Evidence-based Management of R&D Projects Intending Market Deployment

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What's this presentation about?

It describes an evidence-based framework to facilitate the process underlying the transfer of R&D outputs from one entity for their adoption as inputs by others:

- This process is typically treated as a "black box."
- Corporations initiate internal R&D for a reason, and need similar reasons to transfer in R&D from external sources.
- Scientists and engineers want a justification for the required diligence regarding downstream requirements.
- Laboratory R&D project managers "need to know" how to be good stewards of newly created knowledge, and how to present a persuasive value proposition to others.

Innovation & Impact

- Traditionally, each sector defined terms in own narrow context, unconcerned with downstream market activities or broader societal benefits, comfortable in status quo budgets and paradigms. But that applecart is tipping . . .
- National Science Board (2012) – "*Innovation is defined as the introduction of new or significantly improved products (goods or services), processes organizational methods, and marketing methods, in internal business practices or in the open marketplace."* (OECD/Eurostat, 2005).

Commercial Innovation Markets

Industry routinely delivers technological innovations to society through internal capabilities, accessing external capabilities as necessary:

Market Opportunity

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Corporate Research, Development & Production

↓

Marketplace Deployment of Products and Services

Government R&D Laboratories

Public tax dollars are allocated to generate new knowledge outputs embodied in 3 different *states*:

- Scientific research ➔ *Conceptual Discovery Output* (*know what ?*)
- Engineering Development ➔ *Tangible Invention Output* (*know how ?*)
- Industrial Production ➔ *Commercial Innovation Output* (*know why ?)*

– New knowledge outputs in any state may or may not be perceived as valuable by prospective transfer partners.

CONCEPTUAL DISCOVERY STATE

Labs conduct scientific research (basic, fundamental, curiosity-driven) to expand the base of fundamental knowledge.

Need for fundamental knowledge

↓

$$ to Agency Laboratory/Team

↓

Scientific Research (Basic)

↓

Conceptual Discoveries

↓

Agency Use & Journal Publication

↓

Socio-Economic Value ???

TANGIBLE INVENTION STATE

Labs conduct scientific research (applied, oriented)
AND engineering development to transform conceptual discoveries into operational prototypes – *'proof of concept'*.

Need for breakthrough prototypes

↓

$$ to Agency Laboratory/Team

↓

Applied SR & Experimental ED

↓

Proof of Concept Prototypes

↓

Agency Use & IP Claims

↓

Socio-Economic Value ???

“Innovation” Impact implies Utility

Public support for investment in technology-based *innovations* grounded in 3 expectations:

✓ New/improved devices/services with economies of scale that contribute to societal quality of life.

✓ Sufficient return on investment through sales to sustain company, pay taxes and compete globally to generate new net wealth.

✓ Benefits realized in short-term (5–10 yrs).

Innovation’s context is Societal Impact via Commercial Marketplace.

Commercial Market is path to Utility

- Industry survives in competitive system by translating knowledge into market utility through Production methods (beyond R&D).
- Utility = Money to Seller / Function to Buyer.
- No $ale – Research discoveries are freely published and globally disseminated, while Development prototypes lack commercial hardening or economies of scale.

R and D outputs ≠ Market Innovation.

So What is Path To Transfer?

- *What do R&D project leaders need to know?*
- *What best practices exist to link sponsored R&D to external product or service creation?*
- *What models, methods and metrics help plan, manage and monitor such transfer efforts?*
- *How do the activity stages within product/service creation link with critical decision gates?*
- *How to treat knowledge disclosures to balance scholarly, commercial and public benefit goals?*

Need to Knowledge (NtK) Model

- ***Orientation*** – Actors engaged in innovative R&D projects "need to know": Problem/Solution; Methods/Outputs; Stakeholder Roles; Goal in context of intended Impact.
- ***Integration*** – Product Development Managers Association (PDMA) new product development practices (*implementation*); Canadian Institutes of Health Research (CIHR) knowledge to action model (*communication*).
- ***Validation*** – Stage-Gate structure populated with:
  - Supporting evidence (1,000+ excerpts) from scoping review of academic and industry literature: 
  - Links to validated tools for completing recommended technical, market and customer analyses: 

Need to Knowledge (NtK) Model for Technological Innovations

Phases	Stages and Gates
Discovery (Research)	Stage 1: Define Problem & Solution
	👍 👎 ?
	Stage 2: Scoping
	👍 👎 ?
	Stage 3: Conduct Research and Generate Discoveries → Discovery Output!
Invention (Development)	*Communicate Discovery State Knowledge* 👍 👎 ?
	Stage 4: Build Business Case and Plan for Development
	👍 👎 ?
	Stage 5: Implement Development Plan
	👍 👎 ?
	Stage 6: Testing and Validation → Invention Output!
Innovation (Production)	*Communicate Invention State Knowledge* 👍 👎 ?
	Stage 7: Plan and Prepare for Production
	👍 👎 ?
	Stage 8: Launch Device or Service → Innovation Output!
	Communicate Innovation State Knowledge 👍 👎 ?
	Stage 9: Life-Cycle Review / Terminate? 👍 👎 ?

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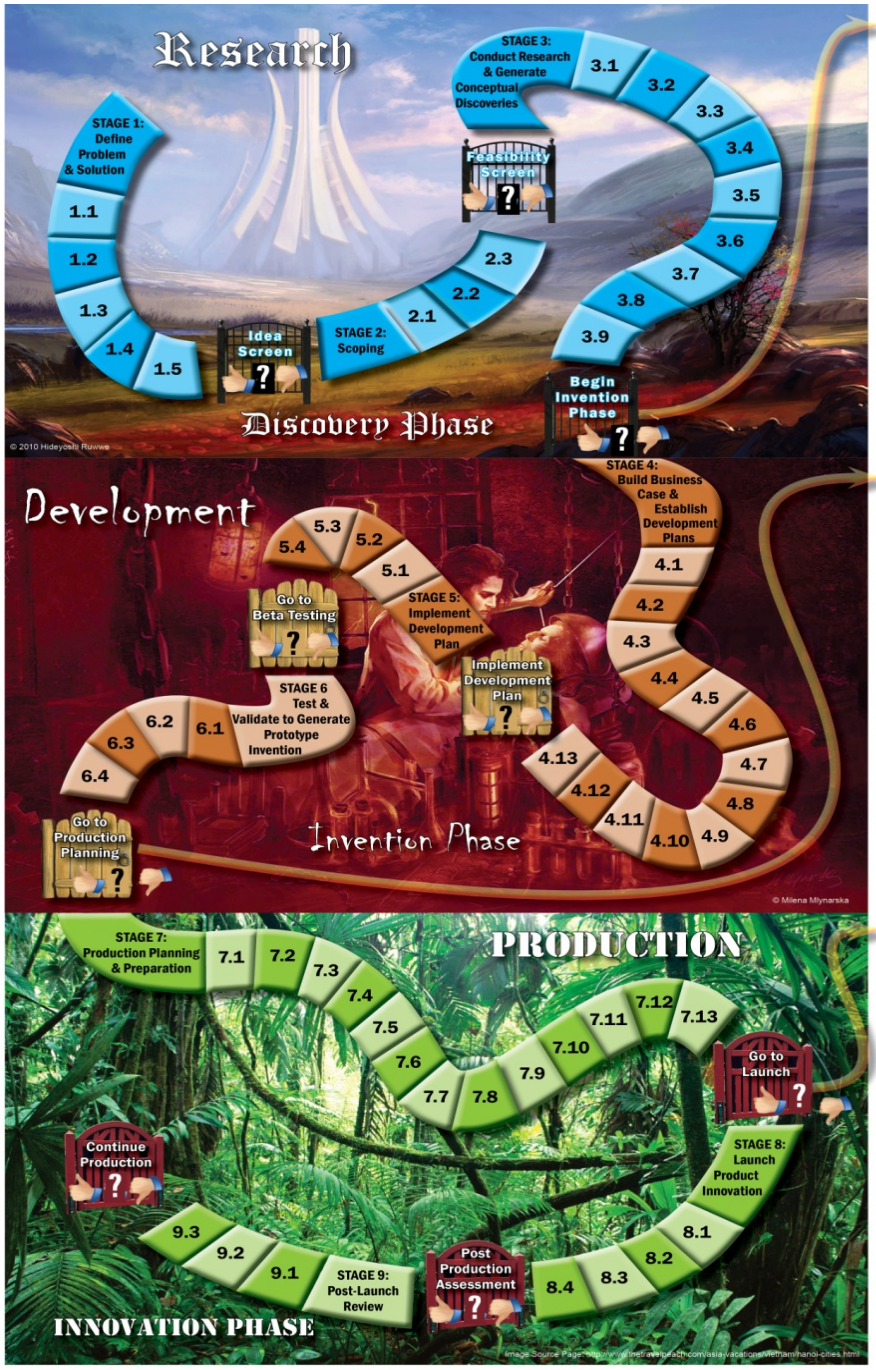
"Gamification" of Technological Innovation

Progress may be circuitous and iterative, punctuated and prolonged, risky and unpredictable.

Yet, it must be deliberately and systematically planned, implemented and managed.

Serendipity is not a plan!



TT Lessons from Literature

- Literature from both Industry and Academia converge on *best practices* in new product development, where due diligence supplants *ad hoc* approaches and objectively tests *subjective* assumptions of value.
- Excerpts cluster differently for each Phase of R/D/P, but the topics of *Cross-Functional Teams* & *Analytic Tools* dominate papers addressing the required expertise.
- Stage/Step level activity do not require a linear progression, but *Decision Gates* cannot be properly addressed without all the necessary facts.

Requirements for Technical & Marketing Analysis

- Analyses are required throughout all three Phases, while R&D staff are typically only familiar with a sub-set of analytic tools.
- Technical, market and customer analyses address three different yet equally critical issues for technological innovation.
- Knowing what you don't yet know -- but need to do -- is critical to creating a successful team.

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NtK Model's Toolbox

Tools for Technical, Marketing and Customer Analyses

http://sphhp.buffalo.edu/cat/kt4tt/best-practices/need-to-knowledge-ntk-model/ntk-commercial-devices/master-list-of-tools.html

Five Tool Competency Categories

- Electrical/electronic engineering tools: measurement systems, design and testing systems and mass manufacturing tools.
- Material science tools: required to make the choice for a particular manufacturing material or to examine the characteristics of a potential material.
- Mechanical engineering tools: encompasses the generation and application of heat and mechanical power and the design, production, and use of machines and tools.
- Business tools: such as quantifying customer requirements, benchmarking, marketing tools, business feasibility, process improvement and return on investment.
- Inclusive/Universal Design tools: to ensure that the widest possible audience will be considered in the design process, regardless of age, size, ability or disability.

NtK Model Utility

- Clarifies processes and mechanisms underlying technology-based Innovation, by integrating academic & industry literature and analytic tools.
- Establishes linkages between three distinct methods and their respective knowledge outputs for implementation/communication.
- Offers a structure to sponsors & grantees for program/project planning, proposal submission & review, project implementation, progress monitoring and summative evaluation.

Related Publications

- *Lane,JP, Godin, B.* (2013) ***Methodology Trumps Mythology****, Bridges,* Office of Science & Technology, Embassy of Austria, Washington, DC, 36. *http://ostaustria.org/programs-projects-english/event-management/2013-04-23-10-55-57/2003-2001/382-categories-all/magazine/volume-36-december-14-2012/opeds-a-commentaries/6002-methodology-trumps-mythology*

- *Lane, JP, Godin, B, (2012)* ***Is America's Science, Technology, and Innovation Policy Open for Business?*** *Science Progress,* June 12, 2012*, http://scienceprogress.org/2012/06/is-america%E2%80%99s-science-technology-and-innovation-policy-open-for-business/*

- Flagg, J, Lane, J., & Lockett M. (2013) **Need to Knowledge (NtK) Model: An Evidence-based Framework for Generating Technology-based Innovations.** *Implementation Science*, 8, 21, http://www.implementationscience.com/content/8/1/21

- Stone, V. & Lane J (2012). **Modeling the Technology Innovation Process: How the implementation of science, engineering and industry methods combine to generate beneficial socio-economic impacts.** *Implementation Science*, 7, 1, 44. http://www.implementationscience.com/content/7/1/44.

- Lane, J & Flagg, J. (2010). **Translating 3 States of Knowledge: Discovery, Invention & Innovation.** *Implementation Science*, 5, 1, 9. http://www.implementationscience.com/content/5/1/9.

- Edquist, C, *et al* (2015). **Public Procurement for Innovation**. Cheltenham, UK: Elgar Publishing Inc. http://www.e-elgar.com/shop/public-procurement-for-innovation.

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