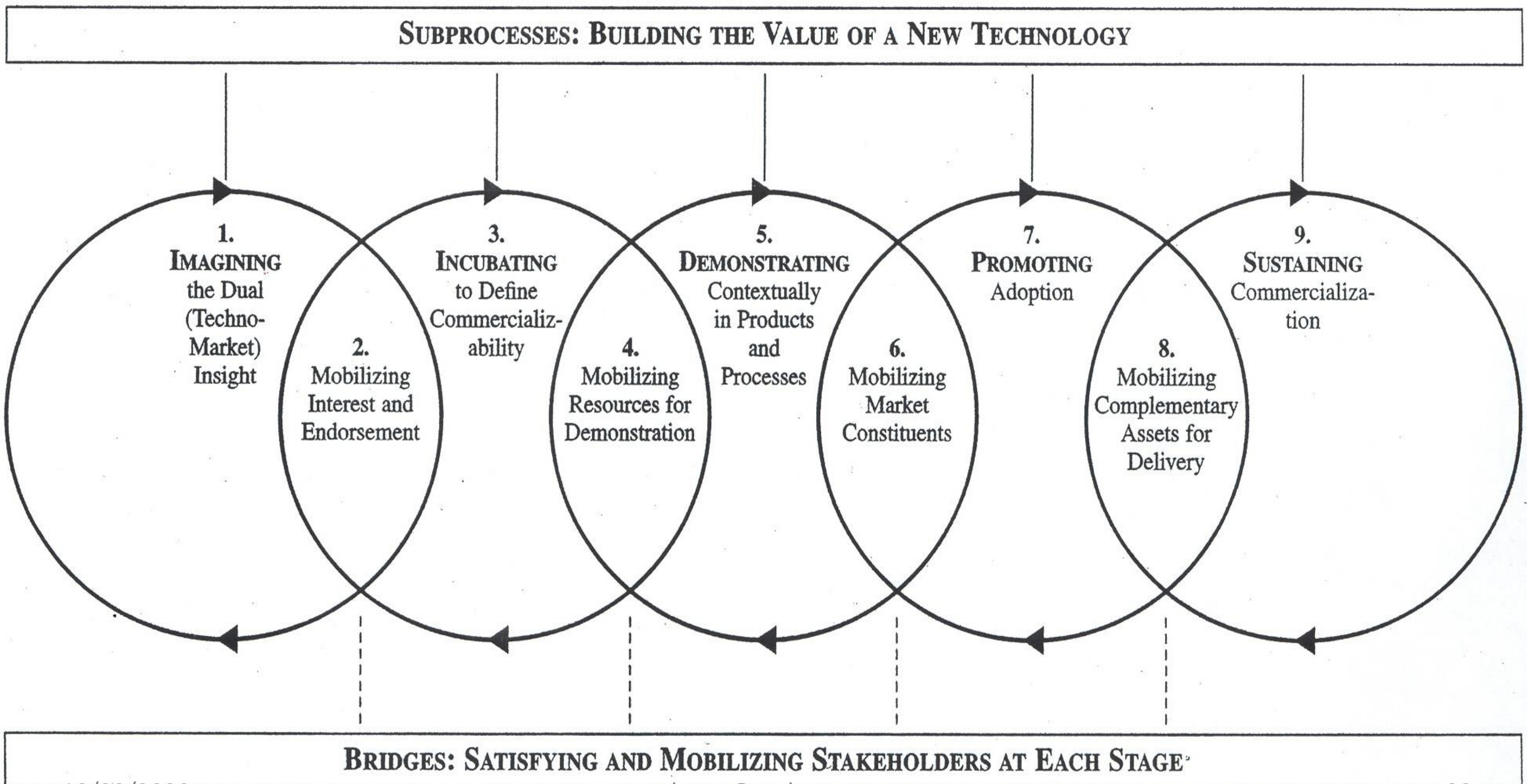
- No declaration of what to do and in what order - opportunistic and continuous adaptation to ever changing circumstance.
- No, or low-level rules of thumb or tactics
- Not yet gained widespread popularity (lacks strict controls).
- Concept is developed continuously in parallel with product and production process development.
- A clear and living vision of the desired results is communicated and encompassed by all involved.
- Uses empowered collocated cross-functional project teams. Team size is continuously adjusted to the need of the work at hand.
- Make many small, and few large decisions.

Complexity Aspects of Product Development

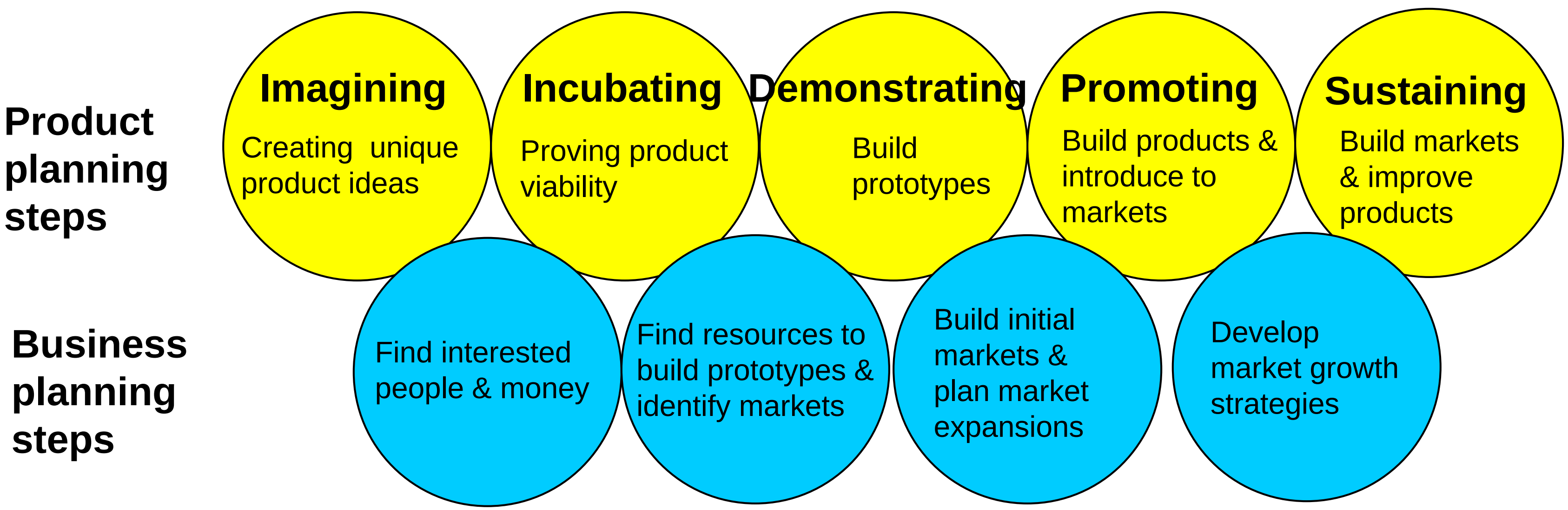
- NPD is a complex system because it is an open system, incompressible, and made up of a large number of dynamically and nonlinearly) interacting non-decomposable elements (McKelvey 2004). This has several ramifications:
  - It is difficult to associate effect with cause, making prediction virtually impossible.
  - System history plays an important role, and affects system evolution. NPD is dependent on past reality.
  - It can not be controlled, but can only be influenced.
  - Self-organization leads to emergent properties and efficiencies unattainable with top-down direction.
  - Informal structures self-organize, emerge, and persist despite changes in the organization.
  - Understanding requires multiple perspectives on the nature of the system.
  - Perfect information will not remove uncertainty.

- Culture determines what strategies are possible or acceptable. Then plans are born out of accepted strategy. Plans are transformed into work. It follows that our culture, our outlook, our view of the world is important for the way we perform product development. The more so when we understand that our paradigm and its invisibility, in force of it being a paradigm, is the hardest prejudice to fight and therefore potentially the most dangerous.
- If we believe in a linear, ordered world where simple causation exists, then planning is indeed possible, and machinelike action will yield desired results. The human mind seems to favor this worldview and humans appear to be born with an intuitional idea of simple causation (Pinker 2002). Scientific findings in the last decades, however, have given us a new understanding and appreciation of the world as a complex system. iew.

The Process of Technology Commercialization



Technology Commercialization Process



Resource Needs

People	Small	Moderate	Medium	Large
Physical	None	Moderate	Medium	Large
Financial	None	Moderate	Large	Largest