

Innovation and Problem Solving

MECH3661/AERO3660/MECH 2660

Lecture 8

Purpose of “Innovation”

- Invention plus distribution
OR
- Invention plus commercialisation
- Frequently progression with diminishing novelty from *radical* to *evolutionary*. I.e, incremental improvements
- Not only technological – can be “service factors”
 - Wright brothers revolutionised travel with powered flight
 - Fedex and UPS transformed mail services with no new technology. Nowdays it is internet based commerce
 - Dell direct to consumer marketing of PC’s represents a marketing innovation

One can also categorise innovation based on how it impacts the entity developing it

Technological capabilities		Preserved	Destroyed
Market capabilities	Preserved	Regular	Revolutionary
	Destroyed	Niche	Architectural “Paradigm shift”

The greater the innovation, the higher the risks, but the greater the reward

- Lowest innovation: “me-too” drugs target a validated disease and offer an incremental benefit (efficacy, convenience, cost, safety). High probability for success 20-30%
- Medium innovation: first in class drug addressing a new target and offering a significant benefit, probability of success 5-10%
- High innovation: first in category eg gene therapy or antisense RNA offering significant benefit. Probability of success < 1%

List some of the Innovations that have changed the world ???



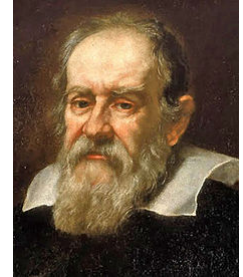
Some of the Innovations that have changed the world



- Language
- Clothing
- Control of fire
- Agriculture
- Domestication of animals
- Boat
- Wheel
- Plough
- Writing
- Refinement of metals
- Arch
- Gunpowder
- Steam engine



- Telescope
- Microscope
- Vaccination (eradication of small pox)
- Internal combustion engine
- Reinforced concrete
- Flight
- Harnessing nuclear power
- Telephone
- Antibiotics
- Radio
- Television
- Computer
- DNA technologies
- Space exploration



Some Innovations that would **change**
the World ??

Your suggestions.....

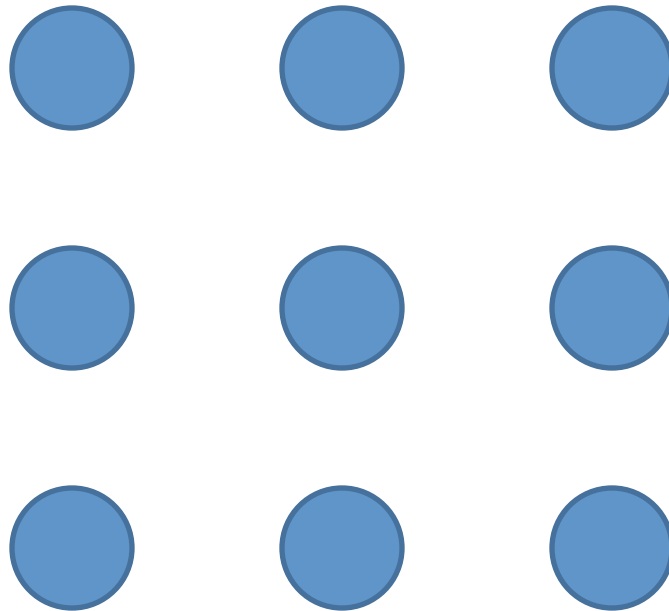
Some Innovations that would Change the World

- Cure for AIDS affordable for the third world
- Commercial (hot or cold) Fusion Reactors
- Tissue Engineered Organs Suitable for Transplant
- Practical zero “net cost” renewable energy
- Effective gene therapy , to defeat cancer risks
- Effective control of limited renewable resources
- Direct bidirectional communication: Computer to Brain
- Room temperature superconductors

What is required for Innovation?

- **Domain & Environment - Relevant Skills**
 - Technical skills, talent, knowledge, source of funding
- **Creativity-Relevant Skills**
 - Cognitive style/way of thinking, awareness of ways to generate ideas, work style conducive to translating ideas to actions
- **Task Motivation**
 - Interested in a task for its own sake, not for external rewards (these tend to inhibit creativity) ie, an inventor seeking to win an award, may be less creative than one seeking to pursue a novel idea

Can you draw four or fewer straight lines without raising your pen and pass through all circles?



Stages of Creativity

- **Preparation**
 - gathering information, defining task, generating alternatives, seeking and analysing related data
- **Incubation**
 - Subconscious mental activity and divergent thinking to generate and explore unusual alternatives
- **Illumination**
 - Gaining new insight – the Eureka moment
- **Verification**
 - Ideas tested to evaluate validity & repeatability

This process is **typically** cyclical or iterative

Techniques for Enhancing Group Creativity

- **Brainstorming**

- Generate as many ideas as possible without evaluation
- Four rules: No criticism, freewheel, offer many new ideas, improve on ideas already offered
- Can be enhanced by computer assisted, rather than face-to face interactions

Techniques for Enhancing Group Creativity (continued)

- Nominal Group Technique
 - Individual members independently prepare lists of ideas on a problem
 - Each member presents ideas in a round-robin session without discussion (if one idea triggers another its presentation must wait to a later cycle)
 - When all ideas listed, members discuss them to clarify and evaluate.
 - Members silently and independently vote on the alternatives by rank-ordering or rating.
 - The final result comes from pooling individual votes.

This method is good for generating many options while maintaining group satisfaction/inclusion

The Oracle of Delphi 9th Century BC-389AD



560 BC Croesus sent to the oracle asking "Would his monarchy last long?" The Pythia answered: "Whenever a mule shall become sovereign king of the Medians, then, Lydian Delicate-Foot, flee by the stone-strewn Hermus, flee, and think not to stand fast, nor shame to be chicken-hearted."

Croesus thought it impossible that a mule should be king of the Medes and thus decided to attack Persia.

However, it was he, not the Persians, who was defeated, fulfilling the prophecy. He apparently forgot that Cyrus, the victor, was half Mede (by his mother), half Persian (by his father) and therefore could be considered a mule. Herodotus, "Histories" Penguin Classics, Harmondsworth.

Delphi Method

- RAND Corporation developed the Delphi method in the 1950s, originally to forecast the impact of technology on warfare.
- The method entails a group of experts who anonymously reply to questionnaires and subsequently receive feedback in the form of a statistical representation of the "group response," after which the process repeats itself.
- The goal is to reduce the range of responses and arrive at something closer to expert consensus. The Delphi Method has been widely adopted and is still in use today.

Delphi Method

- The Delphi method solicits the opinions of experts through a series of carefully designed questionnaires interspersed with information and opinion feedback in order to establish a convergence of opinion..
- The that “consensus” is used as a foundation for an innovation “road map”

Successful introduction of innovative products

Adoption of innovative products is not uniform by consumers who can be divided as follows:

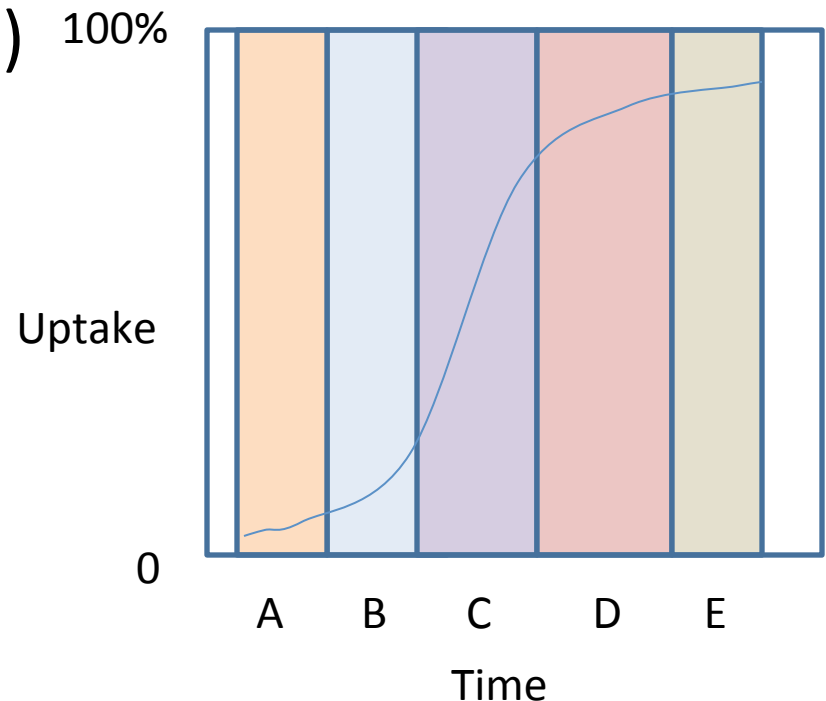
A. Innovators or lead users(2.5%)

B. Early adopters (13.5%)

C. Early majority (34%)

D. Late majority (34%)

E. Laggards (16%)



Lead users

- Know the need for the product
- Have a problem the product addresses
- Can contribute the initial design
- Provide a knowledge base for developing the product
- Can be used for testing and evaluating prototypes

Lead users

- Suggested process for innovation
 - Identify a market of technology trend (eg, maybe consider Delphi method) sound out, identify and collaborate with ***potential lead users***
 - Identify lead users (especially if opinion leaders)
 - Analyse the lead users needs data (as distinct from wants)
 - *Project/translate the lead-user data* to the market of interest with incentive for early adopters

Example new potential drug for cancer treatment

- Identify leading oncologists with a strong interest in the targeted cancer
- Engage them in defining the necessary outcomes in terms of dosing and efficacy, and the best initial patient group for testing
- Employ them to execute the first clinical trials
- Organise for these oncologists to present findings in professional meetings
- Employ these oncologists to champion the product through meetings with regulators to assist in gaining marketing approval
- Employ them to introduce the product to the broad customer base.

Taking innovation from prototype to product in an organisation

- Requires
 - A champion – often quite a junior level employee who can commit to the product concept
 - A mentor – to guide the champion through the corporate minefields
 - A sponsor – Someone higher in the company who has power to direct resources
 - A gatekeeper – someone who knows the marketing or technological issues who can guide the champion in developing a business case that will enable a corporate decision to back the product.

Obstacles to innovation as an individual

- Problem : need resources to develop credibility for product, but funding bodies want credibility to justify investment
 - Start with own personal assets \$50,000
 - Source funds from family and friends \$100,000
 - Individual investors (angels) \$1,000,000
 - Venture capitalists \$50million (want 25-51% ownership)
 - IPO (initial public offering)
 - Fills need for operating capital
 - Creates a public market for acquisitions
 - Creates a public market for entrepreneurs shares
 - Improve the debt-equity ratio

Problems in decision making with innovative products

- Uncertain probability of success in producing product
- Little information or public data on potential market
- Limited resources for development VS existing players
- Significant pressure for rapid progress & meet milestones (from sponsors, investors, etc)
- Challenge to maintain high quality decision making in the face of uncertainty
- Critical to rationally estimate probabilities of outcomes and establish “go/no go” points

The problems of “Groupthink”

- Unspoken rules governing acceptable contributions or behaviour by group members can impact quality of group function

The Challenger disaster

Groups are generally superior to individuals in problem solving. However, group dynamics can reverse this order

- What led the scientists and engineers at NASA and Morton Thiokol to launch the space shuttle challenger even though they had information that extreme cold would effect the performance of critical seals in the fuel tanks?
- “Groupthink” describes the propensity of cohesive groups to avoid topics that cause disagreements or might unsettle discussion.

8 Aspects of Groupthink

- Illusions of vulnerability – excessive optimism
- Collective rationalisation – discount warnings
- Belief in inherent morality – belief in rightness of cause
- Stereotyped view of out-groups – competitors are “enemies”
- Direct pressure on dissenters – pressure to prevent arguments
- Self-censorship – doubts not expressed
- Illusions of unanimity – majority opinions assumed to be unanimous
- Self appointed ‘mind-guards’ – protect the group and leader from problematic information

Improving Group Function by breaking Groupthink

- Increase diversity – training, background, ethnicity etc
- Designate a “Devils advocate” – person licenced by group to raise concerns, ask probing questions of underlying assumptions.
- Use dialectical inquiry – ask some members of group to assume opposite sides of an argument

Summary

- Innovation is integral and necessary to the long term success of most organisations
- Quality of innovation management separates the industry leaders from the rest
- Innovation can be individually sourced, but can be generated efficiently in diverse competent groups if structured for creativity
- There is no innovation must translate to execution of on an idea or concept into a valuable product/service (offering)