CAS Research
Technology Incubation Lab
APPLIED RESEARCH FOR COMMERCIALIZATION

The Four Languages of Innovation

A Model of Industrial Research and Development

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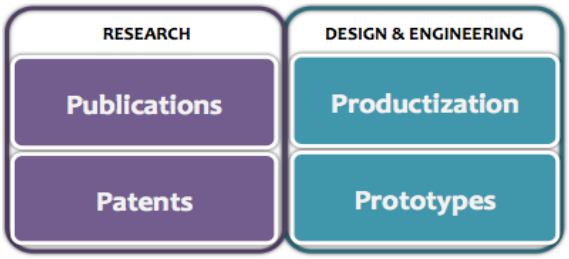

Introduction

Industrial research is defined as planned search or critical investigation for *the acquisition of new knowledge and advancement of science,* with the objective of applying such knowledge and advancement for developing new products, processes or services, or in bringing about a significant improvement in existing products, processes or services. ***Development*** is the *translation of research findings into design for new or significantly improved products, processes or services* [1]. In a nutshell, industrial research and development is ***applied research for commercialization.***

CAS Research is an organization of industrial research and development, missioned to conduct applied research in collaboration with academic research partners, IBM researchers and technologists. Through Technology Incubation Laboratory (TIL) as its development unit, research outcome is being translated into early implementations of new products or improvements of current products, as sellable offerings that solve real world problems of our enterprise customers [2].

CAS Research aims to deliver high-value results with maximized impact in both the advancement of science and technology and in business impact through the creation of sellable product offerings that generate revenue.

Henry Ford once said, "Innovation without execution is hallucination." Innovation success requires execution to produce tangible outcome and to demonstrate valuable contributions. **CAS Research standardizes the expression of innovation success in *the Four Languages of Innovation.*** Each innovation language shares common constructs, formalizes forms of expression of innovation outcome for a target audience who 'speak' that language. Those who speak the same language of innovation share the common sets of criteria and perspectives in processing innovation outcome for evaluation and/or adoption. Expressing innovation in a language that target audience does not share often causes severe negative results that could have been avoided.

For example, presenting a novel algorithm of an optimized publish-subscribe event model, published in a scientific journal, to a product executive, is a typical example of speaking the wrong language of innovation that leads to disengaged communication. The product executive may only want to know about the drastic improvement from the business exceptions that his enterprise customers will benefit from in order for him to evaluate the business benefits to his products. If technology adoption in products is the goal, then speaking the language of productization is necessary. When the wrong language of innovation is used for a target audience, as in this example, expressing the innovation outcome as a scientific publication to a product executive whose primary innovation language is productization, leads to severe negative outcome, such is lack of acknowledgement of the significance of the breakthrough or outright rejection of the innovative idea. These result in adoption inhibition, missed opportunities and other undesirable results. Furthermore, the tragedy is that such negative outcome has nothing to do with the merit of the innovation itself.

The Four Languages of Innovation

The four languages of innovation are ***Patents***, ***Publications***, ***Prototypes*** and ***Productization***, The first two are to establish thought leadership in the advancement of knowledge and new discovery in science and technology. The last two are to build business leadership through enhanced or new product offerings.

One critical by-product of CAS Research's innovation model is the **highly qualified personnel (HQP)** [Note 1]. Members of the research and prototype teams have gained expertise and become the subject matter experts in emerging technology space that are typically hard to find in the industry. CAS Research faculty students are highly skilled resources and therefore prime candidates for hire as the research outcome gets productized. [Note 1: Credit to input from Dr. James R. Cordy, Professor from Queen's University & CAS Research Visiting Scientist]

Patenting

Patenting is a language of innovation that ***expresses innovation as intellectual properties in order to claim ownership.*** Given the business objective of industrial research is for commercialization, patenting becomes a very critical expression of innovation that secures competitive position in the industry at large [3]. *By articulating and identifying elements of the innovation outcome as claims, it demarcates the boundary of property, setting a fence around it to claim and to own.* A patent granted provides an exclusive right for the invention and protects patent owners for a limited period, typically twenty years, in exchange for the public disclosure of the invention. The patent owners' full right in freedom of actions regarding to the invention are then protected [4]. The invention cannot be commercially made, used, distributed or sold without the patent owner's consent.

Describing innovation outcomes in the form of patent disclosures (in terms of novelty, non-obviousness and usefulness) is a skill that needs to be learned, practiced and mastered into proficiency.

Publications

Publication is a language of innovation that captures innovation as a form of ***public record and permanent archive of advances***, in a manner that is ***time-stamped*** *and* ***is recognized by other acclaimed experts in the scientific community.*** It is a very important expression of thought leadership in the scientific and technological arena.

It is also a formal channel to intentionally ***disseminate*** new knowledge and discovery through precise, clear and well-written form such that readers are educated and informed of the new knowledge and discovery [5].

In order to ***discriminate*** quality knowledge, scientific and technology publications are subject to peer review process, such that the truthfulness of the new knowledge claimed as well as the validity of the claims and logic of the argument used are being verified [5].

Subsequent citations of the publications acknowledge the advancement made and then build upon them with further discussions. Citation counts are often used as an indicator of the value and impact of the publications.

Prototyping

Prototyping is a language of innovation that translates the new knowledge and discoveries into ***early implementation of solutions for real world customer problems*** by applying the advances in preliminary design, architecture and engineering of solution prototype. A challenging but an indispensible step towards commercialization, prototyping is pivotal in transforming abstract knowledge advancement and new discoveries into implementation reality.

The purposes of prototyping include, but not limited to [6]:

- Providing early validation of architecture and designs when the research results are applied
- Providing demonstration of implementation of customer solution to product management and potential customers, who often do not share the same knowledge and understanding of the underlying science and technologies, but instead interested in the applicability to their real world problems at hand
- Providing an economic way for eliciting customer and market feedback, shaping the ultimate functional specification through rapid iterations and relatively easy modifications
- Providing a way to manage technical and financial risks of investment

In addition, through prototyping, gaps in the missing science and technology can be revealed and identified as new set of research problem statements.

Productization

Productization is a language of innovation that articulates business value of the innovation as value propositions and business models of the enhanced or new product. Business model is a very common construct used to convert science and technological advancement into customers and market economics. The target audience is the product executives, marketing team and potential customers. The purpose of this language of innovation is to elicit positive business decisions to invest and execute product plans that lead to the general availability of the innovation as sellable products or solution offerings in the market. The ultimate expression of industrial adoption is when customers make decisions to pay for it as solution of choice to their real world problems. The inherent value of the results of industrial research and development remains latent until it is commercialized in some way [7]. Productization is intended to express ***the value creation*** of the product innovation or enhancement, enabled by the underlying knowledge advancement and new discovery.

The purposes of productization include, but not limited to [7][8]:

- Stating customer problem statements and the corresponding value of the proposed solution that the new discoveries and advancement apply without focusing on the scientific and technological advancement per se.
- Stating for whom in the market and for what purpose that this solution creates value
- Stating how value is being generated for the industrial corporation who invests in it

- Stating how this matches the core competency of the investing corporation by investing in producing such solutions

Very often, prototype provides an important linkage to translate the applied significance of the technological advancement into a visible and tangible form, in order to manifest the associated business value, presented as valued solutions to real world problems.

Operating Principles for Maximized Innovation Impact

The uniqueness of CAS Research lies in its collaborative research partnership between IBM technologists and its academic research partners, with each having different measures and definitions of success. Maintaining the win-win principle is key for continual fruitful research partnership [2].

The four languages of innovation provide CAS Research a model of return on investment in industrial research and development. The principles discussed in this section call out how the four languages of innovation interact to yield maximum outcome.

Applied Research for Commercialization

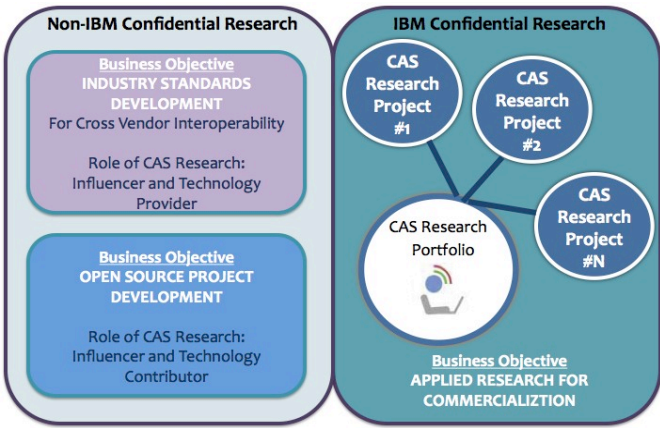

Figure 1: Model of Public and Private Research

First of all, applied research for commercialization is the overall operating principle for CAS Research; with it, comes the following implications:

- Instead of basic research, we focus on applied research: the practical application of science with a *near term research timeline*, orientated around customers' real world problems.
- The alignment to customer/market problem priorities: critical factors that shape the priority of our research agenda and model include the possibility of the translating customer problems into research problem statements; the possibility of commercialization and its business potential.

Publications Depend on Patenting

Maintaining the freedom to commercialization is one of the key priorities for CAS Research. Manage when, how and what to keep research proprietary and when to make it public (see Figure 1) is a constant, critical balancing act. Making publications pending on patenting is important in order to allow the business to manage the balance [3].

A managed process needs to be established to make room for critical discussions and decisions regarding issues like:

- What is proprietary knowledge that needs protection?
- When advanced knowledge and new discovery should be introduced into pubic?

Material is screened for publication with an eye to patent implications. Material is published once they satisfy themselves that sensitive information is protected, typically by patent applications [3].

Patent early to maintain win-win is important for our academic partners' requirement to publish. Similarly, publications are also critical to IBM for the following reasons. First of all, it builds technical reputation for IBM as an industrial corporation. It is a vehicle to establish our technical credibility and raises corporate image. In addition, it serves the purpose of

generating adoption for the new knowledge and technologies at hand. The community of researchers often builds upon what is published [3] and drive adoptions and further advancement. Advances in technologies are often interactive and cumulative. They facilitate collaboration and linkages to related work. [9].

Raising Impact by Research Portfolios

At CAS Research, research portfolios are individual research projects grouped under a broader and more abstracted technology scope in order to ***discover relationships*** between research results of the participating projects ***within*** a given research portfolios, as well as to discover relationship of research outcome ***across*** different research portfolios. It is a method of innovation to drive broader technological and product impact in a technology space that is less established and unchartered. Establishing and studying these relationships often lead to new advancement and discoveries with further innovation opportunities. Such approach enables prototypes that represent more comprehensive solutions to customer problems, and therefore, enhance the value proposition for productization.

Bringing Problem Spaces Closer

To solve a problem, information related to the origin of the problem and problem-solving capabilities must be brought together in the same 'location'. The mapping of customer problem statements from the real world of the enterprise into scientific into technological problem statements are often "sticky", that is, costly to acquire and to transfer [10]. However, the key to business value creation from industrial research and development is in the accurate abstraction of customer problem statements into scientific research problem statements that lead to the technological advancement. Such research results are then applied in early prototypes of products, validating the technical capabilities in solving customers' original business problems. The ultimate proof of its business value is the customers' decisions to spend their dollars in purchasing the resulted product that provide solutions to their problems.

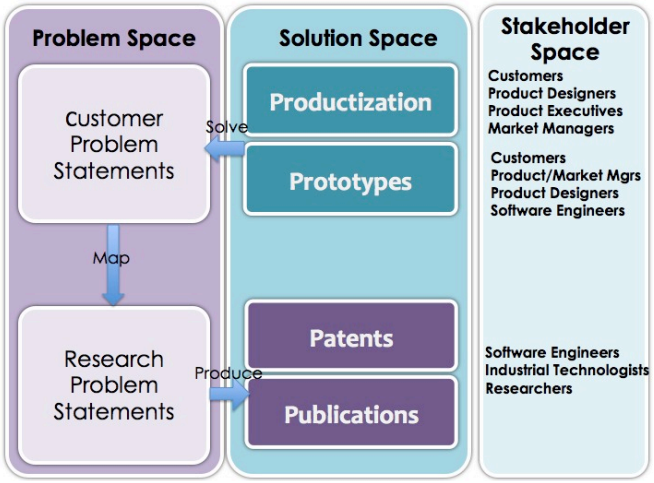

Figure 2: Spaces that need to be put in one locale

Getting IBM Business stakeholders and customer advocates involved in industrial research and development up front is very important. This minimizes communication gap between the customer problems as a starting point and the resultant solution. Proper abstraction of customer problems into science and technology problem statements may increase the applicability of research advancement and discovery in solving the customers' problem at hand.

Starting to get business stakeholders and customers involved in industrial research and development teams will help to bridge the "stickiness" [10] and gaps across different problem spaces. This also brings the potential benefit of upfront buy in from the business stakeholders and customers, who are given opportunities to provide their input and shape the agenda. With fast iterations of collaborative prototypes, prototype implementations can be given to customers and business stakeholders for

early feedback.

Prototyping to Create a Platform for Design & Productization Dialog

Patenting and publications alone do not materialize into sellable offerings. Technology Incubation Laboratory plays an indispensible role as a development unit in prototyping, transforming research results into tangible solutions that users can use and operate with. Prototyping is used in CAS Research to illustrate the innovation in a consumable form of solving real world customer problems from end users perspectives.

When business stakeholders and customers are bringing customers problem spaces closer to technological problem spaces through ongoing collaborations, it increases the chance of fruitful industrial research. Prototypes are logical continuation of the next stage, used as a medium for persuasion in order to create a platform to spark off design dialogs among researchers, software engineers, potential customers and product executives [6]. This fast, iterative approach will yield competitive benefits and guide the value-creation process, with minimized investment risks.

Conclusion

As an organization missioned for industrial research and development, CAS Research is focused on applied research for commercialization in collaboration with our faculty members as academic partners. Its success is expressed in all four languages of innovation, namely, publications, patents, prototypes and productization. Members from the research and prototype project teams become resource pipeline for Highly Qualified Personnel (HQP) in time of productization. Operational principles have been called out so that these four languages will not undermine each other. The objective of near term commercialization is a key factor to set research priorities. New setup in research project groupings into research portfolio is intended to foster new opportunities for innovation. New collaboration setup is also intended to bring problem spaces into the same locality in order to enable relevance. Prototyping is used as a key platform for iterative design and productization discussion.

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