

# Managing Knowledge in the Three States of Conceptual Discovery, Prototype Invention & Commercial Innovation

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**Abstract:** This position paper explains that knowledge is generated through three related yet distinct methodologies, each codified within standard practices recognized by trained professionals. The outputs from each methodology are embodied in three different states much like the traditional states of matter: gas, liquid, solid. Effective Information Sharing (IS) and Knowledge Management both require a clear understanding of these distinctions and relationships. National policies designed to generating commercial innovations through public investment in the academic sector are particularly vulnerable to problems arising from confounding these methodologies, their outputs and the transitions between states of knowledge.

## 1 INTRODUCTION

This position paper attempts to untangle a set of distinct yet related constructs underlying technological innovations, which are frequently conflated and thereby impede progress in defining policies and practices required to successfully accomplish technological innovation. These issues exist within any organization conducting research and development, including those embracing open innovation. The issues are most problematic for organizations and nation's actively investing resources in universities yet relying on passive forces for communication and migration of intellectual property to the private sector.

Governments fund scientific research in university and non-profit laboratories to advance the base of knowledge on which modern civilization is built. In parallel, governments fund industrial production in areas of national need such as energy, transportation, aerospace and defence. Both forms of investment are largely successful because they closely link resources with methodologies to generate the intended outcomes.

However, since the middle of the last century these Science, Technology & Innovation (STI) policies and programs have unsuccessfully forced a hybrid process which has not enjoyed the same level of

success. That is, governments fund university faculty trained in the methods of scientific research, yet expect the knowledge they generate to be readily perceived as valuable to corporate professionals trained in the methods of new product development. Further, the vaguely defined and poorly perceived process of technological innovation is largely silent about the crucial role transformational role played by engineering development.

If Information Sharing (IS) is the foundation for Knowledge Management (KM), and if KM applies expertise to organizational processes, then in the language of Logic Models, both depend on a clear definition and understanding of the elements linking inputs, processes, outputs and outcomes.

The paper offers evidence supporting the author's position, and simple clarifications regarding the constructs important to framing and conducting effective Knowledge Management and Information Sharing practices.

## 2 THREE METHODOLOGIES

Three distinct yet related methodologies: 1) Scientific Research; 2) Engineering Development; 3) Industrial Production, can each be conducted

independently. However, they also combine to generate new or improved products or services for the commercial marketplace, or for supporting corporate business practices. Successful IS and KM strategies benefit from their interplay.

The three methodologies can be individually distinguished according to five attributes:

- Purpose
- Process
- Output
- Legal
- Value

## 2.1 Scientific Research Methods

**Purpose:** Generate new to the world knowledge in any area with intellectual merit. The traditional distinctions between ‘basic’ and ‘applied’ research imply that the scholar’s intentions determine eventual value. To the contrary the record shows that the recipient of new knowledge is the arbiter of value.

**Process:** Empirical analysis reveals novel insights regarding the relationship – causal or correlation -- between key variables under scrutiny, with other variables held in check. Because science is exploring the unexplained, the process must be carefully controlled, results analyzed to determine their likelihood of occurring by chance, and replicable by others.

**Output:** A *Conceptual Discovery* expressed through a written manuscript or oral presentation. The output exists only as an observed phenomenon so it has no inherent substance. Given this ‘gaseous’ state, the discovery itself can be instantly manipulated through reinforcement, expansion, revision or refutation.

**Legal:** A conceptual discovery gains the status of intellectual property (IP) the moment it is articulated. However, that IP status is limited to copyright protection for the investigator’s claim to be the first to articulate the discovery. This protection is preserved through the academic citation system and ethical safeguards against plagiarism.

**Value:** It is common for discovery’s to be announced in aspirational terms, such as ‘may someday lead to’ or ‘offers the promise of improving’ something or other. These very statements are evidence that the only inherent value is *novelty*; being the first articulation of a new contribution to the knowledge base; new knowledge

as *know what*. The intangible must be made to work in reality before it can contribute to society.

## 2.2 Engineering Development Methods

**Purpose:** Generate functional artifacts by reducing knowledge to practical forms. This is the professional practice of development through design, combination and trial, rather than the academic definition as theory building or intervention deployment.

**Process:** Trial and error experimentation and iterative testing to demonstrate a proof-of-concept model of some new hardware or software. While science relies on objective inquiry, engineering relies on intentional delivery of specified results.

**Output:** A *Prototype Invention* which is claimed and embodied in an operational form. This reduction to practice is key to demonstrating that something which can be conceived can also be built to function within the parameters of the physical world. While more tangible than concepts, the prototype may be constructed from expensive or fragile materials, so it is analogous to a ‘liquid’ state of matter. The materials or processes involved may be subject to change but only within the parameters required to sustain operational capabilities.

**Legal:** The creator of a functional prototype is entitled to seek protection against infringement for twenty years through a patent application. Patent protection differs from copyright in several ways. First, it is not passively granted but must be actively claimed. The claims are reviewed on a country by country basis, with patents granted based on being ‘first to file’ a claim on that particular invention. Also, acknowledging the source through citation does not grant rights to use. Instead, the creator (inventor) can grant permission for others to use through a license or sales agreement.

**Value:** A prototype invention must demonstrate both the novelty of a conceptual discovery, as well as the *feasibility* of a functional prototype. There are no patents for claims that cannot work in reality such as anti-gravity or perpetual motion machines. Demonstrating feasibility – no matter how – is the hallmark of a patented invention; new knowledge as *know how*, as in how to make it work in practice.

## 2.3 Industrial Production Methods

**Purpose:** Generate products, components or services which can be successfully sold in the commercial

marketplace. These methods typically integrate the outputs from both scientific research and engineering development, while avoiding unnecessary replication.

**Process:** The systematic specification of materials, and components to yield a defined set of attributes, within acceptable operating parameters. The intention here is not only to reduce a concept to practical form but to do so as efficiently and effectively as possible.

**Output:** A *Commercial Innovation* embodied as a viable device or service in a defined context of a market opportunity. To gain economies of scale and meet customer expectations the output must represent a final form which can be mass produced, widely distributed and supported through a standard set of skills and resources. This is analogous to the 'solid' state of matter, because none of the element comprising the final form can easily or readily altered. Once they are, the new/improved device or service is given a new model or version designation to demarcate it from previous versions.

**Legal:** A device or service can obtain additional intellectual property protection by applying for and receiving a trademark or service mark, based on words or symbols assigned as unique identifiers. The court system recognizes that such identifiers accrue monetary value, so non-owners can be sued for damages in the event of improper use which is assumed to impair revenues or damage reputations.

**Value:** A commercial innovation clearly must contain both novelty and feasibility attributes to have any chance of success in the competitive marketplace. However, it must also demonstrate *utility*, defined as generating revenue for the manufacturing company and providing functional benefit to the customer. When one speaks of the value proposition for a new commercial venture, it necessarily addresses all three values.

The three methodologies generate new knowledge in three distinct states, so the next question is how is knowledge communicated between sectors and transformed between states.

### 3 THREE TRANSITION POINTS

Professionals involved in Information Sharing and Knowledge Management roles face the unenviable task of monitoring and tracking activity that is

largely hidden from view, precedes announcements of the resulting outputs, and often rely on the tacit knowledge of those conducting the work.

The scientist announces their discoveries after the fact, while the engineer's inventions only become public after the patent is filed or granted. Corporations treat as proprietary on-going product/service projects until they are unveiled through press releases and marketing campaigns.

These three examples are all information sharing and each results from a deliberate strategy of knowledge management. They all represent opportunities to identify a point where knowledge in one state of matter is being absorbed for transformation into another. Here again the terms associated with each shift should be distinguished and understood.

#### 3.1 Knowledge Translation

Knowledge Translation (KT) is the latest iteration of related terms associated with the effective communication of new knowledge from the creator to the audience of potential adopters. The KT wrinkle is that new knowledge must be conveyed within the value systems and operating contexts of the audiences to facilitate uptake and application.

This adds a new responsibility on scholars to seek common ground with audiences either at the end of their projects – or hopefully – prior to initiating new projects. The KT approach fits within the analogy to gaseous matter as the investigator can compose the message accompanying the conceptual discovery to best fit the target audience's context. Of course, this assumes that there is some relevant to the discovery, beyond the rigor applied to the scientific research methodology.

Identifying instances of successful knowledge translation is a matter of identifying case examples where the conceptual discovery has been cited in the publications of another scholar, or adopted in the practices of professionals.

#### 3.2 Technology Transfer

The phrase Technology Transfer (TT) has gained as many meanings as the term 'innovation' in society. In this paper's context it is appropriately limited to the exchange of ownership and control over intellectual property protected as patented inventions. The claimed invention's novelty and feasibility become valued by some third party that seeks to apply the claims in a practical form.

The invention's owner may offer temporary control through a license – which may be exclusive or non-exclusive to the licensee – or may surrender permanent control through a sale. This exchange from one party to another is evidence that the receiving party intends to transform the prototype into a commercial devices or service.

Given the liquid state of the prototype, one cannot be certain how it will be transformed, yet the results can be inferred by considering the core claims in the context of the organization acquiring the rights to practice the invention. Of course, some patents are acquired not to practice but to hold as a safeguard against practice by others, but that is another topic.

### 3.3 Commercial Transaction

The transfer of ownership over an invention to a corporation is likely to be the last public disclosure until a new product or service appears in the marketplace. Yet that appearance is evidence that the third transformation has occurred. That specific kernel of knowledge has been transformed from a liquid (prototype) to a solid (product) state of matter.

## 4 CONCLUSIONS

Professionals concerned with STI policies and the programs they support may follow the linkages between these three transformations to see how – and to what extent – the three methodologies and their related sectors combine to generate technological innovations. Milestones for progress through each of the methodologies, and their respective outputs, outcomes and impacts can also be traced to assign credit and identify opportunities for further commercial exploitation.

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