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# Exploring Innovation in Technology from the Perspective of Entrepreneurship and Invention

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**Abstract** This paper reports on a study on perceptions about innovation in technology from the viewpoints of entrepreneurship and invention. The results of the study indicate that perceptions on technological innovation are largely seen through the paradigms of entrepreneurship and invention, and can be classified into four distinct categories. A proposed framework is developed from the study's recorded responses and presented as an interpretive model to explain the observed outcomes. The goal of this paper is to provide insights about attitudes on innovation for practitioners in technology fields and offer a testable model for researchers to further study and validate the framework presented. Along with the proposed framework, we provide descriptions of the innovation categories based on the responses from the study's participants.

**Keywords** Technology, Innovation, Invention, Entrepreneurship

## 1. Introduction

The word *innovation* is a term of great interest yet rarely defined. It has many descriptions that tend to reflect particular usage, rather than a universal application. But, how might one think about innovation as it applies to technology? The question of precisely defining technological innovation has been historically explored as "revolutionary versus evolutionary"; "process versus product"; and "incremental versus radical" [1-4]. However, there are no current research models attempting to classify "types" of innovation into distinct categories.

This paper, explores perceptions on *technology* and *innovation*. We begin with defining technology and innovation by their conceptual use and historical evolution. We then investigate technology and innovation through the perspectives of invention and entrepreneurship, and report on a three part study of "entrepreneurial technologists" to investigate current understandings and descriptions of technology and innovation. We propose a framework to classify innovation along four categories, based on observations from the study results.

Many agree that innovation is a change agent [5]. In fact, Ben Franklyn once said that "When you're finished changing, you're finished." Technology and change seem to go hand-in-hand. But, when we think of changes in technology, how do we recognize the impact of innovation upon our way of performing our routines? How do we understand and assess the nature of innovation in technology?

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## 2. Research Question

When we think about technology, we often refer to various techniques and elements of the scientific method and how it can be applied to solve problems [6]. Sometimes we apply this task to the business environment, other times we use management tools and strategic concepts applied to design and development as a solution to a business problem [6]. But, how should we think about the overarching landscape and constructs of technology and innovation? This leads us to our research question: How can we classify innovations in technology?

## 3. Technology

The modern conventional definition for technology is "*the application of scientific knowledge for practical purposes."* An alternative definition is "*science or knowledge put into practical use to solve problems or invent useful tools*." Yet another definition for technology is "*the application of science, especially to industrial or commercial objectives"* [7], [8].

The significant phraseology to note above is *application, knowledge, and science*. Notice how these definitions highlight the application of science or knowledge to business (industry, commercial).

If we explore the etymology of the word technology, we see that it comes to us from the Greek words *techne* meaning *art or skill*, and *ology* meaning *learning or study of*. So in the

literal sense, technology is the study of art or skill, or the learning of art or skill. In its contemporary usage, **technology** is associated with tools, machinery, automation, procedures and methods for humans to gain leverage or advantage in use or skill [8].

So what is a "technologist?" The simple definition is "one who specializes in technology" [7]. Not a very informing definition. Some suggest that technologists can be compared to engineers. Let us consider the field of engineering. After all, it is the discipline that traditionally has claimed ownership over the study of and design of technology and its applications. We often think of engineering as the design and build of physical things. Whereas an engineer engages in engineering activities, what of the technologist who engages in technology activities?

In the modern application of technology, especially *information technology*, engineering is extended to additional domains such as software engineering, computer engineering, and system engineering.

The study of the development and application of technology relates to the human ability to control and adapt to the natural environment around us. If we extend this definition to the *business environment*, technology can be operationally defined as a *tool, technique, or procedure designed to improve performance*, by efficiency or effectiveness, in the process to which it is applied.

So, what makes someone a technologist and how do technologists describe technology? The study reported in this paper asks 120 of them these very questions.

# 4. Innovation

So what is innovation, how does it relate to technology, and how can both of these concepts fit into a framework?

Stephen Hawking once said that "Intelligence is the ability to adapt to change." Some might link intelligence and the ability to change, to innovation.

Innovation can be defined in several ways. It is one of those ambiguous concepts that, like tofu, tends to take on the flavor of whatever is applied. One view of innovation is "*the introduction of something new."* An alternative view is *"a new idea, method, or device*." Yet, another view of innovation is simply the one word description "*novelty*" [8].

If we apply the paradigm of design [6] to innovation, then we should view innovation applied to the business process in terms of its value added proposition – its ability to solve a business problem. In that light, a working definition for innovation can be: "*translating an idea or invention into a good or service that creates value*."

In the context of a framework, we might view *innovation* as it relates to *technology* by its application and influence. If we view technology as the prime mover, the foundation of science and knowledge applied to a process with the goal of improving that process, then innovation might be described as the evolution of developing new forms of technology to increase our mechanical advantage to achieve our goals. Our goals are often measured as increased performance by greater effectiveness (producing more) or better efficiency (producing cheaper) [9], [10].

Clearly, the obvious meaning of innovation or innovating is in the *creation* of something new. But, the new development is not limited to a clean slate invention. Some of the best examples of innovation are improvements to current offerings. From this perspective, we can view innovation as a new thing itself, a new design of a thing, a new feature or capability of a thing, or simply a new way of doing the same thing. The emphasis here is on the creativity and novelty, and the value of the proposed novelty.

# 5. Entrepreneurship

The label **entrepreneur** is given to an individual who "*organizes, manages, and assumes the risks of a business or enterprise"* [7]. Two elements that seem to be most commonly associated with a dictionary or open source definition of entrepreneur are *risk* and *initiative*.

The term **entrepreneurship** is commonly defined as "*the process of starting a business or new endeavor"* [7]. Under this definition it seems that risk, although not directly mentioned, may in fact be assumed.

It is interesting to note that, whereas the entrepreneur is described as the person who starts a business and is willing to risk loss in order to make a profit, the description of entrepreneurship is more closely aligned with the process of starting a business, the development of a business model, and the acquisition of resources [11].

# 6. Invention

The construct of invention shares some overlapping characteristics with innovation. For example, one definition for invention is "*a product of the imagination*" [7]. An operational description for invention is "*a new scientific or technical idea, with the ability to be demonstrated*." – This may sound most similar to design [6] in terms of the demonstration of feasibility in the solution. An alternative description is "*a new device, method, or process developed from study and experimentation*" or "*a device or process that has been created or made up*." – This might sound reminiscent of the framework of design [6] and the application of the scientific method to a problem.

If we look to U.S. Patent Law for guidance, then an invention is *a new, useful process, machine, or improvement that did not exist previously, is not obvious, and is unique* [12]. Under this usage an invention is distinguishable from *ordinary mechanical skill or craftsmanship*.

Whichever variation of definition or description for invention we may choose, we need to consider how these specific choices frame our thinking and portrayal as an innovation relates to the particular technology identified, within the environment as defined.

## 7. Pilot Study: Finding Entrepreneurial Technologists

So what is an entrepreneurial technologist? We set out to determine if, in fact, such a category of individual exists. We began with a focus group utilizing semi-structured interviews of 10 self-identified entrepreneurs who claimed to be engaged in a field of technology. These participants indicated by consensus that an entrepreneur is "one who takes an idea to market." Each member of the group agreed that it is this specific description that makes them identify as "entrepreneurial."

Of particular note here is how the group's definition did not include risk. The group was prompted with this question, to which they responded, "well of course risk *too*," but they reiterated their agreement that it is the ability to "take an idea and make it into a reality" that *really* makes someone entrepreneurial."

Several members of the group identified themselves as inventors as well as entrepreneurs. The group as a whole was very clear that an entrepreneur may also be an inventor, but one does not need to invent the innovation be an entrepreneur. The key distinction, according to the group members, was in the *ability to bring the invention to market*.

From our focus group interviews, we developed a series of semi-structured interview questions for a pilot study of 50 entrepreneurial technologists, now defined as "entrepreneurs in the field of technology." The interviews consisted of questions about their attitudes and perceptions on innovation in technology, based on their perspectives as entrepreneurs or inventors. The responses were coded by three reviewers who were not part of the study. A cluster analysis was performed using the coded responses. The results suggested that there were four distinct categories for classifying innovation.

It is interesting to note that, although many of the 50 participants in the pilot study (15 individuals) identified as an inventor as well as an entrepreneur, no one identified as an inventor alone.

## 8. Full Study of Entrepreneurial Technologists

We administered a survey consisting of questions developed from our focus group and pilot study to a population of 120 self-identified entrepreneurial technologists, not included in the prior pilot or focus group. The participants of the study were selected from various technology companies along Florida's "I-4 Corridor." The goal of the full 120 person study was to either confirm or disprove the framework of four innovation categories that emerged from the pilot.

In the full study the participants were asked about how they define technology, innovation, entrepreneurship, and invention. The participants were also asked to use descriptive characteristics to explain how innovations impact existing technologies and how people use them. They were also asked to justify why they identified themselves as entrepreneurs in technology and how they distinguish between entrepreneurship and invention.

The 120 participants ranged in age from 25 to 53. There were 72 males and 48 females in the study. 110 participants had at least a bachelor degree, 70 had a master degree, and 10 had a PhD or other terminal degree.

Similar to the pilot, the participants' responses were coded using three independent reviewers not part of the study, and not part of the pilot. Confirmatory Factor Analysis (CFA) was the chosen method of analysis. The results supported the four categories originally developed from the focus group and the pilot.

## 9. Classifications of Innovation: Substitute, Alternative, Replacement, Extension (SARE)

The results of the three portions of the study (focus group, pilot, and full study) suggest that the impact of a particular innovation takes the form of a specific application of technology and can be described by its effects using four categories: *Substitute, Alternative, Replacement*, and *Extension*. We have developed these categories into a proposed framework to offer insight and explain how a new technology in the form of an innovation might be adopted for use by the consumer of the technology. We describe the framework using an acronym **SARE** as a way to remember the four categories as explained below.

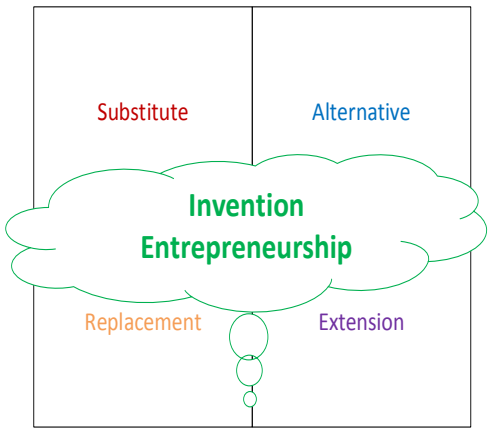


**Figure 1.** SARE Innovation Framework

According to the responses reviewed, when we think of an innovation offered **as a substitute** we are considering a scenario whereby the legacy technology is still current and serves the purpose and intent of the end-user. *The new innovation is an equivalent technology*. This means that there is no discernable improvement in performance or in application of the new technology. The technology is offered to take the place – substitute – for the legacy technology, but without a value added proposition, the adoption of the new technology is predicted to be quite slow. In this scenario,

substitution is slow to take root, but eventually gains traction as the legacy technology begins to age and lose perceived value. Early adopters, who are motivated to possess the most current technology are the best influencers for this category. Without significant and meaningful advantage in use, the early adopters are the most likely candidates to keep the innovative offering alive in the marketplace. Think of this classification describing a new way to do the same thing.

According to our observed results, an innovation **offered as an alternative** suffers from a similar lack of significance as that offered as a substitute. The main distinction between a substitute and an alternative is that technology offered as *a substitute is largely a replication of the legacy features and functionality, merely with an updated presentation*; whereas a technology offered as an *alternative is intended to be a distinct, different method* to compete against the legacy form. Technology offered as an alternative to a legacy will typically have features and functions presented in an unusual or unconventional manner – offering a uniquely different way of achieving the same task as the legacy. Think of this classification as a better way to do the same thing.

Our study found that technology **offered as a replacement** is comprised of a distinct and significant improvement over the legacy technology. In this instance there may be new features and functions, or a new process or method. A replacement technology might represent an improvement in performance, durability or other form of value, making it a more attractive choice to adopt over the legacy. Think of this classification as an improved way of doing the same thing, such as the latest version of a smart phone or other device.

The fourth category emerging from our study is technology **offered as an extension.** This description seems to carry the greatest impact of the four categories of innovation. An extension technology offers *new ways of doing new things*, *previously unavailable*. We see this in devices containing new features and functions, more powerful abilities, additional capabilities, extended boundary conditions, longer lifetimes, new environmental parameters, significantly different physical properties (such as lighter or stronger materials), and an overall comprehensive robustness not previously available in the legacy technology.

Extension technologies tend to be *breakthrough inventions*. Think about the internet, email, Facebook, or texting. Each one of these technologies presented a new way to perform a communication activity that previously did not exist. Extension technologies share similar characteristics with replacement technologies, but set themselves apart in that they typically are more robust or unique in their approach, when compared to replacements.

## 10. Proof of Concept and Feasibility

A completely unpredicted conversation emerged from the participants in the study. We found that an overwhelming number of participants in both the focus group and the pilot study were very interested in the feasibility of an innovation as an invention, and its proof of concept as a demonstrable reality.

Many of the participants indicated that "a truly new invention or innovative technology has to overcome several hurdles," the most significant of which include "raising enough capital to complete the development process" and "bringing the product or service to market." The four classifications (substitute, alternative, replacement, extension) consistently emerged in our conversations with the participants, and were often associated with "an entrepreneurial effort" and understanding "how the innovation can be best explained to potential investors, marketers and customers alike," and help to "determine how to position or brand the item."

Several participants in the pilot mentioned the design of the prototype, or minimum viable product (MVP), that demonstrates feasibility in the solution:

"Okay, so you built the working demo; you even drafted a white paper explaining the underlying concepts; used a rigorous scientific methodology to support your results with evidence, now what?"

"How do you get someone to give you the necessary capital to get to the next step?"

"What are the questions you need to address to get your innovation to market?"

Responses from the interviewees also revealed items needed to be established for an innovation capable of being produced: *technical status, technical risk, and hires*.

Participants indicated that ***hires*** refers to the description and explanation about who is in and who is out; who is part-time and who is full-time; *who* is running *what* at the company; and there better be a company – "no corporate structure, no business entity, equals no money from investors."

Several participants suggested that there needs to be a management team in place, and they better have bona fide skills and accomplishments at bringing a product such as this one to market. Several also mentioned the saying that "you bet on the jockey, not on the horse." Meaning, the technology may impress, but your management team better also impress. The general consensus was: When in doubt, choose great management over great concepts. A great entrepreneur will turn a good idea into a great reality. An average entrepreneur will turn a great idea into a mediocre reality, if at all.

The participants indicated that **technical status** refers to a clear demonstration of "where we are in the lifecycle process." There is also "a need to understand whether the innovation is fundamentally defensible." Meaning, is this patentable, or do we have a viable trade secret? How are we able to prevent others from easily replicating our invention? Technical status also includes a deep internal analysis and explanation of our use of funds:

"How much have we spent so far, and on what?"

"What is our specific revenue model for the vertical space that we are targeting? We also need to explain why no one else in our market is doing this, and what prevents someone else from doing this? For that matter, what market we are operating in?"

"We need to define these issues to understand ourselves, before we can go making a pitch to others."

Participants indicated that **technical risk** refers to the simple question of *what do we need to make this work*? How sound or proven is the underlying technology that we are relying upon? What is our ability to build the product? Are there any assumptions about our supply chain that we need to know? What are the dependencies and sequences of actions that affect our ability to deliver the product to market? How stable is the product, our operation, our management team, our development lifecycle, and our market?

Finally, many of the participants indicated that we need to understand and be able to explain: (1) who our customers are, (2) what our sales model is, (3) why they will pay what we think they will pay, (4) how will we be able to maintain these relationships, and for how long?

An interesting side note was that, several of the more experienced interviewees suggested that, in addition to a functioning prototype serving as a *proof of concept for the innovation*, we may also need to establish a cadre of beta customers to serve as a *proof of concept for the revenue model*.

## 11. Conclusions

This paper presented a proposed framework for classifying categories of innovations in technology. We presented a discussion on the constructs of innovation, technology, invention and entrepreneurship, and we reported on a three part study of self-identified entrepreneurial technologists. We described and explained the four emerging patterns for categories of innovations and developed the framework as depicted in Figure 1 in the paper. Our next steps will be to continue to expand the study and extend the boundaries of the framework to see if we can generalize our results to a larger technology community and further explain ways to classify innovations in technology. We welcome feedback on our discussion presented here.

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