



Innovation Management

Introduction

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Innovation Productivity



- *The prime question regarding innovation is its productivity.*
- Not its excitement,
- Not its brilliance,
- Not its shining.
- Innovation is not a decorative feather on one's hat.
- *Innovation is judged and appraised by the effort needed to achieve an innovative goal.*

Innovation Management



- Productivity must be managed.
- Innovation Productivity must be managed.
- But some say that innovation is rooted in creativity, and creativity defies management...
- This mistaken attitude resulted in drawers packed with creative ideas that go nowhere.

Innovation, Creativity, Management



- Creativity is essential but not sufficient
- Management lights a durable fire from the creative spark.
- Management brings together the flint stones to make a spark more probable.
- Creativity is whimsical, so its management must be highly adaptive, responsive, nimble.
- Adaptive management requires Feedback Control
- Feedback control requires effective, objective measurement of the state of innovation progress.

Innovation Management – *new vision*



- Innovation management was considered as one of many aspects of management, covered by the now common principles of good management.
- The New Vision is that Innovation Management is a breed apart. It must be practiced on its own terms.

McKinsey II



- Early in the last century James O. McKinsey was a lonely voice arguing that management practice may be regarded generically, applicable to many different matters and projects.
- Today management science is a respected school in every major university.
- This century innovation management is presented as a generic practice, and it also takes time for it to penetrate.



James O. McKinsey

Why is Innovation Management Unique?



- Nominal management wrestles with how to handle, configure, organize what we have and know.
- Innovation is the process of converting the unknown into known. A much bigger management challenge.

Innovation Defined



- The process of acquisition of knowledge relevant to achieving an innovative goal.
- An innovative goal is a goal that requires acquisition of knowledge not yet realized.
- An innovative goal may be unspecific, or specific (to 'know more', or to 'cure a disease').
- We focus on specific innovative goals.

R&D Limited Innovation



- Innovation is a universal human trait, and springs out everywhere, usually with spontaneity rather than rigorous management.
- We limit ourselves to innovation when it is cast within a research and development (R&D) project.

R&D



- Began in the late 19th century in Germany, bloomed throughout the 20th century in the US.
- A well-motivated, generally multi-participants, well-organized effort to achieve a well-stated objective, using reasonable resources.

Management & measurement



- To manage a process, one needs to measure its progress.
- An innovative (R&D) project is a process where knowledge is being acquisitioned.
- How to measure knowledge acquisition?

Measuring Knowledge



- **By results**

“if you drive a car, you know how to drive”

- **By Information**

Based on Claude Shannon theory of information.

- **By the Knowledge Acquisition Effort**

“if you studied 10 years you must know it all”

- *By the credibility of the estimate of the effort needed to achieve the stated objective.*

Measuring Knowledge by Results



- **Binary Limitation:** either full knowledge not available, or full knowledge is available. No progress tracking (needed for management)
- **Trailing:** after all relevant knowledge is available, some construction and implementation is called for. It may last long, so knowledge acquisition is recognized much later.

Knowledge & Information



- Knowledge is conveyed through information.
- Information is conveyed through a string of bits
- The information content of a string of bits has been formulated by Claude Shannon.

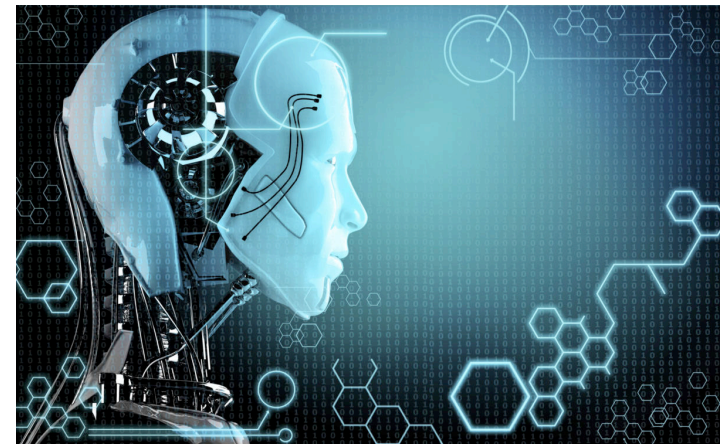
Entropy:

$$H = - \sum p(x) \log p(x)$$

Entropic Innovation Management (EIM)



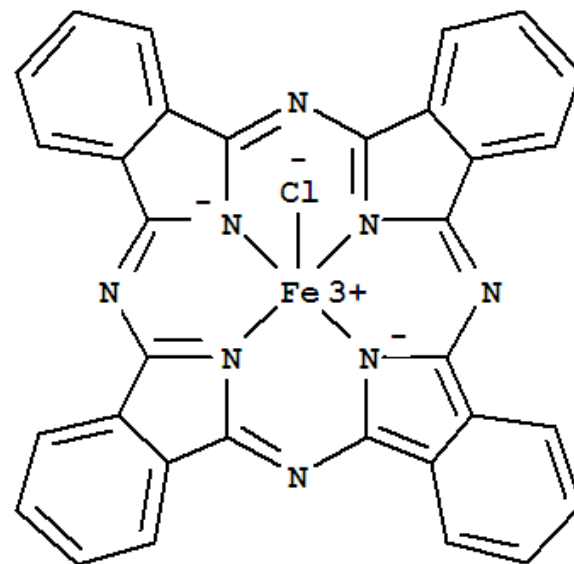
- Since all knowledge can be reduced to a string of bits, a credible estimate of the size of the string, defines the innovative knowledge as a selected option in a finite set.
- The advent of AI and Quantum Computing may allow for “Smart Brute Force” Innovation Management Strategy.
- EIM may revolutionize the innovation process, offer an overwhelming advantage to its pioneer. *Stay Tuned!*



Innovation Security



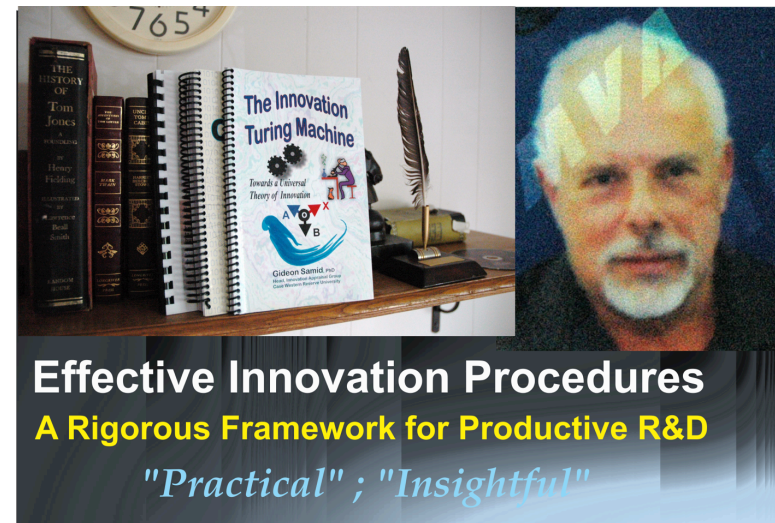
- Claude Shannon Entropy found good use for innovation security.
- If your innovation leaks to your competitor, you lose its advantage.
- Technology spying has mushroomed domestically and internationally.
- Chemistry is spy-easy, molecular structure is entropy loaded.



Estimate Credibility Innovation Management (ECIM)



- Estimate Credibility (EC) is an instant continuous metrics, enabling low-delay feedback configuration, leading to optimal innovation management strategy.
- Smartly applied ECIM will increase creativity output!
- Ahead we delve into ECIM.



The Innovation Effort



- Innovation happens under a force, it requires effort.
- Innovation Effort has abstract qualities (e.g. motivation, inspiration), and number-expressible qualities (e.g. cost, time).
- Most of the literature, seminars, workshops focus on the abstract qualities of the innovation effort. We focus on the specific.

Units of Innovation Effort



- **Exhaustible Resources**
 - **Generic:** Money, Time, Common Talent, Supplies, Equipment.
 - **Specific:** Special Skills, Uncommon supplies, Uncommon Equipment
- *Money and Time – basic Units for Innovation Effort*

Cost-to-Complete, Time to Finish



- At any point of the innovation project there is a cost-to-complete the project, C , and a time to come to the finish point, T .
- C , and T are known exactly when the project is successfully completed (unless the accounting was deficient)
- At time point t , before the project is finished, C is estimated by $C^*(t)$ and T is estimated by $T^*(t)$

Credibility of an Estimate



- Every Estimate comes with a credibility feature, expressing the likelihood for the estimate to be helpfully close to the true value.
- An Estimate with credibility $V=0$ is useless.
- An Estimate with credibility $V=1$ is no Estimate
- Every Estimate, X , comes with a credibility measure $V(X)$: $0 \leq V(X) \leq 1$

The Credibility of the Innovation Estimate Measures the State of Innovation



- The Higher

$$V(C^*(t)),$$

- and the higher

$$V(T^*(t))$$

- – the more advanced the state of innovation of the appraised project.
- *This is the principle statement of the Innovation Acceleration Methodology.*

Cost Estimation Fundamentals

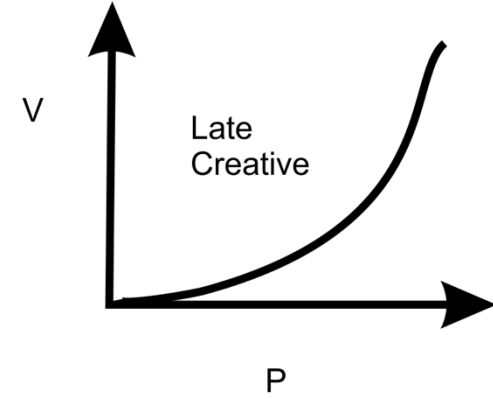
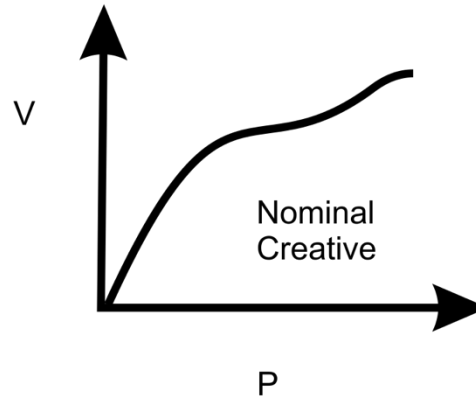
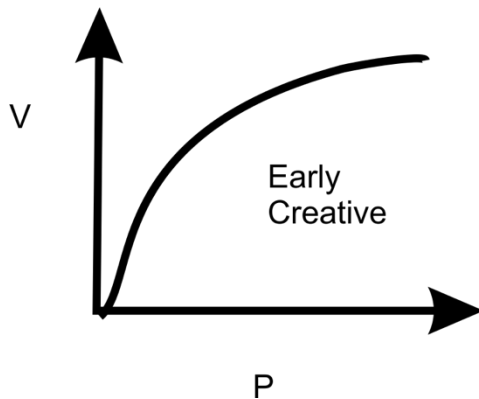


- Cost Estimation C^* is associated with an error E defined as $E = |C - C^*|$, where C is the eventual actual cost.
- E is comprised of misapplied knowledge, (EK) and unapplied relevant unknown (EU)
- $E = EK + EU$
- Assuming $EK=0$, then $E = EU$.

$$\text{Lim } E (U \rightarrow 0) = 0$$

- Therefore E measures the amount of relevant unknown which needs to be converted to known for the innovative objective to be achieved.

Innovation Project Progress

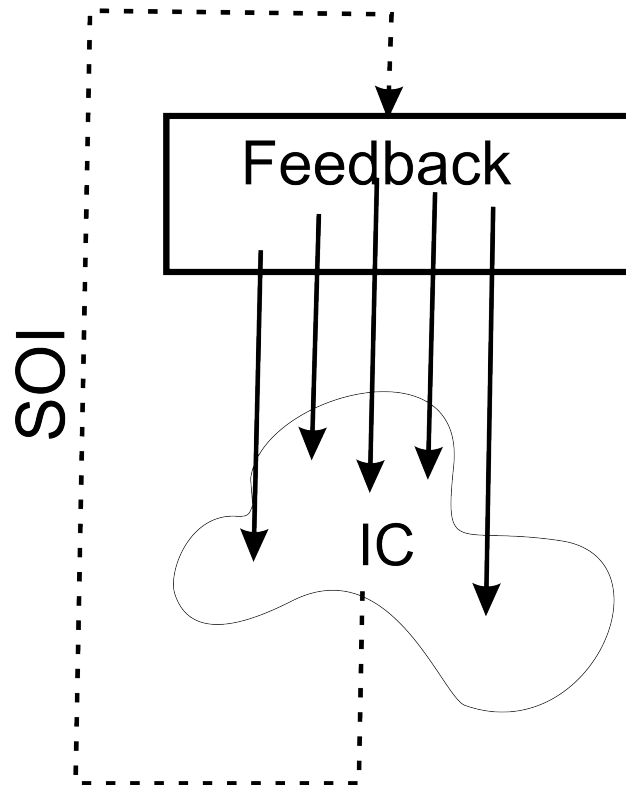


Real-Time Measurement of the State of the Innovation Project allows for Rational Innovation Management Strategy, leading the Accelerated Innovation and to a Competitive Advantage.

Adaptive Innovation Management



Adaptable Innovation Strategy



The less accurate the appraisal of the state of innovation progress, the farther from optimal the management of the project

Common Mistakes



- Poorly credible estimates of Innovation Projects lead to (i) rejecting good projects that are over-estimated, (ii) under-funding of good projects, that are under-estimated, (iii) wasting resources on ill-advised innovative moves.
- Relying on poor-credibility subjective innovation estimates allows for innovators to hide the true innovation state from themselves and from other stakeholders.
- VC: “90% of progress happens in 10% of the time. The last 10% takes 90% of the time...”

Innovation Project: Formal Definition



- Innovation Project (IP) is a set of actions taken to resolve an innovation challenge.
- To resolve an innovation challenge some relevant unknown, U , must be turned into known, K ($U \rightarrow K$)
- An Innovation Project is an effort to increase the credibility of the estimate of the effort needed to resolve the Innovation Challenge.

The Project Environment

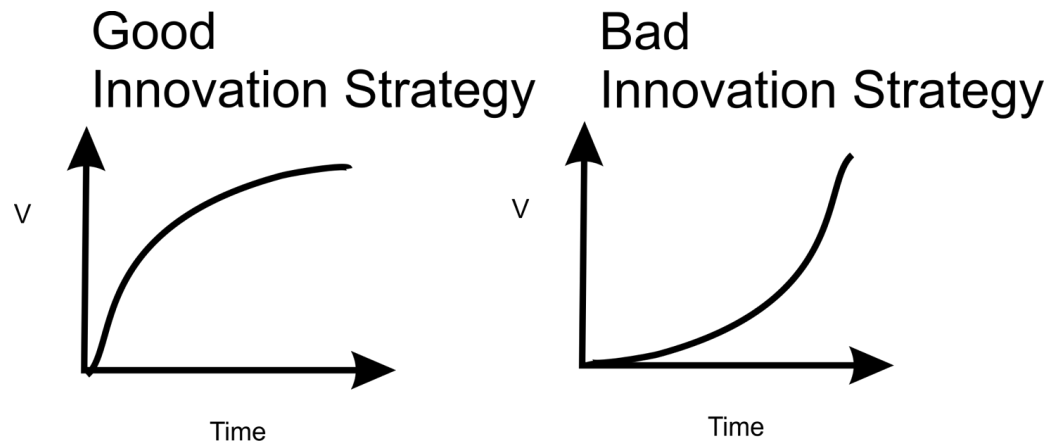


- An innovation project is fitted in an encompassing environment with a larger goal supported by the project.
- The funding for any innovation project is justified only if the committed funds cannot better support the environmental goal.
- A credible estimate of C2C and T2F is necessary for funding decision.

Pre-Funding Strategy



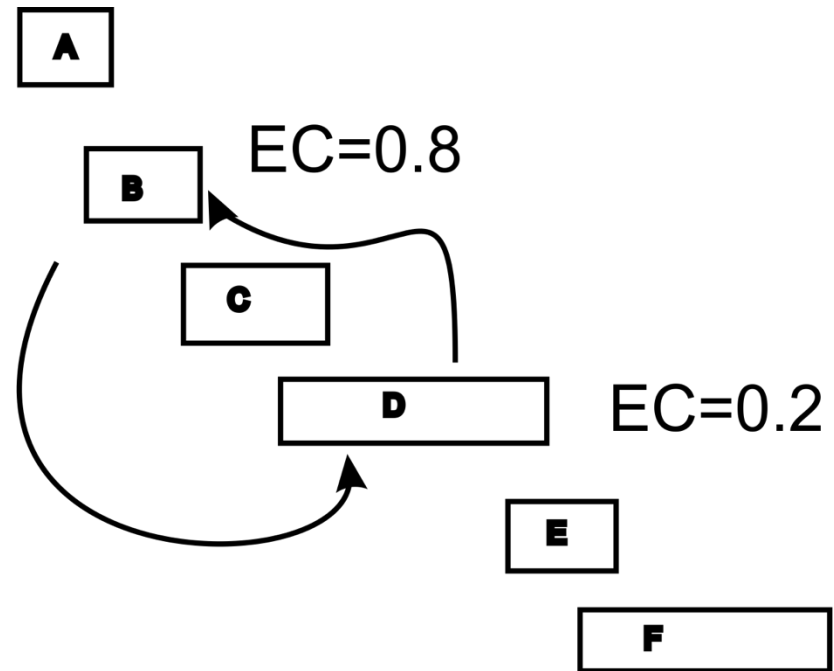
- Present the prospective funding source with estimate of cost-to-complete, and time-to-finish the project for which funding is requested.
- Provide an objective credibility attribute for the submitted estimate.
- Assure the prospective funding source that the project will be prosecuted so as to increase the credibility of the estimate as fast as possible.
- Thereby the unspent funds can be re-allocated if the IC turns out to be more challenging.



Post Funding Strategy



- Identify hidden ‘cost mines’
- Schedule work to prioritize the “mines”.
- Rush to report an estimate setback.



E.g.: membrane with no structural strength, mixing cost for viscous fluid, vibration damage for electronic circuits.

Basic Estimation Practice

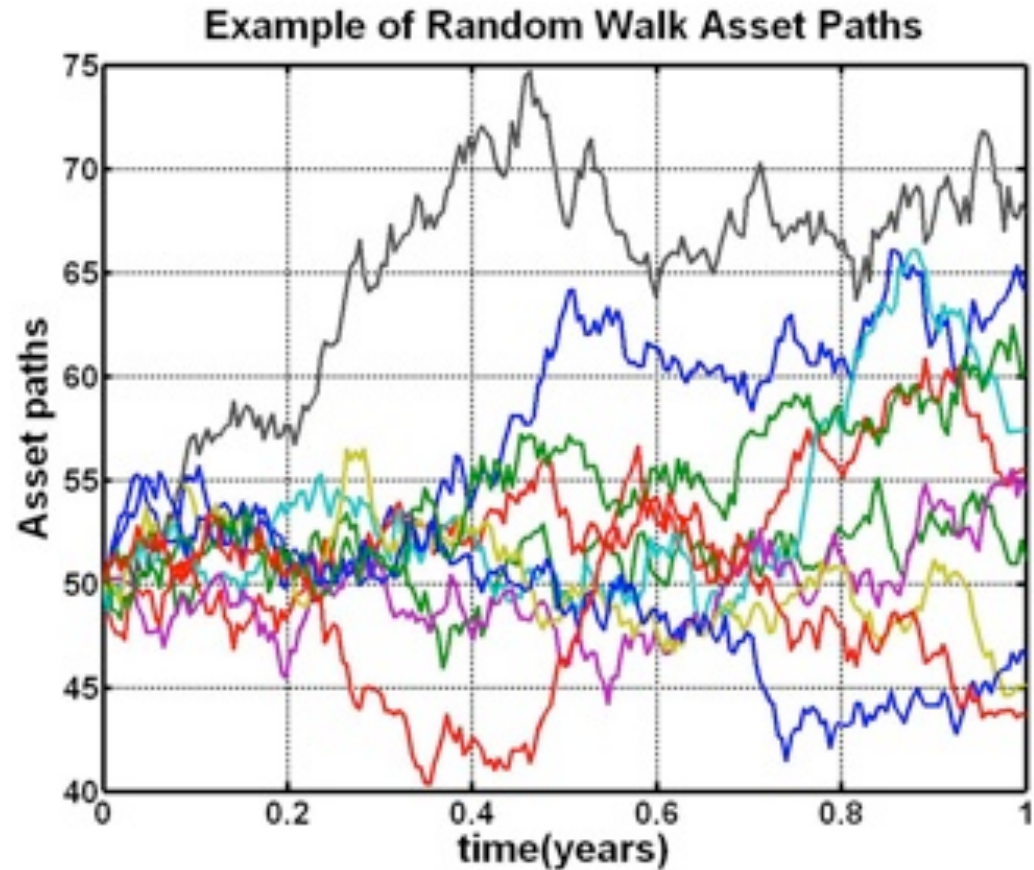


- **Most Basic:** come up with your best guess; characterize: very credible, medium credible, poorly credible.
- **Most Basic Plus:** come up with a useful range, then estimate the chance the cost will fall within the range: high, medium, low.
- **Most Basic Plus Others:** An average of Most Basic Plus over a knowledgeable group of estimators.

Advanced Estimation Practice



- Monte Carlo
- BiPSA
- Big Data
- AI



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