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The Art and Science of Discontinuous Innovation: A Case Study in Product Reinvention

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THE ART AND SCIENCE OF DISCONTINUOUS INNOVATION:

A CASE STUDY IN PRODUCT REINVENTION

by

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of a thesis submitted by

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ABSTRACT

THE ART AND SCIENCE OF DISCONTINUOUS INNOVATION:

A CASE STUDY IN PRODUCT REINVENTION

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Divergence of new and old technologies is a source of tremendous innovation potential. As the dizzying pace of technological innovation accelerates indefinitely into tomorrow, not only do new paths diverge exponentially; doors already opened are increasingly abandoned for the allure of things undiscovered. Mature, late-stage life-cycle products left behind in today's fast-paced world open the floodgates to reinvention.

This paper tests the hypothesis that innovativeness can be encouraged through the learning and application of universal innovation principles and processes. The implications of this research area are far-reaching. If innovation can be encouraged, then it can likely be taught. If it can be taught, then it can be systematized. More pervasive systematic innovation will accelerate change in the world. Individuals and organizations that master this kind of innovation will gain tremendous competitive advantages. The

more people innovate, the more opportunities to innovate there will be. Creativity begets creativity.

The microcosm studied in this thesis – that of discontinuous innovation applied to mature products – underscores the promise of potential far grander. If innovators, whether in small businesses or large corporations, seeking to capitalize on existing products with proven demand can combine *innovation* with *iteration* to consistently produce value for product stakeholders, what could they do to disrupt products as we know them? How many new product categories would emerge? Finally, if ordinary people everywhere began seeing themselves as and acting like innovators, what would stop any of us from changing the world?

This paper distills existing and original theories of innovation into a new model called *Innovation Harmony*. The Innovation Harmony model details four crucial aspects of innovation, which are 1) Harmonize the views of stakeholders, 2) Understand the principles of innovation, 3) Create a creative environment, and 4) Apply the principles of innovation (follow a methodology).

The paper concludes with a summary of a case study conducted at Brigham Young University, wherein 17 students attempted to reinvent the conventional Waffle Iron in a controlled environment. Their innovations are presented in the Appendix. Relevant analysis and recommendations are discussed in conclusion.

ACKNOWLEDGEMENTS

My deepest gratitude goes to Candice and Amber. Without your support and love this thesis would not have been undertaken, much less completed. Mom and Dad, thank you for guiding me. Ruth Ann, thank you for motivating me. Dr. Hawks, thank you for reassuring me. Dr. Strong, thank you for teaching me. So many thoughts in this paper stem from our discussions and your ideas. Dr. Todd and Dr. Giauque, thank you for approving me! And finally to those who participated in and judged the case study, thank you for your time and ideas. You are wonderful innovators.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1: INTRODUCTION

1.1. Background

"Everything that can be invented has been invented."

– Charles H. Duell, U.S. Patent Commissioner, 1899

In today's complex and hyper-competitive global economy, it is easy for innovators to feel overwhelmed. One might understandably feel as Charles Duell did at the turn of the 20th century: that the world of invention and innovation has reached its saturation point. The dual nature of today's pervasive information further complicates the matter. It is easy to obtain information and easy to create it. The innovator's novel idea will prompt precursory research, only to reveal that the idea has already been dreamt and discussed countless times before. One may be easily and erroneously led to believe that further pursuit of innovation is futile.

Let us not be dismayed, however. Just as hindsight now reveals the folly in Mr. Duell's assertion, we too must take comfort in the clear truth of invention and innovation. The more that is invented and innovated in the world, the exponentially greater our ability to innovate and invent. Every new door opened leads to countless other, newer doors.

But this is not all. As the dizzying pace of technological innovation accelerates indefinitely into tomorrow, not only do new paths diverge exponentially; doors already opened are increasingly abandoned for the allure of things undiscovered. The divergence

of new and old technologies is a source of tremendous innovation potential. Mature, late-stage life-cycle products left behind in today's fast-paced world open the floodgates to reinvention.

The renaissance of products is core to a fundamental aspect of human psychology: our constant need for re-birth. We constantly strive to differentiate and re-invent ourselves, often through the products and services we create and consume. Our voracious appetite for innovation manifests itself at every level of society, including and perhaps most evidently in individuals' and businesses' ongoing attempts to introduce new products to market. Capitalism is clearly a driving force in this process, driven itself by individual and societal need for differentiation. The endless challenge of innovation and differentiation creates a dilemma that cannot fully be solved, for the gap that creates the dilemma is the very source of its solution.

The void created by new products outpacing their mature product counterparts intersects at an idea termed in this paper as *Discontinuous Innovation.* The concept of 'discontinuous' innovation resides somewhere between the commonly-held theories of 'sustaining' versus 'disruptive' technologies. On the one hand, sustaining technologies maintain a constant trajectory of performance improvement that has been historically demonstrated in a market [8]. They offer consumers more and better of the same. Disruptive technologies, on the other hand, introduce an entirely new set of initially-underperforming attributes than those historically valued by consumers. Eventually these disruptive technologies improve in performance, eventually surpassing and supplanting previous technologies.

Discontinuous innovations – as introduced in this paper – neither maintain a product's historical performance improvement trajectory nor entirely disrupt it. They redefine products by *re*-inventing them – not by offering lesser initial performance but rather revolutionary and redefined, augmented performance. Since the sustaining technology curve is essentially flat for most mature products, the only alternatives to discontinuous innovation are disruption or commoditization.

If, then, opportunities for sustaining, disruptive and discontinuous innovation abound, to whom shall go the rewards? If intellectual property is to become the capital of the 21st century, as Alan Greenspan said, then who will own it? How will it be created? Is the ability to innovate innate and intangible or can organizations *encourage* innovativeness concretely? Is innovation art, science or a combination of both? These are some of the questions this thesis was undertaken to address and hopefully answer.

1.2. Problem Statement

This thesis attempts to answer the following basic but powerful questions: Is there an "X Factor" to innovation that makes innovativeness innate or can innovativeness be encouraged? If innovation can be encouraged, *how* can it be encouraged? What are the universal principles and processes of innovation that encourage innovativeness?

1.3. Purpose of the Study

The purpose of this study is to first summarize, second synthesize and third teach/test universal principles and processes of innovation. To that end, this study defines product innovation, determines how innovativeness can be measured or assessed, delineates factors contributing to innovative environments, outlines potential sources of

innovation and tests synthesized theories stemming from these considerations in a case study.

1.4. Significance of the Study

The implications of this research area are far-reaching. Opportunities for implementation abound. If innovation can be encouraged, then it can likely be taught. If it can be taught, then it can be systematized. More pervasive systematic innovation will accelerate change in the world. Individuals and organizations that master this kind of innovation will gain tremendous competitive advantages. The more people innovate, the more opportunities to innovate there will be. Creativity begets creativity. That is possibly the most powerful and earth-changing tenet of innovation. By analogy, perhaps not everyone can become a professional tennis player. Some lack the personality, talent, skill or physical abilities. Yet anyone can learn to play tennis and, once taught, they can learn to improve their tennis-playing skills. Is innovation the same? Is it largely a function of confidence born of study, comprehension and practice?

The microcosm studied in this thesis – that of discontinuous innovation applied to mature products – underscores the promise of potential far grander. If innovators, whether in small businesses or large corporations, seeking to capitalize on existing products with proven demand can combine *innovation* with *iteration* to consistently produce value for product stakeholders, what could they do to disrupt products as we know them? How many new product categories would emerge?

Finally, if ordinary people everywhere began seeing themselves as and acting like innovators, what would stop any of us from changing the world? The possibilities are

endless. Albert Einstein said: “Imagination is more important than knowledge, for knowledge is finite and imagination is infinite.”

1.5. Hypothesis

It is hypothesized that innovativeness can be encouraged through the learning and application of universal innovation principles and processes.

1.6. Scientific Methodology

This research effort applies the scientific method to innovation. An innovation hypothesis is formulated in chapter one. Available research theories and findings are summarily presented in chapter two. These findings and theories are condensed and combined with original frameworks into a comprehensive innovation model in chapter three. Model and hypothesis validity are tested in chapter four through use of a case study. Finally, implications, conclusions, opportunities and recommendations are discussed in chapter five.

1.7. Delimitations

- Research predominately assesses driving principles, techniques, processes and factors of successful product innovation rather than reasons to innovate or effects of innovation. Findings are primarily concerned with the ‘how’ of innovation as opposed to the ‘why.’
- This research addresses product development as a whole – a popular theme in design and engineering – only insofar as it pertains to innovation.
- Innovation success measures are often subjective. Product innovations occur inextricably with external forces such as marketing and advertising, which in turn

contribute to success measures such as customer demand and market penetration. These factors are outside the scope of this research effort. Consequently, this study serves as a theoretical exploration of innovation rather than a definitive determination.

1.8. Definitions

- **Creativity** – The intentional creation of unique, valuable ideas.
- **Discontinuous Innovation** – The reinvention of products, processes or services.
- **Disruptive Technologies** – Inventions that introduce an entirely new set of initially-underperforming attributes than those historically valued by customers.
- **Innovation** – The implementation of creative and inventive ideas into the marketplace.
- **Innovation Harmony** – A new theory involving universal principles, processes and frameworks that work in unison toward achieving universal innovation success.
- **Invention** – The creation and reduction to practice of unique, valuable ideas.
- **Sustaining Technologies** – Innovations that maintain a constant trajectory of performance improvement that has been historically demonstrated in a market.

1.9. About the Author

Daniel C. Smoot is a graduate student at Brigham Young University, working toward completion of a Master of Science (MS) degree in the Ira A. Fulton College of Engineering and Technology, with emphases in Manufacturing Systems and Product Development.

Dan recently graduated from Brigham Young University's (BYU) MBA program, with emphases in Marketing and Entrepreneurial Management. This MS thesis constitutes Dan's completion of the requirements for the MS/MBA Integrated Product Development program, BYU's industry-leading curriculum in integrated business and product management. Dan graduated with a Bachelor of Science from BYU's Mechanical Engineering program (BSME) in 2000.

Following the completion of his BSME, Dan worked as a manufacturing project and process engineer for BD Medical Systems (Becton, Dickinson and Co.) and Manufacturers' Services Ltd. (Celestica), respectively. Extensive internship and consulting engagements since 1997 have included employment at Qualcomm, Myriad Genetic Laboratories, 3Com Corporation, Pacific Research and Engineering, Dow Chemical and Control4, as well as numerous startup and small business ventures.

Dan and his wife, Candice, have a one year-old daughter, Amber Michelle, and currently reside in American Fork, Utah.

CHAPTER 2: LITERATURE REVIEW

"Depending on what management fad is hot, you might be tempted to believe that there is only one ideal way to design products and services. This isn't true. There is no single best way."

– Kawasaki [16]

2.1. Product Innovation Defined

This chapter begins an exploration of available research in the form of studies, publications, ideas, conjectures and theories pertaining to innovation. As pronounced by Kawasaki, there is no one ideal way to design products and services. Innovation is subjective, with few bounds or finite measures. If this is true, then what *is* innovation?

2.1.1. Rogers and Shoemaker

Rogers and Shoemaker [32] defined innovation as "an idea, practice, or object perceived as new by an individual." This definition leaves the matter open to wide interpretation. Objective measures mean little with respect to innovation, Rogers and Shoemaker argued. Furthermore, whether or not an idea is actually, objectively new is not nearly as important as its perceived or subjective newness. Thus, if people perceive an idea as new and fresh, then it is innovative.

2.1.2. Robert

Robert [29] made an important distinction between innovation and invention. He said: “Innovation is the broader concept of continuous improvement, whereas invention is one form of innovation. Inventions are usually associated with discoveries – technology, patents, formulas, and so forth.” Given this distinction, innovation can be looked at as a slower, more methodic process that provides competitive advantage to an individual or organization over time, whereas invention embodies instances of discovery within an ongoing span.

Robert referred to product innovation as a tool used by organizations to redeploy assets and resources for increased productivity through a process of systematic anticipation, recognition and exploitation of change. If innovation is a systematic tool, then its results must have substance and can therefore be defined and measured.

2.1.3. Kuczmarski

Kuczmarski [18, 19] described innovation as a multifunctional and disciplined management process as opposed to an unstructured brainstorming activity. Innovation fuses analytics and creativity. It is a pervasive attitude that enables individuals and organizations not only to see beyond the present but more pointedly to *create* the future.

2.1.4. Majaro

Majaro [21] depicted the relationship between creativity and innovation as a series of intersecting circles (Figure 2.1), where creative ideas are the input and innovation is the output. Ideas are screened to produce results, which include making something newer, better, faster, cheaper, and/or more aesthetic.

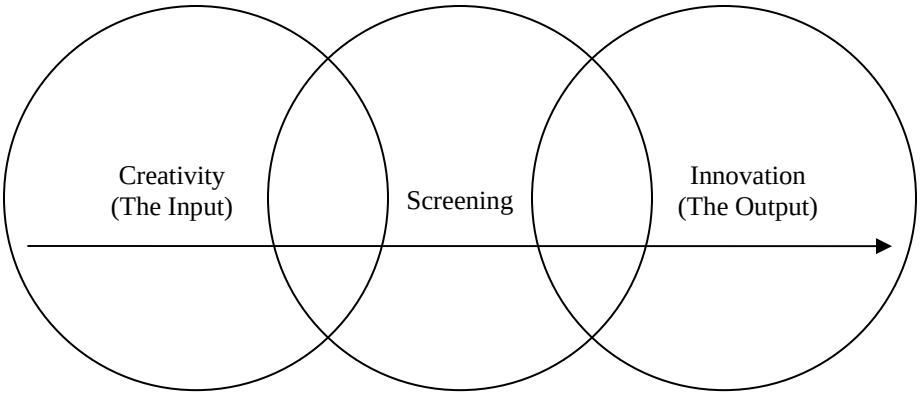

Figure 2.1. Relationship Between Creativity and Innovation

2.1.5. Product Innovation Definition Summary

Innovation is different from invention or creativity. Invention is associated with a new concept that is demonstrated to have value. As defined by the US Patent Office, it must be unique, have value and be reduced to practice. Creativity is closely related. It must contain four elements: uniqueness, value, intent and implementation. Both invention and creativity can be seen as stopping at what we might call the "prototype" stage. Innovation picks up from that point and carries the idea into commercialization. It is a fusion of continuously-applied attitudes, talents and tools. Its measures are subjective but definable. Innovation is a change vehicle, one that creates a new future state.

2.2. Types of Innovation

"Problems cannot be solved by thinking within the framework in which the problems were created."

– Albert Einstein

One of the problems with innovation is that it can be hard to understand in concrete terms. This section looks at prevailing theories that look at innovation from a

conceptual standpoint. These “types” of innovation – or innovation concepts – are important to understanding innovation more objectively, from the outside looking in to its inherently subjective nature.

2.2.1. Robinson

Robertson [30] defined *discontinuous* innovation as a process involving the establishment of new consumption patterns for existing products and the creation of previously unknown, new products. This paper takes a slightly different view of discontinuous innovation, as set forth in chapter one. Discontinuous innovation connotes new consumption patterns for existing products while disruptive innovation refers to the creation of entirely new products.

2.2.2. Christensen

These concepts are in part an extension of Christensen’s [8] distinction between sustaining and disruptive product performance trajectories. Christensen explained that sustaining technologies “maintain a trajectory of performance improvement that has been established in a market; that is, they give customers more and better in the attributes they already value.” Disruptive technologies, on the other hand, “introduce a very different package of attributes to a marketplace than the ones that mainstream customers historically have valued.” As seen in Figure 2.2, customer/market need trajectories, represented by sustaining technology lines, intersect with technological improvement trajectories, causing the outpacing of performance improvement that customers need or are able to absorb.

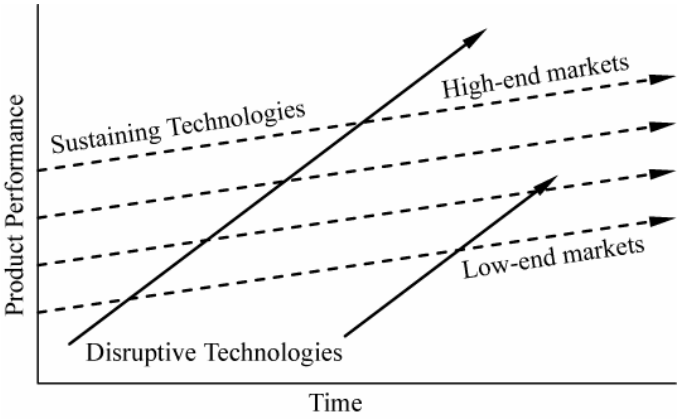

Figure 2.2. Christensen's Product Performance Trajectories

2.2.3. Garcia and Calantone

Garcia and Calantone [12] defined innovation much as has been discussed as "an iterative process initiated by the perception of a new market and/or new service opportunity for a technology-based invention which leads to development, production and marketing tasks striving for the commercial success of the invention." 'Innovativeness' was defined as a measure of the degree of perceived 'newness' of an innovation.

Newness factors include new-to-the-world, industry, scientific community, firm and customer. These factors can be applied to a wide range of innovation possibilities: new technologies, product lines, product benefits/features, product designs, processes, services, competition, customers, customer needs, consumption patterns, uses, improvements/changes, development skills, marketing/sales/distribution skills, managerial skills, learning/knowledge and quality/benefits.

Figure 2.3 demonstrates Garcia and Calantone's Technology/Marketing S-curve Theory, which closely mirrors Christensen's Product Performance Trajectories concept. The S-Curve Theory depicts technological growth rate (defined as product performance)

as a function of research and marketing effort, which could just as easily be defined as innovation effort. As the growth curve reaches a plateau for mature products, disruptive products invade with initially lesser performance that accelerates and eventually surpasses their predecessors.

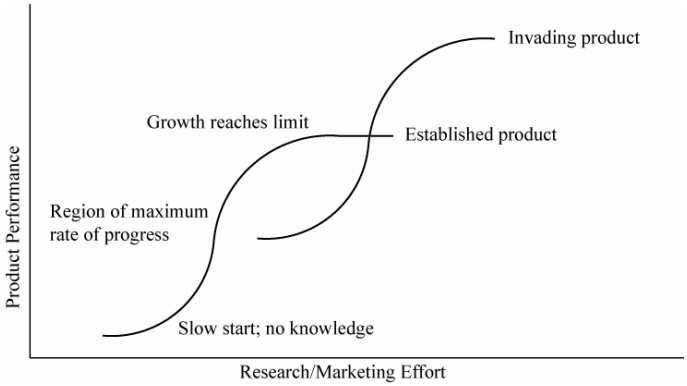

Figure 2.3. Technology/Marketing S-Curve Theory

2.2.4. Rosenau, Griffin, et al.

Rosenau, Griffin, et al [33] discussed a concept called the M-Curve theory (Figure 2.4), which explains the relationship between time invested in the innovation process, idea volume and the generation of new versus old ideas. The interface between the two arches of the 'M' represents a psychological barrier faced during middle phases of successful product innovation efforts. As teams work synergistically to produce new, novel ideas, their efforts will be rewarded as they push through that barrier and continue to generate concepts. This is where the concept of systematic and regimented creativity comes into play. Without requisite process structure, it is likely that innovation efforts will prove at best only marginally successful. Idea volume is critical to innovation.

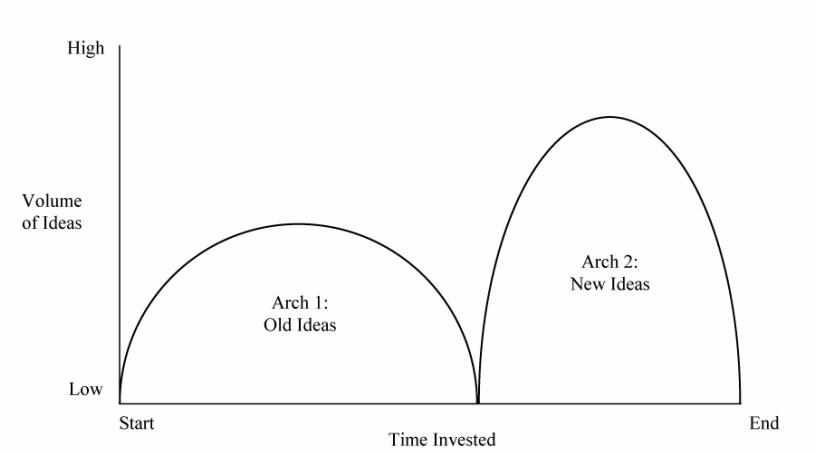

Figure 2.4. M-Curve Theory

2.2.5. Innovation Types Summary

There are many ways to conceptualize innovation. It can take the form of a sustaining or disruptive technology curve, an s-curve or m-curve. It can be discontinuous or continuous. These theories allow innovators to consider innovation from an outside, objective standpoint. They are admittedly oversimplified yet important to understanding what innovation is and how it can be achieved.

2.3. Product Innovation Success Factors

Understanding how innovation can be measured is critical to knowing if and how it can be taught. In order for innovation to be measured, it must have elements of universality. Otherwise, it would forever float in limbo; no one would know exactly how to create or recreate it because no one would know exactly how to distinguish it if and when it had been achieved. This section delves into success factors – the units of measurement – associated with innovation.

2.3.1. Belliveau, Griffin and Somermeyer

Belliveau, Griffin and Somermeyer [3] described a term called “universal design.” They called it the “design of all products and environments to be usable by people of all ages and abilities, to the greatest extent possible.” This definition seems flawed. Such a notion might more appropriately be termed “design for universality.” *Universal* design, on the other hand, should denote universal ‘recognition as good design’ rather than ubiquitous usability and appeal. The former definition would not preclude universally-designed products designed for niche ages or abilities. Yet this does not mean that universality cannot be one of the factors of universal design, for indeed it is.

Belliveau, Griffin and Somermeyer presented numerous principles of design for universality. These principles are significant, as they begin to provide a framework for successful innovation. They begin to provide benchmarks for innovation measurement. Their principles included:

- Equitable use – design is useful and marketable to people with diverse abilities.
- Flexibility in use – design accommodates a wide range of individual preferences and abilities.
- Simple and intuitive use – design is easy to understand, regardless of the user’s experience, knowledge, language skills, or current concentration level.
- Perceptible information – design communicates necessary information effectively to the user, regardless of ambient conditions or the user’s sensory abilities.
- Tolerance for error – design minimizes hazards and the adverse consequences of accidental or unintended actions.

- Low physical effort – design can be used efficiently and comfortably and with a minimum of fatigue.
- Size and space for approach and use – appropriate size and space is provided for approach, reach, manipulation and use regardless of the user's body size, posture or mobility.

2.3.2. Allesch

Universality *is* an important element of universal innovation but it is not the only one. Allesch's [1] outline of fundamental product characteristics (Table 2.1) reveals different elements which add to the corpus of universal, or generally successful, innovation factors. Notably, factors such as specification, price and cost are easily quantifiable. Yet, as with most every factor of innovation, quantified measures only take meaning when compared relatively.

Table 2.1. Fundamental Product Characteristics

Element	Definition
Specification	Specified form, structure, size or component concerning material, product, tool and equipment.
Efficiency	The item in regard to its fitness for the purpose of usage of product, which closely relates to ability or precision.
Reliability	The property that maintains the required function during a specified period under a certain condition.
Safety	The property that avoids harm and destruction.
Maintainability	Keeping a workable situation to accomplish the function of product, or repair-ability.
Transportability	Stability and mobility for transportation or keepings its stability in storage.
Feeling	The property that is evaluated intuitionally by users.
Guarantee	Contents presented by maker as an assurance or statement of virtues.
Price or Manufacturing Cost	The price or cost represented by an amount of money.
Total Life Cycle Cost	The accumulated cost which is required during life cycle period.

2.3.3. Wheelwright and Clark

Wheelwright and Clark [39] summarized the threefold sources of competitive advantage through new product innovation as design quality; product performance; and market share and cost. All of these are important but difficult to gauge. They only become relevant when considered as part of a comprehensive whole. Market share, for instance, is an excellent quantitative measure of customer acceptance and demand within mature product categories. However, it is meaningless in new product categories and *alone* can never objectively measure innovation successfulness since a product's market share is also determined by many externalities. Design quality, product performance and cost are also all excellent innovation measurements but again can only be assessed relatively. They often involve tradeoffs that may be impossible to anticipate or retrospectively qualify.

Table 2.2 summarizes Wheelwright and Clark's discussion of competitive imperatives within new product development efforts, which are equally applicable to innovation environments. These elements center more on the innovation *process* rather than its results, making them an important distinction from previous elements which relate to the *end* rather than the means.

Table 2.2. New Product Development Competitive Imperatives

Required Capability	Driving Force	Implications
1. Fast and responsive	Intense competition; changing customer expectations; accelerating technological change	Shorter development cycles; better targeted products
2. High development productivity	Exploding product variety; sophisticated, discerning customers; technical diversity	Leverage from critical resources; increased number of successful development projects per engineer
3. Products with distinction and integrity	Demanding customers; crowded markets; intense competition	Creative combined with total product quality; customers integrated with truly cross-functional development process

2.3.4. Danneels

Danneels [10] described product innovation as the linking of an organization's technology and customer competences, as depicted in Figure 2.5. Technological competence, representing the supply side of the market equation, consists of manufacturing plant and equipment; manufacturing know-how; engineering know-how; and quality assurance tools. An organization's customer competence, the demand side of the equation, consists of knowledge of customer needs and processes; distribution, sales and communication channels; and company/brand reputation.

Figure 2.5. Danneels' Technological and Customer Competence Model

Given this definition, innovativeness cannot exist in isolation from the customer. In fact, the customer's subjective assessment of innovation is the only basis from which more objective measures can hope to sprout. And yet there are many customers just as there are many kinds of customer. Because the term "customer" tends to evoke images of an end-user, who is only one of many actual customers with a stake in product innovation, this treatise replaces the notion of customer as end-user with that of customer as stakeholder. Product stakeholders are both the creators and measurers of product innovation.

2.3.5. Rosenau, Griffin, et al.

Rosenau, Griffin, et al [33] agreed. They discussed a variety of success factors in developing and launching new products, including "developing a superior, differentiated product, with unique benefits and superior value to customer or user," having a strong market orientation and "getting sharp, early product definition before development begins." Factors leading to successful product innovation included product uniqueness and superiority, consumer needs, market attractiveness, stage of product life cycle, and organizational synergy and familiarity.

Successful innovation is achieved holistically. Thus, innovative, differentiated products tend to share common traits. These authors suggested the following commonalities:

1. Offer entirely new benefits not offered by existing products.
2. Offer a new secondary benefit in addition to the new key product benefit.
3. Make comparative claims versus competition.
4. Eliminate an important negative in existing products in the market.
5. Offer a higher-quality product than is currently available in the market.
6. Tap into current/emerging trends in society.
7. Offer a price advantage versus currently available alternatives.

2.3.6. Innovation Success Factors Summary

The measures of universally successful innovation are both qualitative and quantitative. They are constantly changing because people are constantly changing and people are, for the most part, the principal stakeholders of innovation. People desire various elements in the products and services they make and consume. They desire

safety, newness, differentiation, universality, competitive advantage, quality, speed, performance, efficiency, reliability, perceptibility and simplicity, to name a few. The list goes on but what is perhaps most important, more so than the list elements individually, is the fact that there is a list in the first place. People value certain, specific, even universal things and attributes; innovation is how those things are achieved.

2.4. Product Innovation Models

Innovation creation is at the heart of this study. Traditional product innovation models assess the ability to innovate in terms of inter-related organizational competencies, or divisions of labor, such as research, development and technology; marketing; and manufacturing. These models detail the relationships and flow of information between traditional segments of product development organizations and in relation to the customer.

Traditional linear models include technology push and market pull paradigms, summarized in Figure 2.6 and Figure 2.7. In these models, information and relationships flow sequentially from one logical entity to the next. Traditional non-linear models (coupling and interactive [36]) approach innovation creation from a different, perhaps less systematic paradigm, as summarized in Figure 2.8 and Figure 2.9. Finally, Trott [36], Sharma [35] and Brown [2] presented hybrid linear/non-linear models, as summarized in Figure 2.10, Figure 2.11 and Figure 2.12.

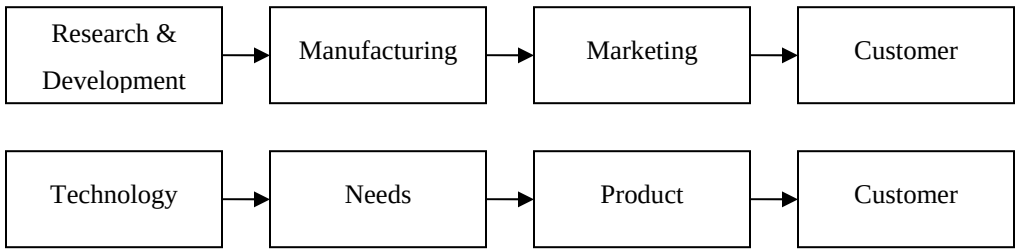

Figure 2.6. Technology Push Models

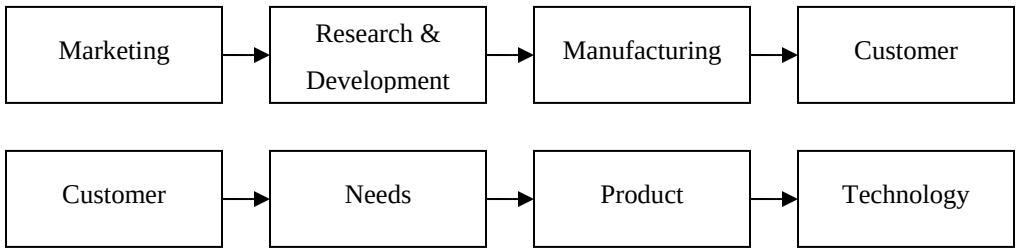

Figure 2.7. Market Pull Models

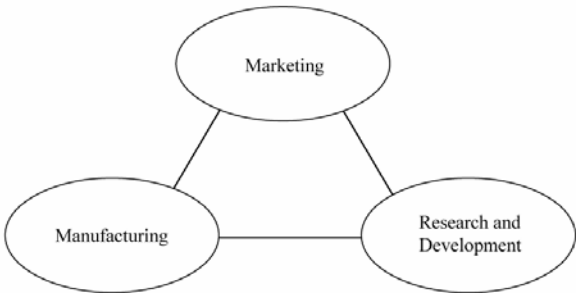

Figure 2.8. Coupling Model

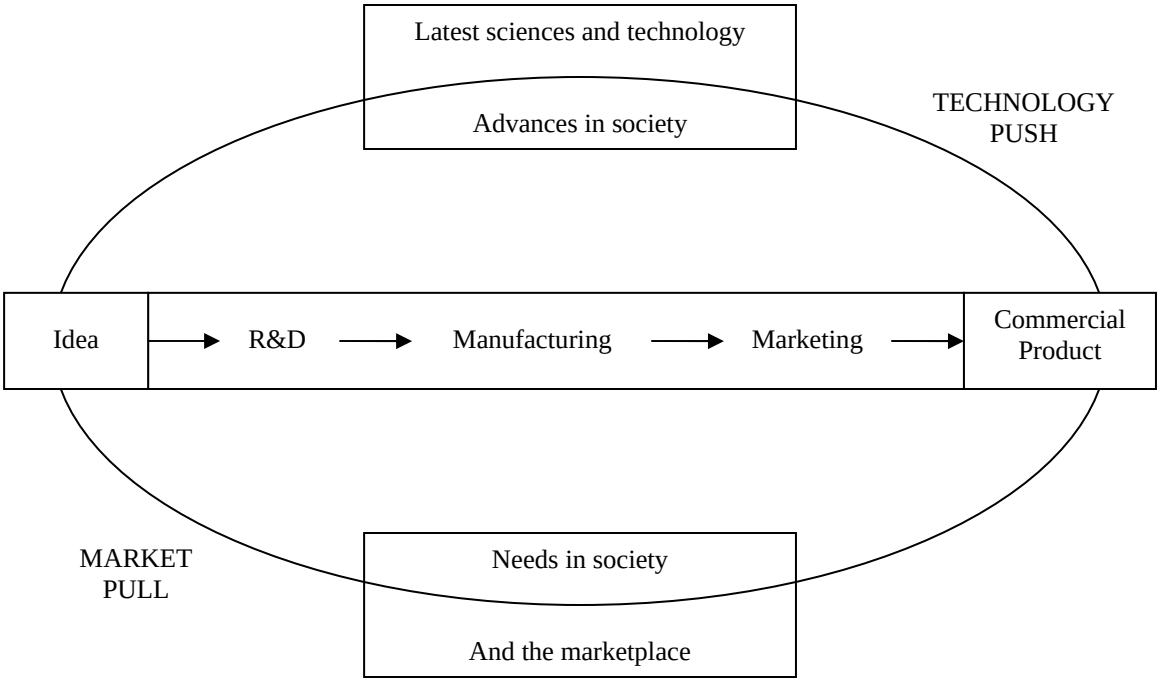

Figure 2.9. Interactive Model

Table 2.3 outlines the chronological development of these linear and non-linear models.

Table 2.3. Chronological Development of Innovation Models

1950-60's	Technology Push	Simple linear sequential process. Emphasis on R&D. The market is the recipient of the fruits of R&D.
1970's	Market Pull	Simple linear sequential process. Emphasis on marketing. The market is the source for directing R&D. R&D has a reactive role.
1980's	Coupling Model	Emphasis on integrating R&D and marketing.
1980-90's	Interactive Model	Combinations of push and pull.

Trott [36] developed a hybrid innovation model, which behaves both linearly and non-linearly. As depicted in Figure 2.10, various external inputs affect the areas of organization and business strategy; research and technology; and marketing, each of

which involves various other inputs. This process accumulates knowledge over time, enabling individuals and organizations to repeatedly produce innovative results.

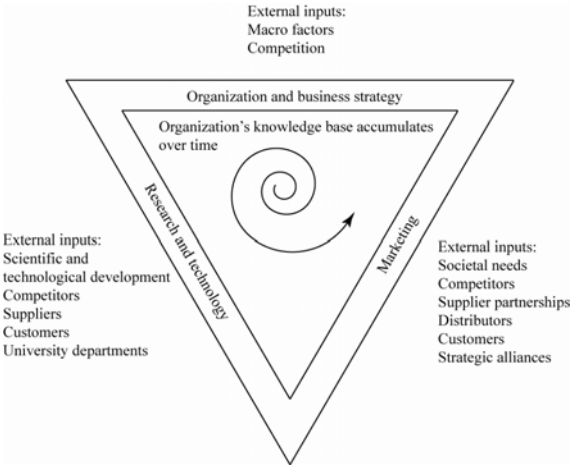

Figure 2.10. Trott's Innovation Management Framework

Sharma [35] described collaborative product innovation as an interrelation of activities and entities working toward a common cause. Figure 2.11 summarizes Sharma's interpretation of the complex linear and non-linear interactions between various innovation stakeholders.

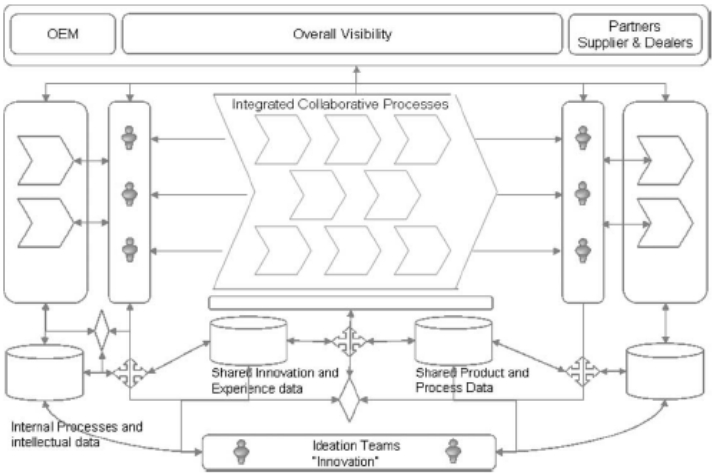

Figure 2.11. Sharma's Collaborative Product Innovation Environment

Brown [1] subdivided the notion of *innovation* into two distinct categories: *consumer innovation*, which produces innovations primarily adopted by households and individuals and therefore creates a market or infrastructure perspective, and *technological or firm innovation*, or innovations created for their own use such as in manufacturing.

In Brown's model, the primary drivers of innovation diffusion are for-profit and not-for-profit *propagators*, whose goal is to "induce the rapid and complete diffusion of the innovation." The agency of these diffusion propagators affects the spatial pattern of innovation in the marketplace. Agency factors include:

- Infrastructure
- Organizational capabilities
- Price, which varies over time and depends on the location of the potential adopter.
- Promotional communications which are implemented to persuade potential adopters to buy and/or use new innovations.
- Market selection and segmentation variables used to target clientele segments differentially. Segmentation factors include geography (region, county and city size, density, climate), demographics (ages, sex, family size, family life cycle, income, occupation, education, religion, race, nationality, social class), psychographics (compulsiveness, gregariousness, autonomy, conservatism, authoritarianism, leadership, ambitiousness), and buyer behavior (usage rate; readiness stage; benefits sought such as economy, status, dependability; end use; brand loyalty; marketing-factor sensitivity, including quality, price, service, advertising, sales promotion).

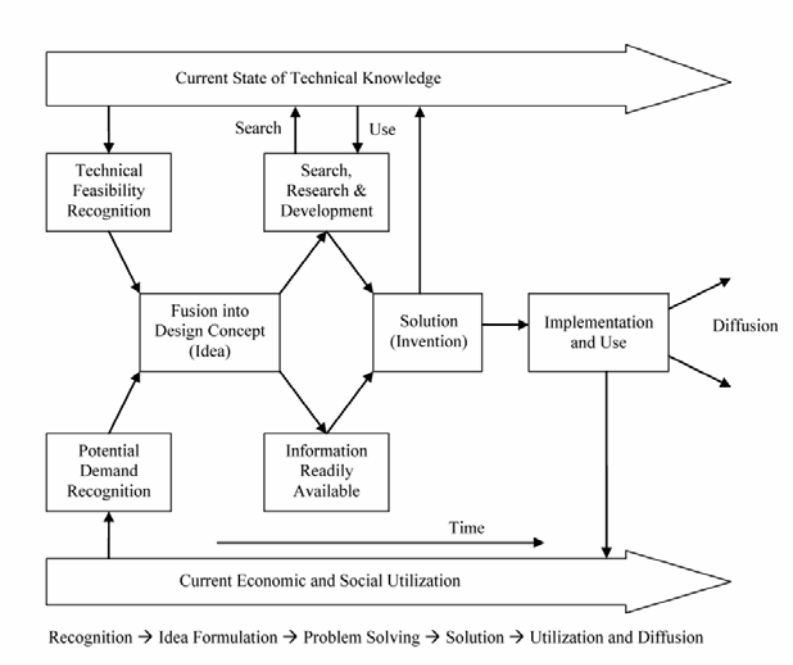

Figure 2.12. Brown's Innovation Process Model

2.5. Product Innovation Environments

The next relevant element of innovation is the environment in which it exists. Can innovation thrive independently of an individual's or organization's environment? If not, which universal environmental factors nurture and cultivate innovation? Which factors destroy it? How are these elements achieved and avoided? The answers to these questions are critical to the understanding, teaching and systemization of innovation.

2.5.1. Bounfour

Bounfour [5] wrote that "innovation has a multidimensional and trans-functional character." Innovation is a change vehicle, enabling an individual or organization to change the rules of the game. Furthermore, systematic innovation creates knowledge. This knowledge, or "continuous process of reinvention," becomes a valuable asset and source of competitive advantage. Bounfour discussed innovation in terms of tacit and

explicit knowledge. Tacit knowledge is difficult to articulate, characterize or formalize; it can be difficult to transfer to others, unlike explicit knowledge which is easily transferable.

Knowledge assets are transferred through socialization (tacit to tacit), explicitation (tacit to explicit), interiorization (explicit to tacit) and combination (explicit to explicit). Various environmental conditions enable knowledge creation through innovation. They include:

- Intention – a strategy or vision of the type of knowledge to be created and implemented.
- Autonomy – "the constitution of project-teams, gathering individuals from different functional or disciplinary horizons, is a powerful level for the development of this autonomy, and thus of creation of new opportunities."
- Fluctuation and creative chaos – which stimulate interaction between organization and environment, leading to changes in organizational behavior.
- Redundancy – the intentional overlapping of information.
- Required variety – which, when reinforced by broad access to information, enables organization members to solve diverse challenges and problems.

2.5.2. Robert

Conversely to Bounfour's constructive factors, Robert [29] outlined seven "deadly sins of corporate stagnation" that are counter-productive to innovation:

1. We must protect our cash cow at all costs, or else we perish.
2. Our industry is mature; there is no more growth or innovation possible.
3. We're in a commodity business.

4. Only entrepreneurs in small companies can innovate. Large companies stifle risk taking and new product creation.
5. Innovators are born. It's a trait of personality, and we just don't have any of these people around.
6. New product creation is too risky.
7. We don't have the resources necessary to innovate.

These "deadly sins" of innovation are central to innovation attitude and perspective. An individual's or organization's perspective on innovation may largely determine its ability to innovate. Failure to cultivate a positive, reinforcing attitude will likely destroy innovation before it ever starts.

2.5.3. Majaro

Majaro [21] explained that creative organizations tend to foster a creative environment by communicating ideas at all levels and maintaining procedures for managing innovation. Individual creativity traits are championed, including conceptual fluency, mental flexibility, originality, suspension of judgment, impulse acceptance, authority-challenging and tolerance of others. Barriers to creativity include overly bureaucratic or under-constrained organizational structure, poor lateral communication, and the 'imported talent' or 'bean-counting' syndromes.

2.5.4. Kuczmarski

Kuczmarski [18, 19] also outlined key environmental considerations for innovation, which included fostering clear accountability, teamwork and communication, motivation and rewards, tenure and experience, and commitment. He argued that three

critical components of an innovation strategy are goals, roles and screening criteria. He further recommended the following environmental factors leading to innovation:

- Optimistic, buoyant and positive upper level management
- A commonly agreed-upon new products strategy
- A balanced new product and technology portfolio
- A consumer-driven development process
- Up-front consumer problems/needs research
- Several dedicated, cross-functional and accountable teams
- A reward structure for new product participants
- A set of innovation norms and values
- A measurement system for assessing innovation and tracking cumulative returns

2.5.5. Prather and Gundry

Prather and Gundry [26] asserted that innovative environments will be challenging and encourage involvement, promote individual and group freedom, give "idea time" and idea support, foster conflict and debate, be fun and playful, trusting and open, and encourage risk-taking. They depicted three arenas of the innovation organization, based on close observations at the DuPont Center for Creativity and Innovation. These arenas were education, application and environment, as depicted in Figure 2.13, with innovation occurring only at the intersection of all three.

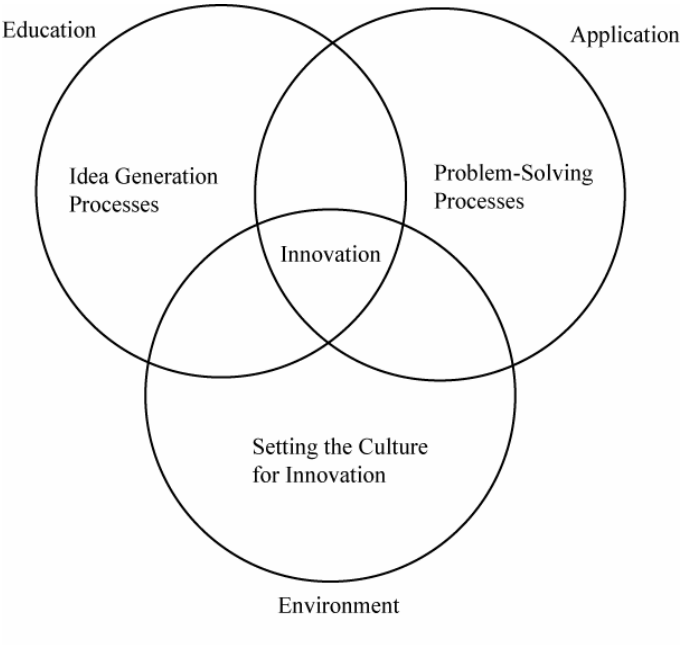

Figure 2.13 Arenas of Organizational Innovation

2.5.6. Carr

Carr [7] identified seven core qualities of creative organizations in the context of an innovation cycle. The innovation cycle involves a chronological sequence of events, from discovery to development, implementation, production, improvement and finally elaboration. Organizations that possess these core qualities of creativity and systematically follow the prescribed sequence of activities are more likely to be innovative. These qualities are as follows:

1. They intend to be creative.
2. Expect their members to direct their creativity toward goals that are important to the organization.
3. Expect their members to perform at a very high level.
4. Expect their members to focus on important problems.

5. Expect their members to spend a significant amount of time trying to formulate a problem in depth before attempting to solve it.
6. Expect their members to consider a wide variety of alternatives before committing themselves to a specific direction.
7. Know that their members must often make many attempts, none of them quite satisfactory, before they come up with the "right" solution.

Carr augmented the qualities listed with ten organizational attributes that support flexibility – a key ingredient to innovation. These attributes are as follows:

1. Built on a high level of trust.
2. Expect everyone to tell it like it is and also expect everyone to ask the questions necessary to find out how it is.
3. Not only permit but encourage everyone to communicate with everyone else.
4. When a problem arises, they look for solutions, not scapegoats; they neither pistol-whip members for making mistakes nor excuse the mistakes.
5. Focus on problems and opportunities, not on personalities and power structures.
6. Use shared values, goals, and objectives to support and enhance self-management.
7. Include their customers and suppliers in their decision-making processes.
8. Are always scanning the horizon and proactively anticipating change: they are skilled at creating their future.
9. Promote ownership and entrepreneurship everywhere.
10. Encourage play, daydreaming and even silliness.

2.5.7. Mauzy and Harriman

Mauzy and Harriman [22] explored some of the rewards derived from companies that implemented creativity programs. In one example, 3M, a diversified technology company that aggressively pursues innovation, estimated that it generated more than $4 billion from new product introductions from 1999-2002. Such supernormal returns on innovation – the direct result of organizational efforts to systematize and reliably reproduce it – are based on six essential abilities:

1. There is no recipe for systemic creativity. There is no silver bullet. Instead, foundational principles and practices can be used to build a framework for individual adaptation.
2. Creativity and innovation are two distinct concepts. Creativity is the generation of novel and appropriate ideas. Innovation implements those ideas and thereby changes the order of things in the world.
3. Creativity happens with individuals, coalitions and teams, and organizations.
4. There are four critical dynamics: motivation, curiosity and fear (opposites), the breaking and making of connections, and evaluation. These form the heartbeat of systemic creativity.
5. Creativity depends on climate. Creativity does not occur in a vacuum; it needs a sympathetic environment.
6. Systemic creativity asks everyone to be a leader. Everyone in an organization is responsible for sparking ideas and shepherding them into useful innovation. A receptionist, no less than a corporate manager, can observe an unhappy customer,

create an idea to correct the situation, and work to make the idea happen. Anyone who takes this initiative leads.

2.5.8. Rowley, Hof, et al.

Rowley, Hof, et al [34] discussed the powerful forces that resist the innovation process, namely the walls built between R&D, manufacturing and marketing. It is therefore critical that constant innovation experimentation be kept cross-functional, economical and scalable. Project teams must remain small and nimble. "To the degree that you can get people in teams small enough that they can be fed on two pizzas, you'll get a lot more productivity."

2.5.9. Edquist

Edquist [11] outlined nine characteristics of a system of innovation approach:

1. They place innovation and learning processes at the center of focus.
2. They adopt a holistic and interdisciplinary perspective.
3. They employ historical and evolutionary perspectives, rendering the notion of optimality irrelevant.
4. They stress the differences among systems and that comparisons among them are important (since it is not possible to compare an existing system to an optimal one).
5. They emphasize interdependence and nonlinearity.
6. They encompass product and process innovations, and sub-categories of these types of innovation.
7. They emphasize the central role of institutions.

8. They are associated with conceptual diffuseness.
9. They are conceptual frameworks or 'approaches', rather than formal theories.

Edquist outlined numerous activities that are important to a system of innovation:

- Provision of research and development (R&D), creating new knowledge, primarily in engineering, medicine and the natural sciences.
- Competence building (provision of education and training, creation of human capital, production and reproduction of skills, individual learning) in the labor force to be used in innovation and R&D activities.
- Formation of new product markets.
- Articulation of quality requirements emanating from the demand side with regard to new products.
- Creating and changing the organizations required for the development of new fields of innovation, for instance, enhancing entrepreneurship to create new firms and intrapreneurship to diversify existing firms, creating new research organizations, policy agencies, and so on.
- Networking through markets and other mechanisms, including interactive learning among different organizations (potentially) involved in the innovation processes. This implies integrating new knowledge elements developed in different spheres of the SI and coming from outside with elements already available in the innovating firms.
- Creating and changing institutions – for instance, intellectual property rights laws, tax laws, environment and safety regulations and R&D investment routines – that

influence innovating organizations and innovation processes by providing incentives or obstacles to innovation.

- Incubating activities, for instance, providing access to facilities, administrative support, and so on for new innovating efforts.
- Financing of innovation processes and other activities that can facilitate the commercialization of knowledge and its adoption.
- Provision of consultancy services of relevance for innovation processes, for instance, technology transfer, commercial information and legal advice.

2.5.10. Sharma

Sharma [35] described innovation as "difficult to describe or define, simply because Innovation is more of an art than science and being inherently intangible its measurement or analysis difficult." However, innovative organizations tend to share a similar mindset, which includes the following elements:

- Process – flexible and not rigid processes that inspire innovation and creativity.
- People – team attitude promoting a culture of innovation with confidence in innovation.
- Knowledge management or effective data access, flow and synthesis for timely decision making.
- Strategy – ability to take calculated and recoverable risks along with measurable short and long term milestones.
- Competencies – clear understanding of core competencies and capabilities.

2.5.11. Innovation Environments Summary

All available research concludes that a supporting environment is critical to innovation. Universal environmental factors that nurture and cultivate innovation include employing a holistic and interdisciplinary approach, autonomy, risk-taking, diversity, organizational synergy, creative chaos, accountability, motivation, rewards, creativity, common values, nonlinearity, and so forth. Conversely, traits such as protectionism and risk-aversion hinder the innovation process and must be avoided in order for creativity to flourish.

2.6. Product Innovation Sources

With a stage set for innovation, how is creativity then evoked? To what sources can individuals and organizations look for new ideas and concepts or, at the very least, unique combinations of old ideas? The list is endless but the following authors have made a good start.

2.6.1. Robert

Robert [29] suggested ten specific business or organizational areas that can be sources of innovation ideas. Changes are pivotal to innovation opportunity, as they break old connections and associations while creating new ones. Robert's suggested areas were unexpected successes, failures, external events; process weaknesses; industry/market structure changes; high-growth areas; converging technologies; demographic changes; perception changes and new knowledge.

Ultimately, opportunities for innovation can be classified into ten core business aspects: product/service concept, market type/category, user/customer class, production

capacity/capability, technology/know-how, sales/marketing method, distribution method, natural resources, size/growth and return/profit.

2.6.2. Rosenau, Griffin, et al.

Rosenau, Griffin, et al [33] took a more infrastructural perspective when considering product innovation sources. They recommended investigating laboratory, management, company situation, distribution, supplier, consumer, marketplace, foreign, government regulations, military and space programs.

2.6.3. Himmelfarb

Himmelfarb [13] detailed key methods for uncovering marketplace needs as a strategic source of innovation. These methods can be used to innovate within new product categories which include new-to-the-world products, new product lines, additions to existing product lines, improvements in or revisions to existing products, repositioning and cost reductions. Methods suggested were:

- Talk to customers; suppliers; competitors; sales reps; distributors; senior management, technical, marketing and manufacturing staff; boards of directors and shareholders, consultants and contract research companies; inventors; and universities.
- Analyze marketplace trends and gaps.
- Identify problems with current products.
- Technical and other publications
- Trade shows and conferences
- Guided brainstorming sessions

- Focus group discussions
- Develop a marketing plan.

Product innovation depends on proper management of the innovation process. A single person should be responsible for identifying idea sources, stimulating ideas and seeking them out, notifying people that their ideas have been heard, cataloging and evaluating new ideas, and reevaluating old ideas.

2.6.4. Kuczmarski

Much like Himmelfarb's [13] delineation, Kuczmarski [18, 19] categorized new products as new-to-the-world, new-to-the-country, new-to-the-company, line extensions/flankers, revisions or improvements to existing product lines, cost reduction, repositioning; licensed, joint ventured or acquired new product.

In a 1993 "Winning Practices" study conducted by Kuczmarski & Associates, Inc., the top reason for new product introduction failure was "lack of understanding of market needs" (Figure 2.14). Understanding both overt and hidden customer needs and wants is clearly a hallmark of successful innovation.

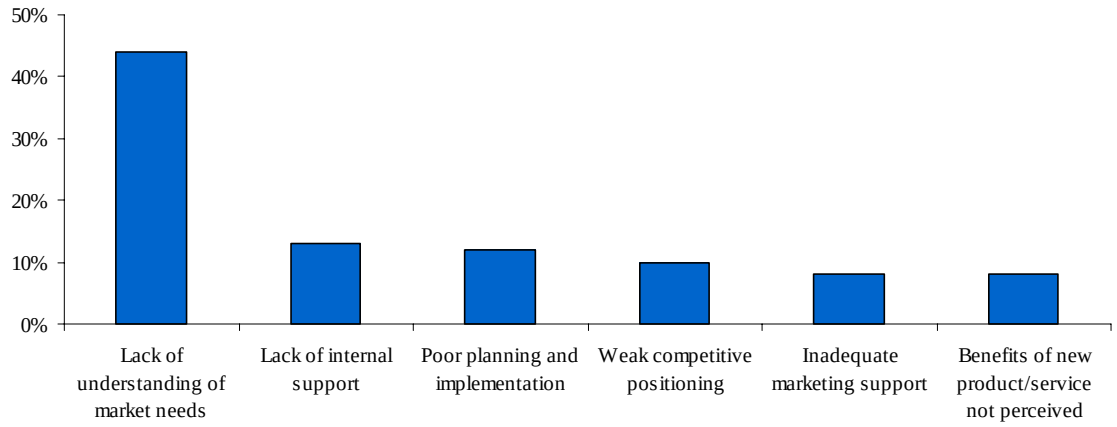

Figure 2.14. New Product Failure Root Causes

2.6.5. Wasson

Wasson [36] delved into sources of mature product market instability, a key ingredient for innovation potential. Customer changes (a moving stream, not a fixed body of people), changes in customers (tastes, standards, lifestyles, needs, etc.), customer mobility, technological changes affecting the industry, the constant appeal of novelty and design compromise (new combinations of attributes) all create instability for mature products. Innovators should channel their creativity through these paradigm changes.

2.6.6. Rhoads

Rhoads [27] outlined nine methods for new product success, which included taking something out of a product, putting something new in a product, answering consumer gripes, making a visible difference, making the task easier, using products in a new way, substituting products, being creative instead of literal and looking overseas.

In contrast, Rhoads discussed three factors that can hinder good, innovative ideas. Termed the "Three D's," these factors were dedication, design and depth. "Dedication" implies that innovators often miss consumer trends by being too dedicated on their tasks or competencies. Resources must be devoted to exploratory research. "Design" emphasizes that relying heavily on quantitative data and conducting narrowly-targeted design research often biases innovators toward more limited courses of action. "Depth" suggests that problem-solution benefits often don't go deep enough to match latent customer needs. Innovators must dig deep while maintaining a broad perspective.

2.6.7. Innovation Sources Summary

The sources of good innovation are as varied as they are numerous. As discussed in chapter one, the more innovation and invention that takes place in the world, the greater the potential for more innovation and invention. Stakeholder changes and changes in stakeholders are excellent sources of innovative ideas, as are new technologies, industry trends and existing product/service weaknesses.

2.7. Product Innovation Processes and Practices

With all other elements in place, including proper understanding of innovation, success measurement factors, a proper environment and the resources available to innovate, what specific processes and practices (tools and techniques) consistently harvest innovative results?

2.7.1. Rogers

Rogers [31] separated the innovation process into six distinct stages: problem definition; basic and applied research; development; commercialization; adoption and diffusion; and consequences. Rogers' definition suggests that innovation cannot be separated from implementation and ultimate adoption. Innovation does not exist in isolation from externalities. It must be approached holistically.

Rogers argued that the rate of innovation adoption (diffusion) depends on customers' perceived attributes of innovation, the type of innovation-decision, communication channels, nature of the social system and the extent of change agents' promotion efforts.

2.7.2. Cooper and Kleinschmidt

Cooper and Kleinschmidt [9] explained the product innovation process from a manufacturing industry perspective. Their steps were: preliminary assessment, detailed investigation (problem definition), development, testing and validation, and commercialization.

2.7.3. Nonaka and Takeuchi

Nonaka and Takeuchi [24] developed an innovation process methodology based on observation of methods in Japanese groups. Their methodology began with sharing tacit knowledge through the principles of autonomy and creative chaos. Next, they recommended creating and justifying concepts by building an archetype (prototype). Finally, their methodology prescribed cross-leveling knowledge in order to maximize the value of the knowledge created.

2.7.4. Majaro

Majaro [21] outlined numerous innovation techniques. These techniques include converting quality circles into creativity circles, building cause and effect analyses (fishbone diagrams and 5-why's analysis) and brainstorming.

Brainstorming should involve a group leader and group scribe as well as other team members. Brainstorming sessions should begin by discussing goals and defining the task. The team may elect to conduct warm-up exercises to free the mind from previous engagements. Next, team members should brainstorm using techniques such as metaphorical analogy, trigger sessions (ideas are first generated independently by team members, then combined and augmented), wildest ideas sessions, morphological analysis

(assessing physical shape and size), scenario writing and/or daydreaming and cluster analysis. Cluster analysis (Figure 2.15) involves recording associated ideas on paper or a whiteboard and drawing connections between related groups/ideas. Majaro emphasized that deliberate, creative idea generation must take place independently of any attempt at evaluation or critique.

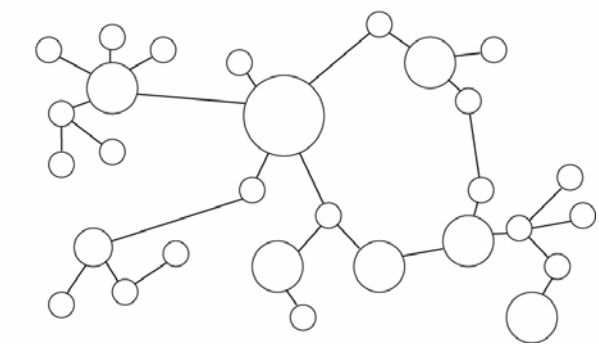

Figure 2.15. Brainstorm Idea Cluster Tool

Finally, brainstorm ideas should be screened using a portfolio management matrix, screening algorithm, force field analysis/diagram and/or other quantified approach to criteria evaluation.

2.7.5. Rosenau, Griffin, et al.

Rosenau, Griffin, et al [33] listed techniques and tools that could be used to generate breakthrough new product ideas. Divergent techniques include linking people, places and things to create new associations and brainstorming on paper, then rotating papers among group members. Convergent techniques include stoplight voting, a quick method of member voting based on knee-jerk preferences; thought organization, including SWOT analysis (strengths, weaknesses, opportunities, threats), ALOU

(advantages, limitations, opportunities, unique features), LCO (likes, concerns, opportunities) and matrix concept selection.

2.7.6. Patrick

Patrick [25] approached product innovation from a marketing perspective: "Customers buy products to fulfill needs, and for no other reason. Those needs, or wants, or desires, may be transparent or they may be subconscious, but they are there." Patrick set forth a process for making this essential link between product design and customer needs:

1. Identify customers' needs based on five levels of emotion that guide consumer behavior:
    - Assimilation – first exposure to incoming data (external stimuli). Data are emotionally clean.
    - Opinions – first emotional responses.
    - Attitudes – general predispositions to respond in a particular way. This is the first level at which behavior can be affected.
    - Beliefs – the collective emotions and feelings that we have formed about things and issues.
    - Values – the most closely-held emotions that we have; the bulwark of our entire motivational structure. More intensely held than beliefs, we have fewer of these. Values are more difficult to change. We don't like to discuss them with strangers. They serve as our life game plan. Includes religion, family, honesty, fidelity, etc.

2. Segment customer needs based on demographic (age, gender, income, education, occupation), geographic (social customs, dress, recreation, homes, foods), psychographic (values and lifestyle systems, labeled as “outgoing optimists”, “conscientious vigilantes”, “apathetic indifferents”, “self-indulgents”, “contented cows”, “worriers”, etc.), buyer behavior, family life cycle (predictable consumption habits), race, nationality, religion and social class.
3. Create product features directed to specific market segments. Factors to consider include packaging, quality, price, unit of sale, brand image, product concept testing, production positioning.
4. Link the product’s benefits, not features, to customers’ needs.
5. Create the unique selling proposition, which links product features and benefits to customer needs. The Perception Expansion Theory states that when people are exposed to new data that are congruent with their attitudes, those data are given added importance. New ideas and products gain additional value as consumers’ needs are satisfied.

2.7.7. Rhoads

Rhoads [27] taught the “Six Thinking Hats” methodology for conducting focus groups. Focus groups are used to discover overt and latent customer needs regarding products and services. Group members are encouraged to think in terms of the respective six hats (may be literal or figurative) in giving feedback. The six hats represent the following notions:

- White hat – information they know about a given product, service or idea.
- Red hat – gut feelings, emotions, intuition.

- Grey hat – critical judgment; why things simply don't work.
- Yellow hat – optimism, benefits, feasibility and value.
- Green hat – creative thinking, new ideas, how things can be improved, altered and modified.
- Blue hat – process-control, summaries, conclusions and decisions regarding the product or service.

Rhoads [27] explained that the problem with many of engineering-driven innovation efforts is that they focus on tangible benefits, instead of core-tangible-augmented benefits. People don't buy tangible benefits; they buy core benefits.

2.7.8. Kuczmarski

Kuczmarski [18, 19] described procedural innovation factors, which include defining a new product blueprint (overall direction for and the role of new products relative to a company's growth objectives and strategy), new product strategy (game plan to achieve the blueprint), consistent execution process, up-front homework (market, competitive and consumer information on target categories, consumer needs and business analysis on new product concepts), and tracking systems (measures progress and performance of new products).

Kuczmarski broke the innovation process down into 2, 4, 7 and 10-step "building blocks," which vary according to the commitment, time frames and resources available for the effort:

- 2-step:
  - Identifying and evaluating new product concepts
  - Developing prototypes and launch plans
- 4-step:
  - Idea exploration and concept development
  - Screening and business analysis
  - Prototype development and product testing
  - Market test and commercialization
- 7-step:
  - Idea generation
  - Concept development
  - Business analysis
  - Screening
  - Prototype development
  - Market test
  - Commercialization
- 10-step:
  - Needs-and-wants exploration
  - Idea generation
  - Concept development
  - Business analysis
  - Concept screening and priority setting
  - Prototype development

- Product-performance and acceptance tests
- Plant scale-up and market testing
- Commercialization
- Post-launch monitoring

2.7.9. Blaich and Blaich

Blaich and Blaich [4] divided the product innovation process down into three constituent disciplines: industrial design (aesthetics, social and cultural backgrounds, visual trends, environmental relation and ergonomic requirements), marketing (market research and analysis, economic situation, distribution systems) and product development (technical research and analysis, economic targets, production methods and ergonomic research).

2.7.10. Prather and Gundry

Innovation requires identifying product opportunities through customer problems and/or needs, generating ideas and implementing the results. Generating ideas is best accomplished by divergence and convergence. Divergent thinking seeks to build, amplify, decorate – to make something more or different than it is. Convergent thinking seeks to select, judge, compare, make things happen, deliver a bottom-line result.

Five pitfalls that hinder innovation listed by Prather and Gundry [26] were:

1. Identifying the wrong problem.
2. Judging ideas too quickly.
3. Stopping with the first good idea.

4. Failing to “get the bandits on the train” – get people whose support you must have or who could derail your project and finding a way to get them on the train so they won’t dynamite the track.
5. Obeying rules that don’t exist.

Tools and techniques for creative problem-solving are to assign an effective facilitator, adopt parallel processing (team members collaborate openly, without having to channel everything through the facilitator), define the right problem, force associations, reverse hidden assumptions, think metaphorically and brainstorm outrageous ideas.

2.7.11. Kelley

Kelley [17] described a process at innovation design firm IDEO called the “Deep Dive.” The Deep Dive is a well-developed and continuously-refined methodology that the company employs to redefine products through innovation. Their methodology is interpreted differently according to project specifics but provides a systematic framework for innovation within their organization. Their innovation process flows as follows:

1. Understand – the market, client, technology and perceived constraints on the problem.
2. Observe – real people in real-life situations to find out what makes them tick: what confuses them, what they like, what they hate, where they have latent needs not addressed by current products and services.
3. Visualize – new-to-the-world concepts and the customers who will use them.
4. Evaluate and refine – the prototypes in a series of quick iterations.
5. Implement – the new concept for commercialization.

Brainstorming and idea-generation efforts have produced a set of universal guidelines which are used to govern innovation at IDEO. These guidelines include: keep a bug list (product/usage annoyances); stay close to the action; there are no dumb questions or ideas; look with a child's eye; inspiration by observation; embrace your crazy user; find rule breakers; yes, people are human; employ observation exercises; look for little innovations; see products in motion; cross-pollinate ideas; and make heroes.

Additional guidelines for brainstorming are to sharpen the focus, stay playful (encourage wild ideas), number your ideas, build and jump from good to new ideas, "the space remembers", stretch your mental muscles and "get physical". Conversely, six universal ways to kill a brainstorm are when the boss has to speak first, everybody gets a turn, experts only are used, offsite meetings are required to consistently generate innovation, no "silly stuff" is allowed and everything must be written down (no doodling).

2.7.12. Kanter

Kanter's [15] exploration of innovation as part of a multistage process, noted also in Robben's [28] work on innovative behavior in high-tech product development organizations, identified four major innovation tasks:

1. Idea generation and activation of the drivers of the innovation (the "entrepreneurs" or "innovators").
2. Coalition building and acquisition of the power necessary to move the idea into reality.
3. Idea realization and innovation production, turning the idea into a model – a product or plan or prototype that can be used.

4. Transfer or diffusion, the spreading of the model – the commercialization of the product, the adoption of the idea.

Kanter [15] further concluded that "innovation is a process that is uncertain, fragile, political and imperialistic. Innovation is most likely to thrive in an organization that allows flexibility, quick action and intensive care, coalition formation, and connectedness."

2.7.13. Ulrich and Eppinger

Finally, Ulrich and Eppinger [37] identified the following concept development steps for market-pull innovation: identify customer needs, establish target specifications, generate product concepts, select product concepts, test product concepts and set final specifications.

2.7.14. Innovation Processes and Practices Summary

Innovation is both art and science. The same can be said of the processes, practices, tools and techniques used to be innovative. Ultimately, the innovation process comes down to first understanding and creating opportunities for change and second testing and implementing the ideas upon which those opportunities are based.

2.8. Conclusions on Innovation Literature Review

Expert theories of innovation are diverse and numerous. It is easy to feel that innovation is so complicated that it is an unsolvable conundrum. Perhaps the status of innovation is, after all, forever relegated to that of an enigma, a matter of chance replication. On the other hand, is it possible that current theories of innovation are classic

examples of the blind men and the elephant? Perhaps all available theories are valid, in part or whole, while it is their *separateness* that makes them incomplete.

CHAPTER 3: SYNTHESIS

May it be that the ephemeral art of innovation is in understanding and applying its science? Perhaps there is nothing magic to innovation after all. This chapter attempts to fuse available theories of innovation into a comprehensive and universal innovation framework – based on research presented in chapter two combined with new concepts developed by the author – that could prove such a solution. Specifically, this chapter provides insight into the definition and nature of product innovation, universal design and innovation factors (units of innovation success measurement), sources of innovation as well as the models, environmental framework, processes and principles which contribute to a new theory called *Innovation Harmony*.

3.1. Product Innovation Definition and Model

Product innovation is a marriage between art and science – a fusion of creativity and analytics. It takes place in sundry forms. It requires discipline and free-spiritedness. Innovation is dynamic, requiring the innovative person or organization to constantly adapt to a changing landscape. Innovation is perception. Objective newness matters little in this regard, for it is the perceived newness of a product that defines its innovativeness, regardless of whether or not it actually embodies new ideas. Innovation may simply entail repackaging old ideas in a new way, for a new application, market or user.

Product innovation anticipates, recognizes and creates change. It is a tool for reshaping the world through people's perceptions and habits. Creativity and invention, the intentional creation and reduction to practice of unique, valuable ideas, are the raw material of innovation. Innovation implements creative ideas into the world, often in the form of continuously-improving and changing products and services.

Product innovation creates a future vision. As such, it requires the ability to see beyond the present while simultaneously understanding the past. It is not whimsical. Consistently discontinuous innovation requires a multifunctional, disciplined process. It requires the application of universal, guiding principles leading to a harmony of stakeholder considerations, wants and needs.

Considering the viability of linear and non-linear models, a hybrid approach to product innovation demonstrates greatest promise, since innovation is itself an interactive process requiring multiple disciplines and considerations coupled into a comprehensive whole. Instances of innovation may be 'push' or 'pull' but that is not the critical element, for in the end both must be at play. It is the simultaneous interaction and coupling of stakeholder needs and wants, indeed of actual stakeholders (and their representatives, in the case of community, society, civilization, the environment, etc.), that yield opportunities for innovation.

3.2. Product Innovation Success Factors

Product innovation successfulness is not black or white. If there is an innovation "sweet spot," it is constantly moving. Innovation success is characterized by a vast array of factors, benefits and attributes with no absolute measures or thresholds. It cannot be

assessed in isolation from manufacturing or marketing, from production or demand – for these are essential (but not the only) elements of success.

Generally, products are increasingly successful the more they fulfill the needs and wants of the stakeholders (whether intended or not) within the system to which they belong. *Understanding and fulfilling stakeholder needs and wants is at the heart of product innovation.* Herein resides the great and unending challenge of innovation: to satisfy stakeholders whose demands constantly evolve and oftentimes seem to contradict each other.

3.2.1. Stakeholders of Innovation Harmony

Stakeholders are more than mere customers. This distinction is critical, since most research emphasizes the role of the *customer* in the innovation process, thereby under-representing or ignoring the additional stakeholders that are so crucial to comprehensive innovation success. Table 3.1 represents a beginning attempt to identify the stakeholders, by needs and wants, of product design and innovation. The list is not intended to be comprehensive or even fully accurate, for stakeholders and their needs/wants are diverse and always changing. It is but a start.

Stakeholders may be different or the same entities/persons. They may be external or internal, domestic or foreign. Individual and collective stakeholder characteristics will determine specific needs and wants. The general needs and wants listed are provided as a frame of reference for innovators who must, in seeking their "sweet spot" of innovation, approach the product system holistically. Otherwise, though a product succeeds across one or several dimensions, it may fail across other equally or perhaps even more

important ones. These dimensions (stakeholders) must constantly work in the mind of the innovator, for they are both the means and the measuring stick of innovation.

Table 3.1. Stakeholder Taxonomy

Stakeholders	General Needs and Wants
Business Owners, Management and Investors	• High sales volume and margins; bottom-line growth • Executable product and project management
Marketers and Advertisers	• Differentiation • Unique selling proposition (benefits and value) • "Curb appeal" • Brand strength
Product Designers and Engineers	• Quality • Technological feasibility • Cost-effectiveness • Innovativeness • Stylishness
Manufacturers and Suppliers	• Manufacturability • Quality • Cost-effectiveness • Short component lead times • Minimal inventory carrying costs • Reliability – minimal returns and rework • Safety to manufacture • Operational leanness • Controllability • Size (Small) • Waste elimination • Ergonomics
Distributors	• Product/Packaging • Lightweight • Size (Small) • Shipping and handling reliability
Sellers	• High margins • High sales volume • Fast inventory turnover • Minimize carrying costs

Table 3.1 – Continued

Consumers	Demographic	• Age • Gender • Race • Ethnicity • Nationality • Religion • Family size • Income • Education • Occupation • Social class • Family life cycle (predictable consumption habits)
	Geographic	• Region • County and city size • Population density • Climate • Social customs • Dress • Recreation • Homes • Foods
	Psychographic	• Values • Lifestyle systems Usage rate • Readiness stage • Buyer behavior and benefits sought (see below)
	The “Special Usage Situation”	• Equitable usefulness and marketability to people with diverse abilities and needs • Flexibility of use, accommodating a wide variety of preferences
	The “Artist”	• Aesthetics • Intuitional “feel” • Emotional response – the “wow” principle • Customization and self-expression
	The “Narcissist”	• Status symbol • Brand image • Affordability may not be a concern
	The “Utilitarian”	• Ergonomics • Robustness • Comfort
	The “Minimalist”	• Simplicity
	The “Penny-Pincher”	• Affordability • Cost-effectiveness
	The “Worry Wart”	• Robustness • Security • Ability to not lose
	The “Green Thumb”	• Environmentally-friendly
	The “Soccer Mom”	• Buy in bulk • “Economy” size

Table 3.1 – Continued

Consumers (continued)	The "Neat Freak"	• Sanitation • Ability to clean and keep clean
	The "Space Saver"	• Efficient use of size and space
	The "Bruiser"	• Fewer moving/breakable parts • Robustness
	The "Protective Parent"	• Safety • Security • High error tolerance
	The "Busy-Body / Multi-Tasker"	• Convenience • Ease-of-use • Consolidation • Mobility/transportability • Stability • Robustness
	The "Handy-Man"	• Ease and cost to maintain and repair
	The "Lifetime Buyer"	• Quality • Dependability • Longevity/Robustness • Total life cycle cost
	The "Technical Novice"	• Ease-of-use and installation
Installers	• Ease-of-use and installation • Foolproof characteristics • Fewer parts/components	
Community, Society and Civilization	• Benefits the poor and needy • Benefits underdeveloped countries and economies • Raises the standard of living	
Nature and Environment	• Biodegradable • Non-toxic • Small • Lightweight	

It should not be misconstrued that the "sweet spot" of innovation requires pleasing all stakeholders. Generally, it is impossible and therefore futile to try to satisfy everyone's needs and wants. Compromise is essential. In this sense, *Innovation Opportunity* – a raw source of potential energy for innovation – can never be fully satiated. Yet somewhere within the opportunity, at the cross-section of stakeholder needs and wants, is a sweet spot where stakeholder value approaches a local maximum.

It goes without saying that marketing and manufacturing, management and the environment, sales and consumption are as fundamental to product innovation as are the

practice of ‘design’ and ‘engineering.’ This is the guiding theme of the *Stakeholders of Innovation Harmony*, as depicted in Figure 3.1.

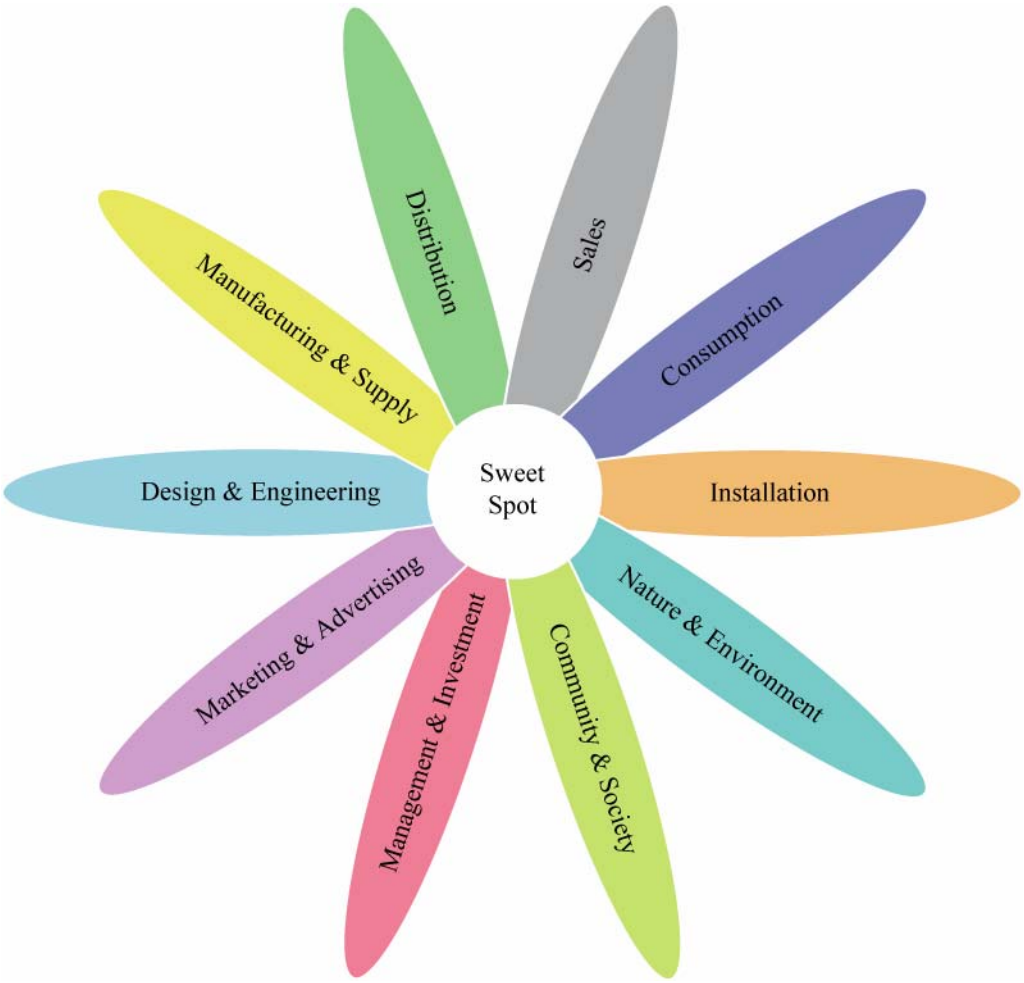

Figure 3.1. Stakeholders of Innovation Harmony

3.2.2. Principles of Innovation Harmony

By assessing the relative and varied demands of stakeholders, consistencies and trends become increasingly apparent. Take simplicity and ease-of-use, for example. It is generally true that most consumers, manufacturers, advertisers and installers (and so forth) prefer that products be as simple to use, make, sell and install (and so forth) as

possible. The same can be said generally of size. Stakeholders, including the environment, distributors and consumers (and so forth) prefer for products to be smaller. These commonalities have been distilled into a few guiding, admittedly generalized, *Principles of Innovation Harmony*. These principles refer to the *ends* (product) of innovation:

1. Simpler is better.
2. Easier is better.
3. Smaller is better.
4. Lighter is better.
5. Stronger is better.
6. Faster is better.
7. Safer is better.
8. More customizable is better.
9. More flexible is better.
10. More aesthetic is better.
11. More harmonious is better.
12. More forgiving is better.

With respect to creativity, several key success factors emerge. These principles are further units of creativity and innovation success measurement. They refer to the *means* (process) of innovation:

1. More ideas are better (idea volume).
2. Broader, more diverse ideas are better (lateral creativity, intuition, imagination, cross-pollination, divergence).

3. Deeper, more knowledgeable ideas are better (linear creativity, logic, knowledge, convergence).

3.3. Product Innovation Environment

A fostering environment is perhaps the most crucial element of innovation and, ironically, the most difficult to qualify or quantify. This does not mean, however, that an innovation environment cannot be systematized. Synergy, like stakeholder needs and wants, is at the core of innovation. Innate individual creativity may be a precursor to, but does not guarantee, innovation success and is therefore conspicuously absent from the environmental factors list that follows. Having the right mind-set to engage in creative processes, fostered by a cultivating innovation environment, is exceedingly more critical.

A new *Environmental Framework for Innovation Harmony* is presented below. These factors are critical to the teaching and implementation of innovation:

Depth and breadth of knowledge. Innovators must have broad and deep access to knowledge through information and perspective. This truism leads to the next: innovation within an organizational construct is more likely to yield greater knowledge depth and breadth.

Organizational synergy and diversity. Innovation is more likely to occur in group versus individual settings precisely because knowledge diversity, depth and breadth are increased through interactive cross-pollination. Synergistic, innovative organizations will consist of flexible and manageable project-teams. Project-teams should enjoy a high level of autonomy, familiarity and socialization. They should be multi-dimensional, trans-functional and diverse. Team members should be committed to each

other and the innovation process. Active involvement, trust and open communication are critical at all levels of the innovative organization.

Structured non-linearity. Sometimes referred to as "creative chaos," structured non-linearity involves the intentional making and breaking of connections through group interaction. Brainstorming activities are an example of structured non-linearity, where silliness and intentional overlapping (redundancy) cross-pollinate ideas and thereby create a fertile environment for innovation.

Clear accountability, motivation and rewards. Individuals and teams should have a strong sense of personal ownership for the innovation process. Likewise, they should share in the rewards of that process, intrinsically and/or extrinsically. Teams should be expected to perform at a high level.

Risk-taking without fear of failure. Contrary to fearing failure, innovation teams should seek to fail early and fail often. Taking risks and failing are critical steps in the innovation process. Management should optimistically encourage innovation efforts to branch out into the unknown early and often.

Productive resistance. In other words, there should be conflict and debate. Team members should feel free to "tell it like it is" without worrying about others taking it personally. This element requires a delicate balance of objectivity and subjectivity.

Common values, norms, goals and objectives. Teams must share a common vision. They must challenge themselves with aggressive but achievable goals. These factors will enable them to focus on important problems and opportunities in the innovation process.

3.4. Discontinuous Innovation Processes and Practices

Chapter two discussed a litany of processes and practices used by individuals and organizations to innovate. This section distills those processes and practices into their most elemental form, with emphasis on the specific application of reinventing mature products.

1. **Identify the Opportunity.**

Identifying a mature product candidate for reinvention may be done qualitatively or quantitatively. For a conceptual demonstration, refer to Figure 3.2, which depicts a theoretical sales volume and average sales price curve for a given product group (such as 'dishwashers' or 'computer monitors'). As the product group matures over time toward commoditization, sales volume and price stabilize. The gap between sales volume and average sales price increases as the product matures, quickly at first, then more slowly as the curves reach a theoretical maximum separation distance. Empirically, the *Innovation Opportunity* is the separation distance between sales volume and average sales price. Subjectively, the Innovation Opportunity underscores the *possibility* that an underlying, rarely overt discrepancy exists between evolving stakeholder needs/wants and the product's perceived benefits. This gap is opportunity to the innovator. While a wide Innovation Opportunity does not *necessarily* mean that the given product can be reinvented, it does suggest that the potential reward for discontinuous innovation is significant.

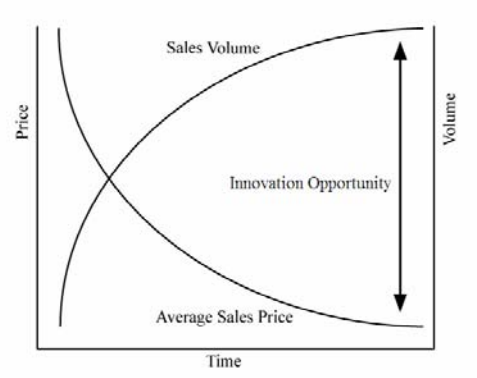

Figure 3.2. Innovation Opportunity

The illustration is simple but important to assessing opportunities for discontinuous innovation, or reinvention. A stabilized Innovation Opportunity denotes strong historical and often strong projected demand for a given product; it also means that prices are approaching rock-bottom while sustaining innovation has reached a plateau. This scenario presents an ideal opportunity for *discontinuous* innovation to intervene and change the rules of the game. The two-fold effects of discontinuous innovation are thus:

1. In addition to traditional sustaining/disruptive technology theories, there is a crucial third possibility – one that can potentially prevent product commoditization while perhaps more importantly preempting always-anxious disruptions, as demonstrated in Figure 3.3. In a very real sense, discontinuous innovations disrupt disruptive technologies by re-defining sustaining technology trajectories. The implications of this concept are significant, particularly for large companies struggling to compete with their smaller, more nimble competitors.

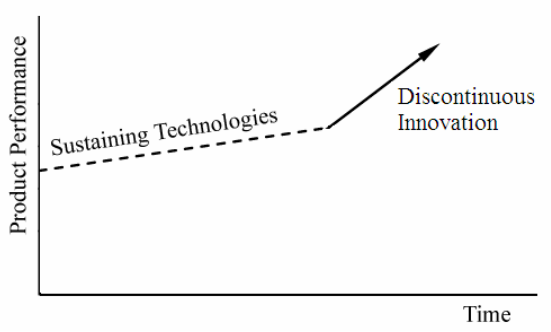

Figure 3.3. Discontinuous Innovation Trajectory

2. Discontinuous innovations re-ignite the average sales price curve without completely disrupting the demand or total sales volume curve – another critical implication for companies with mature products that, for whatever reason, they are not willing to intentionally disrupt or are not capable of disrupting. This follows from the fact that consumers often give high value and are willing to pay more for innovation, or perceived innovativeness. As demonstrated in Figure 3.4, total sales volumes increase as low-price, mature products are cannibalized at a higher price by their re-invented counterparts. The process can and should be repeated over and over again.

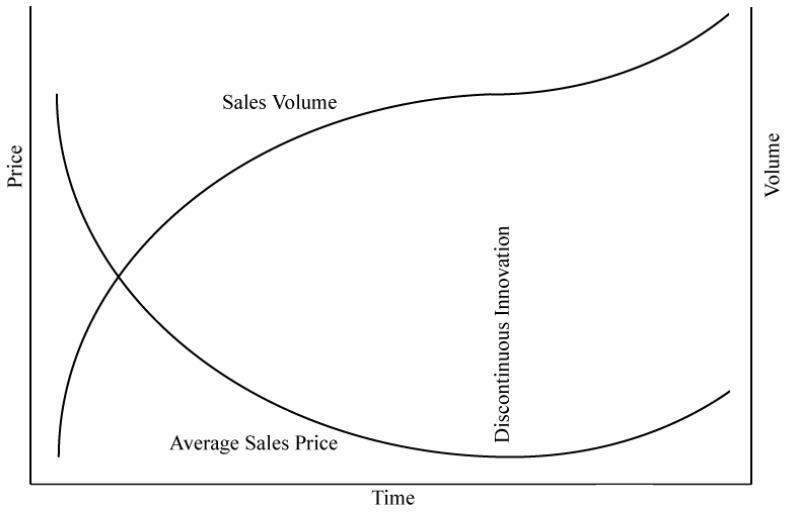

Figure 3.4. Discontinuous Innovation Curves

2. **Qualify and Quantify the Innovation Opportunity.**

This is done by systematically assessing stakeholder needs and wants, not only at project outset but also during intermediate and late stages. Innovators must spend considerable effort identifying the problems and opportunities for innovation before attempting to solve them. Keep in mind that the Innovation Opportunity consists not only of actual features, forms and functions but perhaps more importantly of *perceived, often latent* benefits, strengths and weaknesses. Search for core psychological benefits that stakeholders seek to gain, and the values upon which those benefits are predicated, through their interaction with the product.

3. **Conceptualize the Opportunity.**

Once submersed in a critical mass of stakeholder feedback, having become an "expert" in the chosen product and field, it is critical to disassociate oneself from existing paradigms, preconceived notions, images and expectations. This can be done by conceptualizing the product into its most basic elements, using feature and function maps, as demonstrated conceptually in Figure 3.5 and Figure 3.6 (a more concrete example is provided in the case study). The disassociation of one's paradigms from current product constructs is a foundational step in identifying disconnects between current features/forms/functions and unaddressed stakeholder needs/wants. By so doing, the innovator will be better able to restate, reduce and redefine products into more simplified and/or augmented elements.

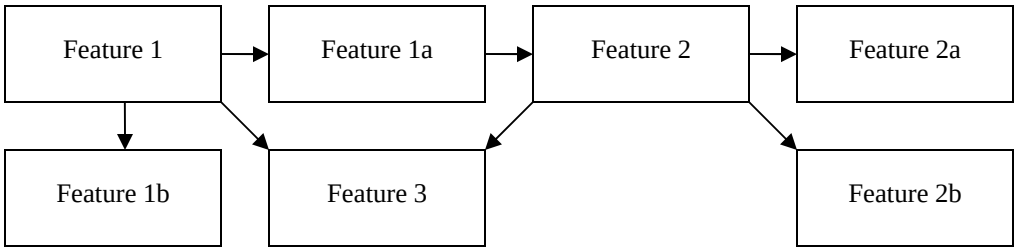

Figure 3.5. Feature Map

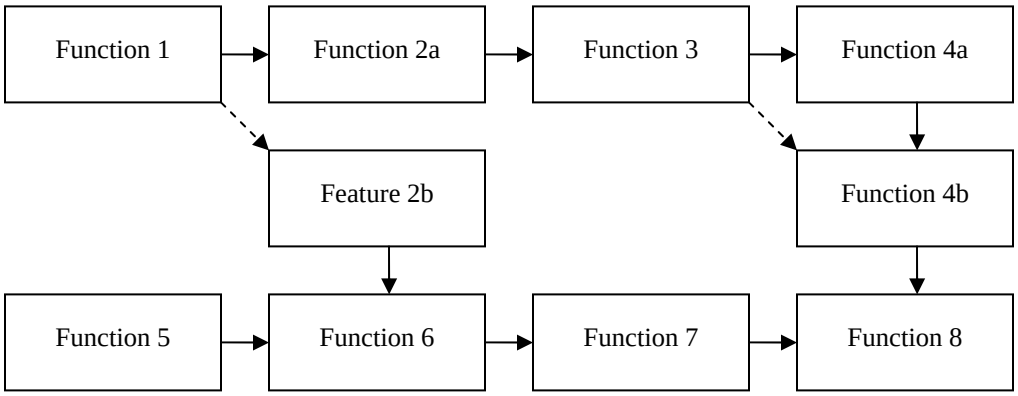

Figure 3.6. Function Map

Figure 3.7 demonstrates conceptually how a feature or function map might be reduced to redefine a product concept.

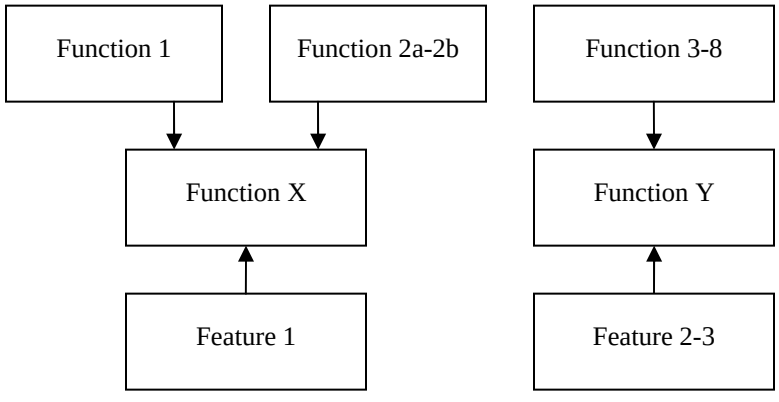

Figure 3.7. Redefined Map

4. Satisfy the Opportunity.

The Innovation Opportunity is satisfied by simultaneously generating, prototyping and refining ideas. This is where science and art combine. Systematically assess functions, features and forms within the *environmental framework, stakeholders and principles of product harmony*, attempting to distill, augment, simplify, combine, add, strengthen and augment fundamental product elements into a new construct. Remember to fail early and often. Brainstorming efforts should be conducted independently of attempts to evaluate or critique. Good ideas – indeed, the best innovations – don't arrive all at once. Good ideas require time, effort and patience, precisely because they are measured only in relation to each other. Idea volume, breadth and depth are therefore crucial to creativity and its validation. While the specifics of this step are beyond the scope of this research effort, it has been determined that sticking with the process or methodology employed will pay dividends. Ongoing efforts to innovate can and should make a difference. Don't give up too soon.

The sources of innovative ideas are diverse and innumerable. They might include but certainly are not limited to:

- Current and external stakeholders (customers, employees, manufacturers, suppliers, distributors, sales reps, senior management, technical, marketing, manufacturing staff, boards of directors, shareholders, etc.)
- External industries
- Achievements within the scientific community
- Other firms and patents
- Additions, improvements and/or changes to existing product lines

- Cost reductions
- New technologies, product lines, product benefits/features, product designs, processes, distribution methods, services, competition, customers, customer needs, consumption patterns, uses, development skills, marketing/sales/distribution skills, managerial skills, learning/knowledge and quality/benefits
- Newer, better, faster, cheaper and more aesthetic design concepts
- Consumer complaints and perceived product weaknesses
- Foreign products and competition

5. **Track the Opportunity.**

Finally, the system is inefficacious without closing the loop or, in other words, measuring the innovation's ultimate successfulness based on stakeholder assessment. How satisfied are consumers? Do they demand the product? Is the product good for society, for the environment, for suppliers, manufacturers, management and other key stakeholders? The qualitative and quantitative answers to these questions should be continually incorporated into the ongoing innovation learning and knowledge creation process.

3.5. Innovation Harmony Summary

The *Innovation Harmony* model (Figure 3.8) encapsulates old and new theories on innovation. *Harmony* connotes a symbiotic union between process and product. Harmonious innovation processes and innovative products are founded and grounded in stakeholder input. The Innovation Harmony model is intended to equip companies and individuals with a better understanding of how innovation can be first implemented and

later systematized. The model begins in broad, universal terms and moves toward specific methodologies that can and should be adapted to the innovator's needs and conditions. The model represents a union of creativity and innovation.

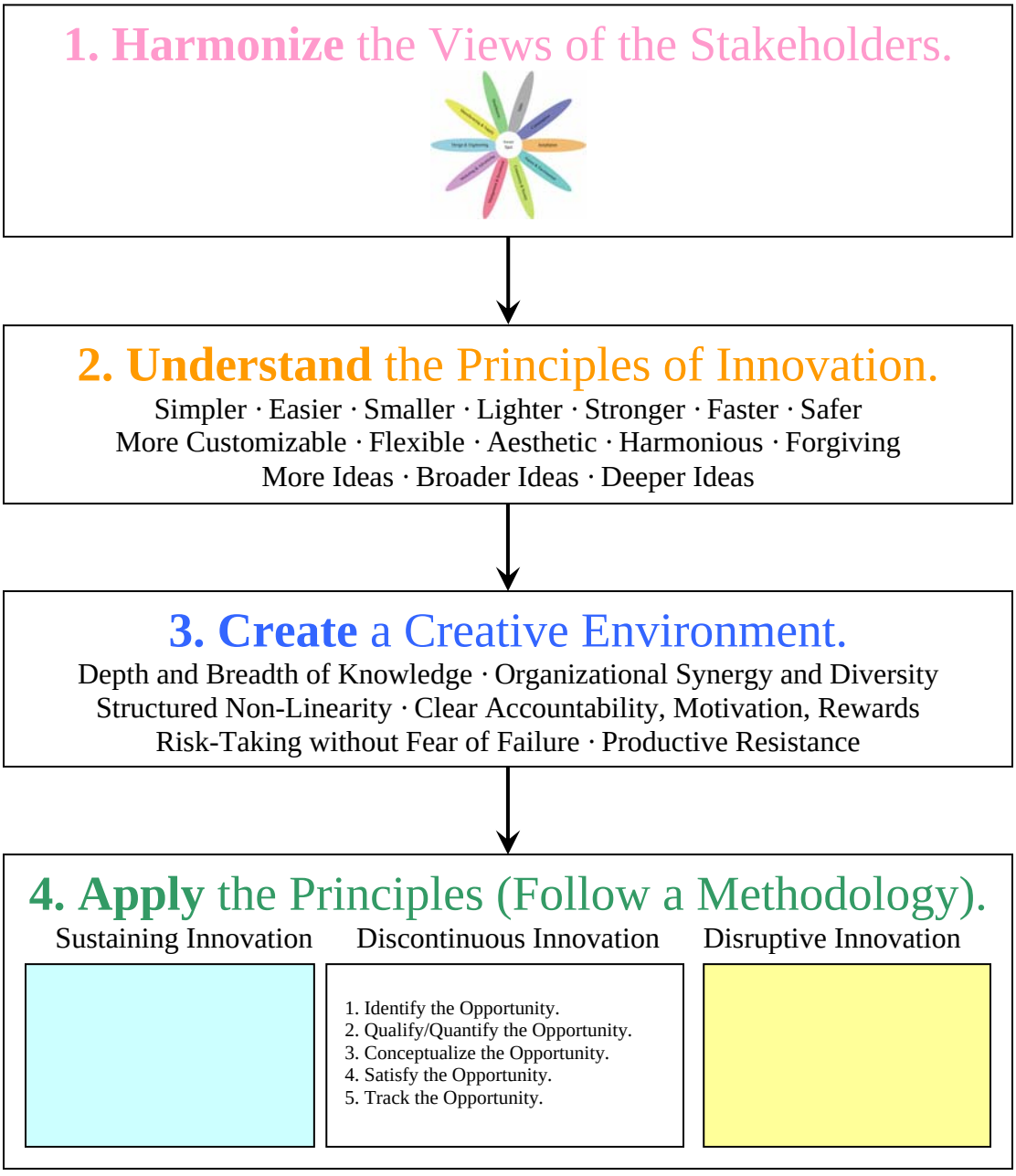

Figure 3.8. Innovation Harmony Model

CHAPTER 4: TESTING THE NEW THEORIES – A CASE STUDY

4.1. Challenge

A case study was designed to test the hypothesis that innovativeness can be encouraged through the learning and application of universal innovation principles and processes. The challenge presented in the following case study was first to teach college students in a controlled environment universal frameworks, principles and processes of innovation and then measure the affect of the teaching process on their "innovativeness." The actual case study is presented in Appendix A. Scanned copies of respondent innovation session documents are included in Appendix B.

4.2. Method

1. **Identify the Opportunity.**

An Innovation Opportunity was identified through collaboration with Brian Beesley, Director of Product Development at Back to Basics, Inc., a world-renowned product innovation firm specializing in kitchen appliance design. The Waffle Iron was selected as the target mature product – one that has seen only minor sustaining innovations in recent decades.

2. **Qualify, Quantify, Conceptualize and Satisfy the Opportunity.**

A written case study was designed for and administered to three groups of undergraduate students at Brigham Young University: a senior team of Mechanical

Engineering students, a randomly-selected group of cross-discipline, History of Creativity students and a randomly-selected group of general university students. Students were given a hypothetical situation in which they were asked to re-invent the Waffle Iron in a series of 5-minute brainstorming sessions. The students were instructed to brainstorm, record (describe or draw) and number their ideas on blank paper. The hypothetical situation was written in such a way as to establish clear accountability, motivation and rewards while encouraging risk-taking without fear of failure. The study was conducted in a timed, controlled environment, with the author serving as proctor. Subsequent to each 5-minute brainstorming session, the students were given additional written instructions on the frameworks, principles and processes of innovation. Prior to the last session, the students were allowed to collaborate, whereas previously they had been instructed not to interact with each other.

3. **Track the Opportunity.**

Student innovation ideas were collected and presented anonymously to individual experts representing the stakeholders of innovation harmony, as listed in Table 4.1. These experts were specifically asked to judge each respondent's sessions' innovativeness based on a common, ordinal (rank-ordered) scale but with singular focus on their respective dimension of innovation harmony. A single score was assigned by each judge for each 5-minute brainstorming session for each case study respondent. No criteria or instructions were given to the judges to help them assess innovativeness (with the exception that they be impartial to drawing ability); therefore, all scores were completely biased toward each judge's interpretation of innovation and innovativeness. Their scores were then aggregated and analyzed, in conjunction with an objective measure of idea volume per

session per respondent, to assess the influence of incremental innovation teaching/learning on perceived innovativeness as measured by stakeholders.

Table 4.1. "Expert" Judges

Stakeholders of Innovation Harmony	Stakeholder "Experts"
Design and Engineering	Product Manager, ATL Technologies
Manufacturing and Supply	Assistant Professor of Manufacturing Engineering Technology, Brigham Young University
Distribution	MS/MBA Graduate, Brigham Young University
Sales	President and Founder, Sundance Doors, Inc.
Consumption (Consumer)	Homemaker
Installation	Not Applicable
Nature and Environment	Freelance Photographer
Community and Society	Former Nursing Home Foundation Director and Master of Public Administration, Brigham Young University
Management and Investment	Financial Analyst, Wasatch Advisors Investment Firm
Marketing and Advertising	Former Chief Marketing Officer, Morningstar, Inc.

4.3. Instructions to Judges

Once collected, scanned and summarized, the case study documents were presented electronically (via email) to the panel of "expert" judges representing the applicable stakeholders of innovation harmony. The judges were instructed as follows: "The students worked on their own during each of five brainstorming sessions (session A through E) to **re-invent (innovate) the conventional Waffle Iron. I would like you to judge how innovative the students were.** 'Innovativeness' is whatever you think it is, so there is no 'right' answer. You simply review each student's five brainstorming ideas and rank the *sessions* in order from 1 [least innovative] to 5 [most innovative]. The students

were only competing against themselves, so you don't need to assess relative innovativeness between students. Don't worry about drawing ability. Focus on the innovativeness of the ideas themselves rather than the way they're presented." The judges were informed of their respective fields of expertise and instructed to "look through the eyeglass of your field as you evaluate innovativeness (i.e. as an engineer, supplier, distributor, salesman, consumer, environmentalist, philanthropist, investor, marketer)."

4.4. Case Study Results and Analysis

The case study produced intriguing results. As ranked on average by the judges, session innovativeness took the form of a bell curve. Session C was judged most innovative at an average score of 3.4, while sessions A and E were least innovative, with average scores of 2.9 and 2.5, respectively. Standard deviations mirrored average rankings, denoting a convergence of judge opinion. Sessions A and E had the highest average score standard deviation (0.67 and 0.93, respectively), while sessions C and D had the lowest average score standard deviation (0.52 and 0.49, respectively). Idea volume diminished linearly over time; session A produced an average of 2.8 ideas per respondent while session E produced an average of 1.8 ideas per respondent. These findings are summarized in Table 4.2. A more detailed summary of case study results is presented in Tables 4.3-4.7.

Table 4.2. Case Study Key Metrics

Innovation Session	Average Innovation Score	Average Innovation Score Standard Deviation	Average Session Idea Volume
A	2.9	0.67	2.8
B	3.1	0.59	2.6
C	3.4	0.52	2.4
D	3.1	0.49	1.9
E	2.5	0.93	1.8

Table 4.3. Case Study Demographic Groupings

Demographic	1	2	3
Age	18-20	21-23	24-27
Gender	Female	Male	--
Major	Engineering and Science	Business	Arts and Humanities

Table 4.4. Detailed Case Study Metric Summary

	Respondent ID#	Demographics			Volume of Ideas: Process — Number of ideas generated during each innovation session.					Innovativeness: Product — Averaged ranking for innovation sessions from 1 (least innovative) to 5 (most innovative).				
		Age	Gender	Major	A	B	C	D	E	A	B	C	D	E
Group X: Engineering Students (Capstone Team)	1	3	2	1	3	3	4	4	3	2.4	2.9	4.6	3.2	1.9
	2	3	2	1	3	2	2	1	3	2.0	2.2	3.7	2.9	4.2
	3	3	2	1	2	2	1	1	1	2.3	3.7	3.1	2.4	3.4
	4	3	2	1	3	3	3	3	3	2.7	3.8	2.9	3.3	2.3
	5	3	2	1	2	2	2	1	2	3.4	2.9	3.4	3.9	1.3
	6	3	2	1	3	4	3	3	3	3.4	3.4	3.6	2.8	1.8
Group Y: History of Creativity Students	7	2	2	1	4	1	1	1	1	3.9	2.1	3.2	3.8	2.0
	8	3	2	3	1	2	2	1	1	3.1	3.3	3.7	3.0	1.9
	9	2	1	3	4	3	2	3	1	2.1	3.0	3.6	3.3	3.0
	10	3	2	3	1	1	1	1	1	3.3	2.8	3.1	3.4	2.3
	11	2	2	2	2	1	2	2	1	2.2	4.0	3.0	3.1	2.7
	12	3	2	1	1	6	8	4	2	3.0	3.4	3.4	3.4	1.7
	13	2	2	1	1	2	1	1	1	3.8	3.9	3.1	2.2	2.0
Group Z: Assorted Students	14	1	1	1	7	2	1	1	1	2.0	2.6	3.4	2.7	4.3
	15	2	2	2	7	6	3	3	3	3.0	3.2	4.4	2.2	2.1
	16	2	2	1	2	2	3	1	1	4.0	2.3	3.6	3.0	2.1
	17	2	1	3	2	2	1	2	2	2.6	2.7	2.4	3.3	4.0
Statistics	**Mean**	**2.5**	**1.8**	**1.6**	**2.8**	**2.6**	**2.4**	**1.9**	**1.8**	**2.9**	**3.1**	**3.4**	**3.1**	**2.5**
	Median	**3**	**2**	**1**	**2**	**2**	**2**	**1**	**1**	**3**	**3**	**3**	**3**	**2**
	Std Deviation	**0.62**	**0.39**	**0.87**	**1.85**	**1.50**	**1.73**	**1.14**	**0.90**	**0.67**	**0.59**	**0.52**	**0.49**	**0.93**
	Minimum	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**2.0**	**2.1**	**2.4**	**2.2**	**1.3**
	Maximum	**3**	**2**	**3**	**7**	**6**	**8**	**4**	**3**	**4.0**	**4.0**	**4.6**	**3.9**	**4.3**

Table 4.5. Case Study Innovation Scores (Judges 1-3)

	Respondent ID#	Judge #1: Design & Engineering					Judge #2: Manufacturing & Supply					Judge #3: Distribution				
		A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
Group X: Engineering Students (Capstone Team)	1	1	5	4	3	2	4	5	3	2	1	2	3	5	4	1
	2	2	1	5	4	3	2	3	4	1	5	1	2	3	5	4
	3	5	3	2	1	4	1	4	2	3	5	1	5	4	3	2
	4	2	3	1	5	4	4	3	2	5	1	2	3	5	4	1
	5	3	2	4	5	1	5	4	3	2	1	3	4	2	5	1
	6	4	3	5	2	1	4	5	3	1	2	2	3	5	4	1
Group Y: History of Creativity Students	7	4	2	3	5	1	4	3	1	5	2	5	1	3	4	2
	8	3	5	4	2	1	5	4	2	3	1	3	2	5	4	1
	9	3	4	5	1	2	5	3	4	2	1	2	1	3	4	5
	10	4	5	3	2	1	2	1	3	5	4	5	3	4	2	1
	11	4	5	3	1	2	4	5	3	2	1	2	3	4	5	1
	12	3	5	2	4	1	5	3	4	2	1	2	3	4	5	1
	13	5	4	3	2	1	3	5	4	1	2	5	3	4	1	2
Group Z: Assorted Students	14	2	3	4	1	5	1	4	3	2	5	1	2	3	4	5
	15	4	2	5	3	1	3	4	5	1	2	1	4	5	2	3
	16	4	5	3	2	1	4	3	5	2	1	5	1	4	3	2
	17	3	2	1	4	5	3	5	4	2	1	2	1	3	4	5
Statistics	**Mean**	**3.3**	**3.5**	**3.4**	**2.8**	**2.1**	**3.5**	**3.8**	**3.2**	**2.4**	**2.1**	**2.6**	**2.6**	**3.9**	**3.7**	**2.2**
	Std Deviation	**1.1**	**1.4**	**1.3**	**1.5**	**1.5**	**1.3**	**1.1**	**1.1**	**1.4**	**1.6**	**1.5**	**1.2**	**0.9**	**1.2**	**1.6**

Table 4.6. Case Study Innovation Scores (Judges 4-6)

	Respondent ID#	Judge #4: Sales					Judge #5: Consumption					Judge #6: Nature & Environment				
		A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
Group X: Engineering Students (Capstone Team)	1	1	2	5	4	3	1	2	5	4	3	2	3	5	4	1
	2	3	1	4	5	2	1	4	2	3	5	1	2	3	5	4
	3	5	4	3	2	1	3	2	5	1	4	1	5	4	3	2
	4	3	4	2	5	1	3	5	4	1	2	2	3	5	4	1
	5	4	3	2	5	1	2	3	5	4	1	3	4	2	5	1
	6	3	4	2	1	5	2	3	5	4	1	2	3	5	4	1
Group Y: History of Creativity Students	7	2	3	4	1	5	5	2	4	3	1	5	1	3	4	2
	8	4	5	3	1	2	3	2	1	4	5	3	2	5	4	1
	9	1	5	2	4	3	3	4	5	2	1	2	1	3	4	5
	10	2	1	5	4	3	4	5	2	1	3	5	3	4	2	1
	11	1	5	4	3	2	1	2	4	3	5	2	3	4	5	1
	12	5	1	2	4	3	5	3	4	1	2	2	3	4	5	1
	13	5	4	2	3	1	2	5	1	4	3	5	3	4	1	2
Group Z: Assorted Students	14	1	5	2	4	3	3	2	5	1	4	1	2	3	4	5
	15	5	1	4	2	3	5	4	3	2	1	1	4	5	2	3
	16	5	1	2	4	3	2	1	3	5	4	5	1	4	3	2
	17	4	5	1	2	3	5	4	1	2	3	2	1	3	4	5
Statistics	**Mean**	**3.2**	**3.2**	**2.9**	**3.2**	**2.6**	**2.9**	**3.1**	**3.5**	**2.6**	**2.8**	**2.6**	**2.6**	**3.9**	**3.7**	**2.2**
	Std Deviation	**1.6**	**1.7**	**1.2**	**1.4**	**1.2**	**1.4**	**1.3**	**1.5**	**1.4**	**1.5**	**1.5**	**1.2**	**0.9**	**1.2**	**1.6**

Table 4.7. Case Study Innovation Scores (Judges 7-9)

	Respondent ID#	Judge #7: Community & Society					Judge #8: Management & Investment					Judge #9: Marketing & Advertising				
		A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
Group X: Engineering Students (Capstone Team)	1	2	1	5	3	4	4	3	5	2	1	5	2	4	3	1
	2	3	2	4	1	5	2	3	4	1	5	3	2	4	1	5
	3	2	5	1	4	3	2	3	4	1	5	1	2	3	4	5
	4	1	3	5	2	4	4	5	1	2	3	3	5	1	2	4
	5	4	2	3	5	1	4	2	5	3	1	3	2	5	1	4
	6	4	5	3	2	1	5	1	3	4	2	5	4	1	3	2
Group Y: History of Creativity Students	7	3	1	4	5	2	4	1	3	5	2	3	5	4	2	1
	8	2	1	4	5	3	2	4	5	3	1	3	5	4	1	2
	9	1	5	4	3	2	1	2	3	5	4	1	2	3	5	4
	10	4	1	2	5	3	1	2	4	5	3	3	4	1	5	2
	11	1	3	2	4	5	4	5	1	2	3	1	5	2	3	4
	12	2	4	5	1	3	1	5	3	4	2	2	4	3	5	1
	13	3	5	4	1	2	3	5	4	2	1	3	1	2	5	4
Group Z: Assorted Students	14	5	1	2	4	3	3	1	5	2	4	1	3	4	2	5
	15	2	3	5	1	4	4	3	5	2	1	2	4	3	5	1
	16	3	2	5	4	1	5	2	4	3	1	3	5	2	1	4
	17	1	3	2	4	5	1	2	3	5	4	2	1	4	3	5
Statistics	**Mean**	**2.5**	**2.8**	**3.5**	**3.2**	**3.0**	**2.9**	**2.9**	**3.6**	**3.0**	**2.5**	**2.6**	**3.3**	**2.9**	**3.0**	**3.2**
	Std Deviation	**1.2**	**1.6**	**1.3**	**1.6**	**1.4**	**1.4**	**1.5**	**1.3**	**1.4**	**1.5**	**1.2**	**1.5**	**1.2**	**1.6**	**1.6**

A single-factor ANOVA (Analysis of Variance) and DBMT (Difference Between Means Test) were used to determine if the differences in innovation scores (between innovation sessions and between respondent groups) were statistically significant. Table 4.8 shows a p-value of 0.005, or a 0.5% probability that the variation occurs by chance, which demonstrates conclusively that there is a statistically significant innovation score variance between sessions.

Table 4.8. ANOVA for Innovation Score Variance Between Sessions

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	7.053	4	1.763	4.065	0.005	2.486
Within Groups	34.700	80	0.434			
Total	41.753	84				

The DBMT (two-sample t-test, assuming equal variances) shown in Table 4.9 provides greater granularity to the ANOVA. It demonstrates which interactions between factors had statistically significant variance. The t-stat represents how many standard errors the mean difference is away from the hypothesized value (zero). P represents the probability that the mean difference would be 't-stat' standard errors away from the hypothesized value even if there were no difference between the two factors. The factors with statistically significant variance were A and C, B and C, B and E, C and D, C and E, and D and E.

Table 4.9. DBMT for Innovation Score Variance Between Sessions

	A&B	***A&C***	*A&D*	*A&E*	***B&C***	*B&D*	***B&E***	***C&D***	***C&E***	***D&E***
Pooled Variance	0.398	0.358	0.344	0.660	0.306	0.292	0.607	0.252	0.567	0.553
Hypothesized Mean Difference	0	0	0	0	0	0	0	0	0	0
df	32	32	32	32	32	32	32	32	32	32
t Stat	-0.785	-2.547	-0.812	1.314	-1.861	0.035	2.005	2.089	3.440	2.075
P(T<=t) two-tail	43.8%	**1.6%**	42.3%	19.8%	**7.2%**	97.2%	**5.3%**	**4.5%**	**0.2%**	**4.6%**

Figure 4.1 shows average innovation score per session broken down by respondent group. All three groups peaked during the third session (C) and then tapered off by the fifth and final session (E). Group Z behaved differently than groups X and Y in sessions B and D, where the respondents' judged innovativeness diminished notably.

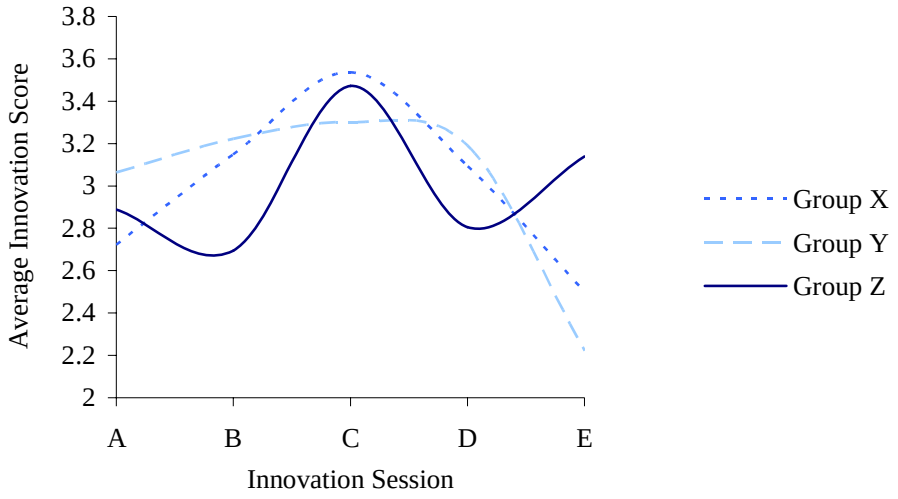

Figure 4.1. Average Innovation Score by Respondent Group

As shown in Figure 4.2, Idea volume diminished from session A to E for all three respondent groups. Group Z tapered off the most, while idea volume for group X remained more constant. Idea volume for group Y increased from session A to C but tapered off like the others by session E.

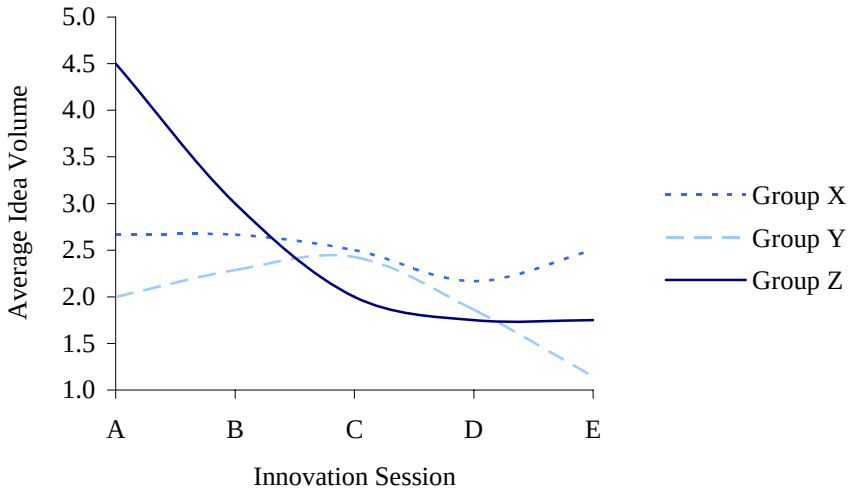

Figure 4.2. Average Idea Volume by Respondent Group

While there was variance in idea volume between respondent groups, it was not statistically significant. Table 4.10 shows a p-value of 0.186, or a 18.6% probability that the variation occurred by chance.

Table 4.10. ANOVA for Idea Volume Variance Between Groups

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	7.461	2	3.731	1.717	0.186	3.108
Within Groups	178.186	82	2.173			
Total	185.647	84				

A correlation analysis was conducted to assess intra- and inter-relationships between demographics, idea volume and judged innovativeness. Correlation signifies the existence of a relationship but does not assess the degree of the interrelationship. For the purposes of this study, a correlation of 0.6 or higher denotes strong positive correlation between two factors. A correlation of -0.6 or less denotes strong negative (or inverse) correlation between two factors.

Table 4.11 shows that a strong positive correlation existed between the volumes of ideas produced by respondents in sessions B and C, C and D, B and C, B and E and D and E. What's surprising is that session A *isn't* strongly correlated with the other sessions. This suggests that, with respect to idea volume, session A behaved erratically and that it wasn't until following sessions that respondents produced ideas more methodically. The inverse correlation between age and idea volume in session A suggests that younger respondents tended to produce more ideas than older respondents in their first brainstorming session. The positive correlation noted in Table 4.11 between gender and age (respondent demographics) merely reflects the fact that male respondents tended to be older than female respondents.

Table 4.11. Demographic and Idea Volume Correlation

	Age	*Gender*	*Major*	*A*	*B*	*C*	*D*	*E*
Age	1.0							
Gender	**0.6**	1.0						
Major	-0.1	-0.4	1.0					
A	**-0.6**	-0.4	-0.1	1.0				
B	0.2	0.1	-0.1	0.3	1.0			
C	0.4	0.3	-0.3	-0.1	**0.8**	1.0		
D	0.2	0.0	0.0	0.1	**0.7**	**0.7**	1.0	
E	0.4	0.2	-0.3	0.2	**0.6**	0.4	**0.6**	1.0

Table 4.12 shows that a strong inverse correlation existed between respondent gender and innovation scores for session E, explained by the fact that female respondents consistently produced some of their most innovative results in the last session, whereas males did not. Since session E was precipitated by group interaction and sharing, it might reasonably be deducted that females innovate better following group discussion, whereas males are less affected by group interaction.

Table 4.12 also shows a strong inverse correlation between innovation scores for sessions A and E, suggesting that respondents who performed poorly in the first session did far better in the last session. Conversely, respondents who performed well in the first session performed poorly in the last session. Appropriately, the positive correlation noted in Table 4.11 between gender and age also appears in Table 4.12.

Table 4.12. Demographic and Innovation Score Correlation

	Age	*Gender*	*Major*	*A*	*B*	*C*	*D*	*E*
Age	1.0							
Gender	**0.6**	1.0						
Major	-0.1	-0.4	1.0					
A	0.1	0.5	-0.2	1.0				
B	0.2	0.3	0.0	-0.1	1.0			
C	0.1	0.3	-0.2	0.0	-0.2	1.0		
D	0.3	0.0	0.1	0.1	-0.4	-0.2	1.0	
E	-0.4	**-0.6**	0.1	**-0.7**	-0.3	-0.3	-0.3	1.0

Table 4.13 demonstrates clearly that, for the purposes of this study, there was no correlation (positive or negative) between idea volume and judged innovativeness.

Table 4.13. Idea Volume and Innovation Score Correlation

		Idea Volume				
		A	*B*	*C*	*D*	*E*
Innovation Score	A	-0.3	0.0	0.0	-0.2	-0.2
	B	-0.3	0.3	0.2	0.3	0.0
	C	0.4	0.5	0.4	0.4	0.4
	D	-0.3	-0.2	0.2	0.1	0.0
	E	0.3	-0.3	-0.4	-0.3	-0.1

It should also be noted from the preceding tables that respondents' majors, or areas of university study concentration, had no bearing on idea volume or the distribution of judges' perceived innovation for sessions A through E.

CHAPTER 5: CONCLUSIONS AND RECOMMENDATIONS

5.1. Observations and Conclusions

The research hypothesis – that innovativeness can be encouraged through the learning and application of universal innovation principles and processes – was, at least, partially affirmed. It remains a possibility but has not been conclusively proved or disproved. On average, the case study respondents' innovativeness, as perceived by "expert" judges, increased over the first three brainstorming sessions. While we cannot assess whether or not the respondents became *more innovative* over time (there were no relative, interval-based innovation scores), we have determined that respondents were most innovative in the middle of the process. On average, innovativeness was encouraged from session A to C by one or more factors, which may include but are not limited to training, experience, time and environment. It is impossible to separate these factors and their impact on the results as a result of the case study method. Nevertheless, it is significant that the iterative process did have an effect on innovativeness. It is logical and possible that the iterations themselves, for whatever reason, were important to encouraging respondent innovativeness from sessions A through C.

The first session (A) was taken without prior information or knowledge having been exchanged regarding innovation; respondents were required to draw from their own preconceived notions of innovation. Interestingly, session A had the highest average idea volume of any of the sessions. This fact suggests that the most ideas are generated when

the innovation process is fresh. Prior to the second session (B), in which innovativeness improved only marginally, a definition of innovation was presented. On the whole, this information appeared to have little effect on the respondents' ability to innovate, suggesting that respondents already had a preconceived notion of innovation and that introducing a new or modified definition was inconsequential. Furthermore, time and process familiarity had little effect on innovativeness in session B. Perhaps respondents were still "warming up" at that point.

The third session (C) witnessed the greatest measure of innovativeness. In this session, information was given regarding the stakeholders and principles of innovation harmony (innovation success factors). Session C's lecture represented the most fundamental and significant information presented to the respondents. It is therefore significant that innovativeness improved so drastically, from an average score of 3.0 to 2.5, between the second and third sessions. It could have occurred because of the information presented, suggesting that respondents' perspective changed and with this change came new ideas and concepts. Another explanation is that respondents were finally "warmed up" by this session. They had gotten into a "groove," so to speak. Yet another explanation is that respondents were more comfortable with their environment and focus group by the third session. The results are inconclusive but they do give impetus to an interesting dialogue as to why respondents were generally most innovative in the middle session. They were encouraged but it is not altogether clear why.

In direct contrast and contradiction to this trend, however, the respondents' innovativeness decreased from the third to fifth sessions. The fourth session (D) was preceded by a lecture on a formal procedure/practice designed to aid in the product

reinvention process. It can be concluded that, while some respondents mentioned that they liked the lecture, it did not improve their ability to innovate but rather may have had the opposite effect. It is surmised that respondents were growing tired of the process at this point. This would explain their diminished idea volume over time, as well as their lackluster innovation performance relative to previous efforts. This trend suggests that keeping the innovation methodology/process fresh and entertaining is important to encouraging innovativeness.

Surprisingly, innovativeness decreased the most in the fifth and final session (E). Prior to this session, respondents were instructed on the environmental framework of innovation and given an opportunity to interact and share their ideas for the first time. From an onlooker's perspective, this process appeared to be the most enjoyable of the case study for most participants and the source of tremendous idea divergence and convergence. Yet, when the respondents made their fifth attempt to innovate following this process, innovativeness decreased sharply. Numerous deductions can be conjectured from this outcome. Respondents may have grown bored with the process. They may have run out of ideas, suggesting that they were drawing from a finite "idea bank" that, once exhausted, was difficult to replenish. It may have been counterproductive to ask respondents to brainstorm individually once they had had an opportunity to interact with other focus group members. This possibility would suggest that the process of writing ideas down and/or working individually is counterproductive and that the entire case study process/methodology should be revamped.

In summary, it is probable that time dependence and process familiarity played a significant role in the outcome of this case study. The improvements in innovativeness

judged between sessions A and C may have been, in part or whole, the result of the respondents' increasing familiarity with the process over time. Likewise, the decreasing innovativeness between sessions C and E may have been a direct result of the respondents getting tired of or overly familiar with the case study process/methodology. The effect of the knowledge created through lectures and interaction may have been negligible. Furthermore, the very process of writing down innovative ideas on paper and working alone may have stifled creativity. Perhaps the only way to learn innovation is in a dynamic environment.

Case study results tend to confirm that innovation is enigmatic. It exists based on universal yet pliant stakeholders and principles. Innovation's arts and sciences, practices and processes, however, are not universal. They are individualistic – as peculiar and unique as the people who employ them. Yet it is still held that innovativeness can be encouraged. Innovators are not born. They evolve. They evolve through intent and persistence.

5.2. Recommendations

The frameworks, principles and processes of innovation need more research. It would be fascinating to undertake a more biological and psychological study of the innovation process – to assess the mental and physical elements of innovation. It is hard to innovate (and judge innovation) in isolation, on paper. Because true measures of innovation success cannot be assessed in isolation from the system for which it is intended and of which it is a part, a more holistic approach to innovation research should be undertaken, preferably with larger, less homogeneous population samples and through mitigation of time and process familiarity and fatigue. Further research should be done in

conjunction with industry, in a dynamic, working environment with real stakes and outcomes.

Specifically, it is recommended that a study be conducted in conjunction with two industry population samples to assess whether or not innovation can be *taught*, not just *encouraged*. Can the average person learn to become *more innovative*? Such a study would assess whether or not innovativeness is innate or learned, or perhaps both. It is recommended that the first population include companies with no formal innovation process. The processes and results of their new product launch efforts should first be judged in order to determine a baseline for change. The companies should later be asked to formulate an innovation process based on universal innovation principles but tailored to their individual environment. This innovation process should be tied directly to a new product launch for each company. The results of the product launches should be studied in detail, with particular attention to externalities such as marketing and market conditions, to assess innovativeness based on a common set of stakeholder metrics.

The second population sample should include companies that have already established an innovation process internally. The same process employed with the first group should be followed and the results compared, allowing a relative and absolute measure of the impact of innovation incubation on individuals' and companies' ability to innovate.

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APPENDICES

APPENDIX A: CASE STUDY

Discontinuous Innovation Case Study

Thank you for participating in this anonymous 60-minute product innovation case study. Please read and follow the instructions provided. Please do not interact with anyone else participating in this study unless specifically asked to do so.

Respondent Demographics:

Respondent ID#:	
Age:	
Gender:	
Major:	
Minor (if applicable):	

Objective: As **Director of Product Innovation** for XYZ Innovation Consulting Company, you have been given an important assignment that will prove crucial to your company's success in the coming years. Your biggest client, **Kitchen Products, Inc.**, has asked you to brainstorm ideas on how to **re-invent** their core product, the **Waffle Iron**. Your boss has encouraged you to be creative and take risks. You are excited about the opportunity to showcase your innovative talents, skills and abilities to this important client. You go to your office, close the door and grab some paper and a pen. It's time to start innovating!

Stop here! Do not turn the page until directed to do so.

Session A Instructions:

1. You have 5 minutes to brainstorm individually on how to **re-invent** the **Waffle Iron**.
2. Please use the entire 5 minutes to:
    a. **Record** (draw and/or describe) and
    b. **Number** ALL of your ideas on the blank pages provided.
3. Remember to communicate your ideas clearly. Drawing ability doesn't matter.
4. You may refer to previous pages as necessary.
5. Do not turn this page until directed to do so.

After an initial brainstorming session, you decide to take a break and review some of your old college notes on Creativity & Innovation for inspiration:

Lecture #1: Product Innovation Defined

Product innovation is a marriage between art and science – a fusion of creativity and analytics. It takes place in sundry forms. It requires discipline and free-spiritedness. Innovation is dynamic, requiring the innovative to constantly adapt to a changing landscape. Innovation is perception. Objective newness matters little in this regard, for it is the perceived newness of a product that defines its innovativeness, regardless of whether or not it actually embodies new ideas. Innovation may simply entail repackaging old ideas in a new way, for a new application, market or user.

Product innovation anticipates, recognizes and creates change. It is a tool for reshaping the world through people's perceptions and habits. Creativity, the creation of novel ideas, is the raw material of innovation. Invention, a form of innovation, pertains to discoveries whereas innovation encompasses the broader notion of continuous improvement and change.

Product innovation creates a future vision. As such, it requires the ability to see beyond the present while simultaneously understanding the past. It is not whimsical. Consistently discontinuous innovation requires a multifunctional, disciplined process. It requires the application of universal, guiding principles leading to a harmony of stakeholder considerations, wants and needs.

Stop here! Do not turn the page until directed to do so.

Session B Instructions:

1. You have 5 additional minutes to brainstorm individually on how to **re-invent** the **Waffle Iron**.
2. Please use the entire 5 minutes to:
    a. **Record** (draw and/or describe) any ideas, and
    b. **Number** ALL of your ideas on the blank pages provided.
3. Remember to communicate your ideas clearly. Drawing ability doesn't matter.
4. You may refer to previous pages as necessary.
5. Do not turn this page until directed to do so.

Lecture #2: Innovation Success Factors (Dimensions & Principles of Innovation Harmony)

Product innovation successfulness is not black or white. If there is an innovation "sweet spot," it is constantly moving. Innovation success is characterized by a vast array of factors, benefits and attributes with no absolute measures or thresholds. It cannot be assessed in isolation from manufacturing or marketing, from production or demand – for these are essential (but not the only) elements of success.

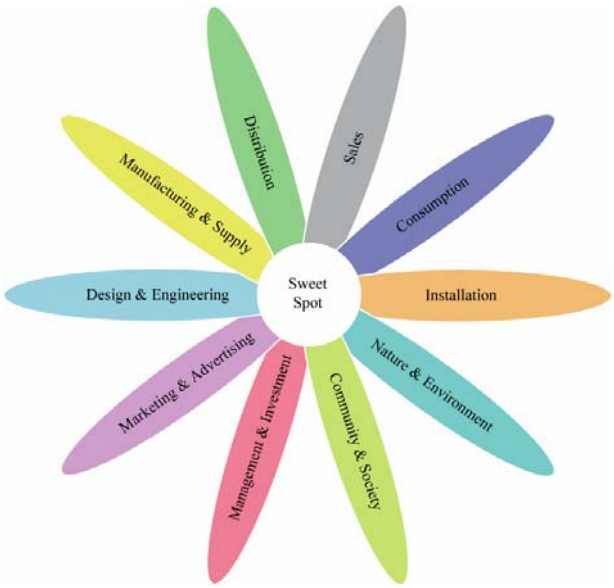
Generally, products are increasingly successful the more they fulfill the needs and wants of the stakeholders (whether intended or not) within the system to which they belong. *Understanding and fulfilling stakeholder needs and wants is at the heart of product innovation.* Herein resides the great and unending challenge of innovation: to satisfy stakeholders whose demands constantly evolve and oftentimes seem to contradict one other.

Stakeholders are more than mere customers. This distinction is critical, since most research emphasizes the role of the *customer* in the innovation process, thereby under-representing or ignoring the additional stakeholders that are so crucial to comprehensive innovation success.

Stakeholders may be different or the same entities/persons. They may be external or internal, domestic or foreign. Individual and collective stakeholder characteristics will determine specific needs and wants. The general needs and wants listed are provided as a frame of reference for innovators who must, in seeking their "sweet spot" of innovation, approach the product system holistically. Otherwise, though a product succeeds across one or several dimensions, it may fail across other equally or perhaps even more important ones. These dimensions must constantly work in the mind of the innovator, for they are both the means and the measuring stick of innovation.

It should not be misconstrued that the "sweet spot" of innovation requires pleasing all stakeholders. Generally, it is impossible and therefore futile to try to satisfy everyone's needs and wants. Compromise is essential. In this sense, the innovation gap – a raw source of potential energy for innovation – can never be fully bridged. Yet somewhere within the gap, at the cross-section of stakeholder needs and wants, is a sweet spot where stakeholder value approaches a local maximum.

It goes without saying that marketing and manufacturing, management and the environment, sales and consumption are as fundamental to product innovation as are the practice of 'design' and 'engineering.' This is the guiding theme of the *dimensions and principles of innovation harmony*, as depicted on the following page.



Dimensions of Innovation Harmony

Principles of Innovation Harmony (Product)

1. Simpler is better.
2. Easier is better.
3. Smaller is better.
4. Lighter is better.
5. Stronger is better.
6. Faster is better.
7. Safer is better.
8. More customizable is better.
9. More flexible is better.
10. More aesthetic is better.
11. More harmonious is better.
12. More forgiving is better.

Principles of Innovation Harmony (Process)

1. More ideas are better (idea volume).
2. Broader, more diverse ideas are better (lateral creativity, intuition, imagination, cross-pollination, divergence).
3. Deeper, more knowledgeable ideas are better (linear creativity, logic, knowledge, convergence).

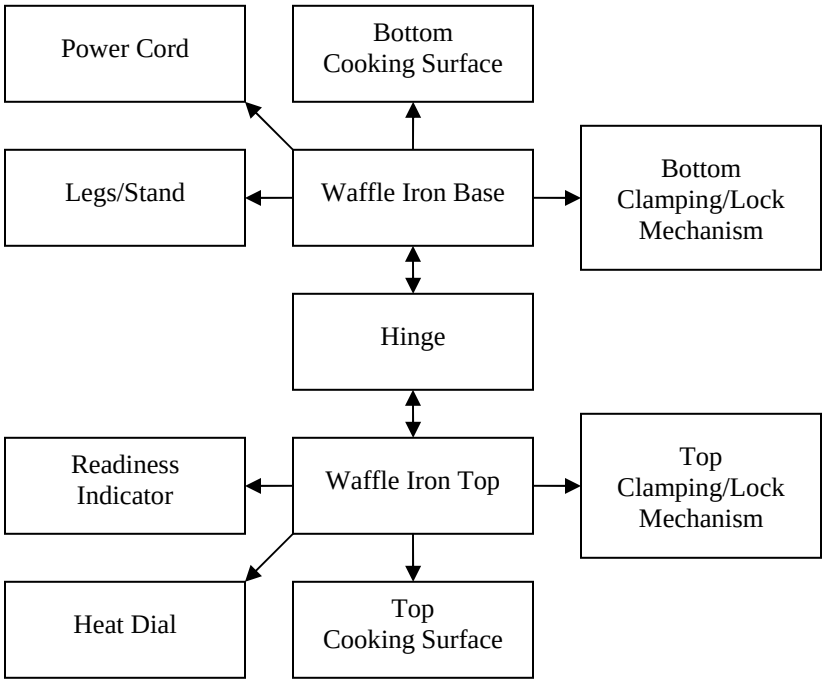
Stop here! Do not turn the page until directed to do so.

Session C Instructions:

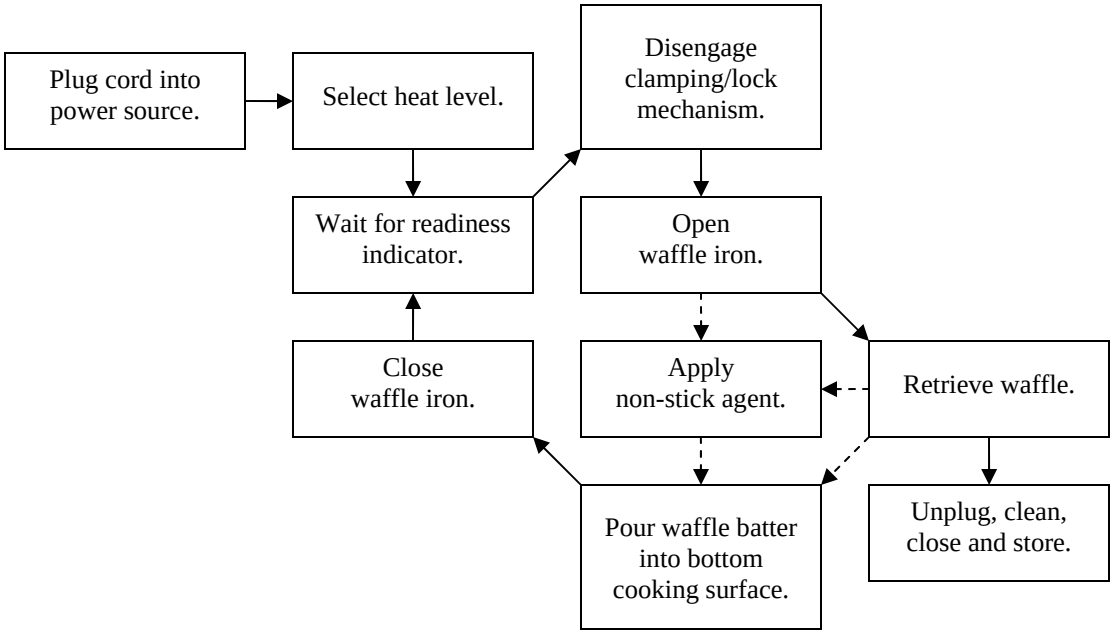
1. You have 5 additional minutes to brainstorm individually on how to **re-invent** the **Waffle Iron**.
2. Please use the entire 5 minutes to:
    a. **Record** (draw and/or describe) any ideas, and
    b. **Number** ALL of your ideas on the blank pages provided.
3. Remember to communicate your ideas clearly. Drawing ability doesn't matter.
4. You may refer to previous pages as necessary.
5. Do not turn this page until directed to do so.

Lecture #3: Conceptualize & Disassociate

Once you have gained a critical mass of feedback from stakeholders, it is critical to temporarily unlearn what you have learned about the product you are re-inventing. Disassociate yourself from existing paradigms, preconceived notions, images and expectations. This can be done by conceptualizing the product into its most basic elements, using feature and function maps, as demonstrated below. The disassociation of one's paradigms from current product constructs is a foundational step in identifying disconnects between current features/forms/functions and unaddressed stakeholder needs/wants.



Waffle Iron Sample Feature Map



Waffle Iron Sample Function Map

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Session D Instructions:

1. You have 5 additional minutes to brainstorm individually on how to **re-invent** the **Waffle Iron**.
2. Please use the entire 5 minutes to:
    a. **Record** (draw and/or describe) any ideas, and
    b. **Number** ALL of your ideas on the blank pages provided.
3. Remember to communicate your ideas clearly. Drawing ability doesn't matter.
4. You may refer to previous pages as necessary.
5. Do not turn this page until directed to do so.

Lecture #4: Innovation Environments (Depth and Breadth of Knowledge, Organizational Synergy & Diversity, Structured Non-Linearity, Productive Resistance)

A fostering environment is perhaps the most crucial element of innovation. Synergy, like stakeholder needs and wants, is at the core of innovation. Individual creativity, innate or learned, may be a precursor to but does not guarantee innovation success and is therefore conspicuously absent from the environmental factors list that follows. Having the right mind-set to engage in creative processes, fostered by a cultivating innovation environment, is exceedingly more critical.

A new *environmental framework for innovation harmony* is presented below. These factors are critical to the teaching and implementation of innovation:

Depth and breadth of knowledge. Innovators must have broad and deep access to knowledge through information and perspective. This truism leads to the next: innovation within an organizational construct is more likely to yield greater knowledge depth and breadth.

Organizational synergy and diversity. Innovation is more likely to occur in group versus individual settings precisely because knowledge diversity, depth and breadth are increased through interactive cross-pollination. Synergistic, innovative organizations will consist of flexible and manageable project-teams. Project-teams should enjoy a high level of autonomy, familiarity and socialization. They should be multi-dimensional, trans-functional and diverse. Team members should be committed to each other and the innovation process. Active involvement, trust and open communication are critical at all levels of the innovative organization.

Structured non-linearity. Sometimes referred to as "creative chaos," structured non-linearity involves the intentional making and breaking of connections through group interaction. Brainstorming activities are an example of structured non-linearity, where silliness and intentional overlapping (redundancy) cross-pollinate ideas and thereby create a fertile environment for innovation.

Clear accountability, motivation and rewards. Individuals and teams should have a strong sense of personal ownership for the innovation process. Likewise, they should share in the rewards of that process, intrinsically and/or extrinsically. Teams should be expected to perform at a high level.

Risk-taking without fear of failure. Contrary to fearing failure, innovation teams should seek to fail early and fail often. Taking risks and failing are critical steps in the innovation process. Management should optimistically encourage innovation efforts to branch out into the unknown early and often.

Productive resistance. In other words, there should be conflict and debate. Team members should feel free to "tell it like it is" without worrying about others taking it personally. This element requires a delicate balance of objectivity and subjectivity.

Common values, norms, goals and objectives. Teams must share a common vision. They must challenge themselves with aggressive but achievable goals. These factors will enable them to focus on important problems and opportunities in the innovation process.

Stop here! Do not turn the page until directed to do so.

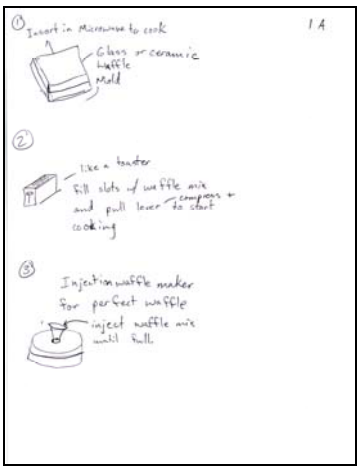
After a half hour spent brainstorming on how to re-invent the Waffle Iron, you're out of ideas! You decide to approach some co-workers for help. After a few minutes rounding people up, your team is assembled. You find a vacant conference room and start discussing. You quickly discover that everyone has good, unique ideas. This might just work after all!

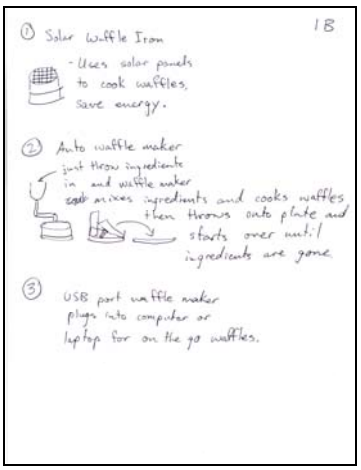
Session E Instructions:

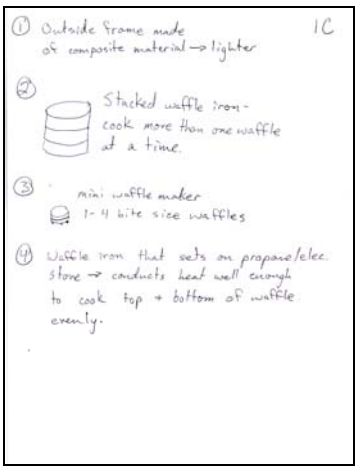
1. As a group, spend 10 minutes sharing existing ideas.
2. Following group discussion, you have 5 additional minutes to brainstorm individually on how to **re-invent** the **Waffle Iron**.
3. Please use the entire 5 minutes to:
    a. **Record** (draw and/or describe) any ideas generated from group discussion, and
    b. **Number** ALL of your ideas on the blank pages provided.
4. Remember to communicate your ideas clearly. Drawing ability doesn't matter.
5. You may refer to previous pages as necessary.
6. Thank you for your participation!

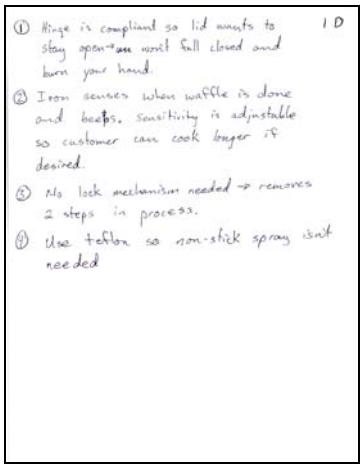
APPENDIX B: RESPONDENT INNOVATION SESSIONS

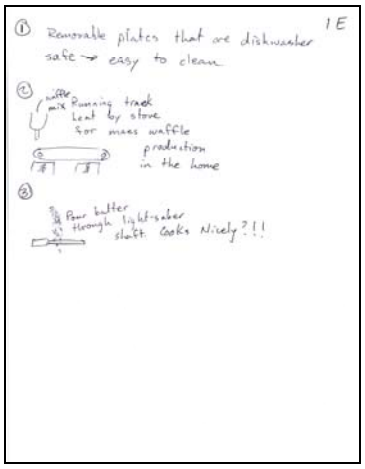
Respondent #1 (Sessions A-E)











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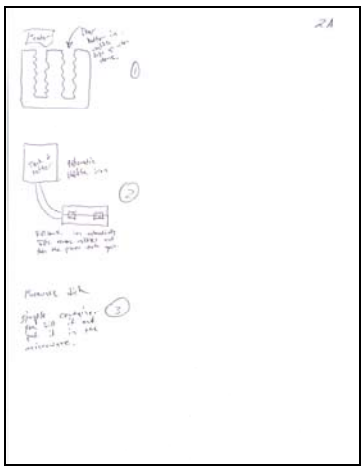

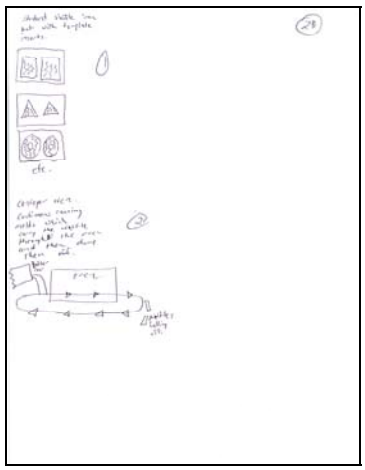

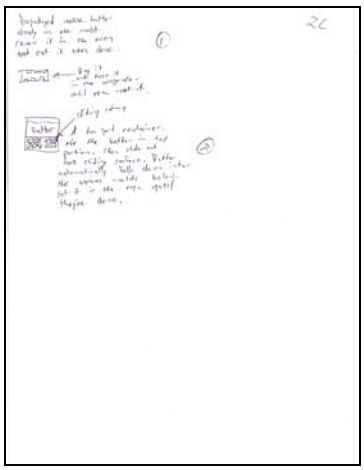

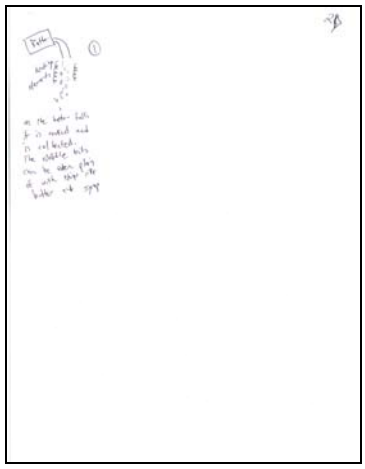

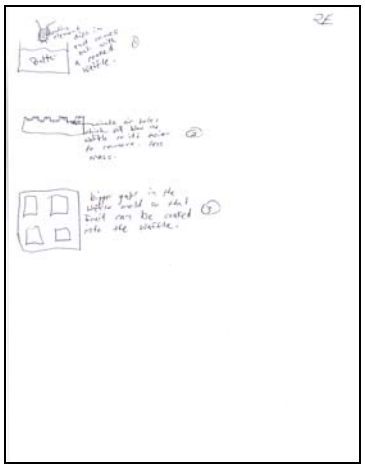

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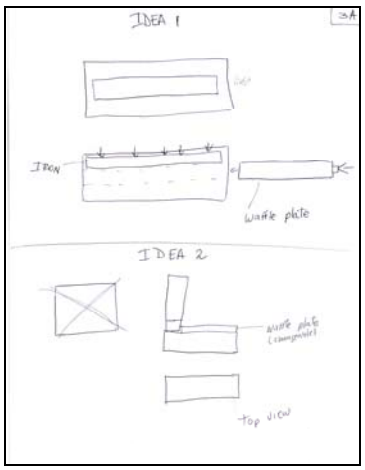

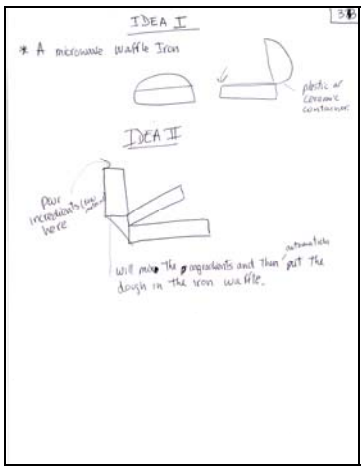

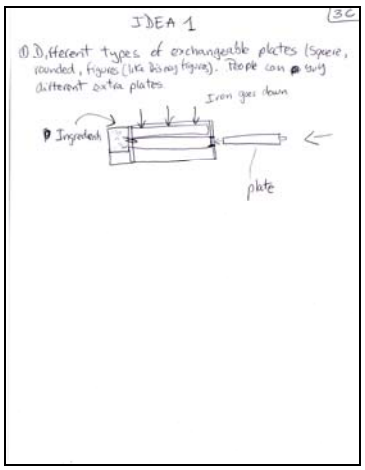

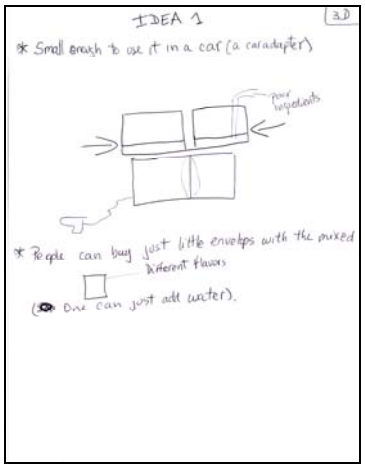

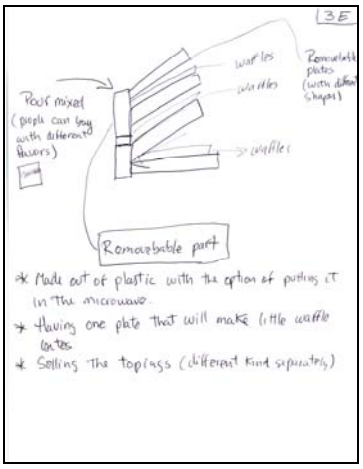

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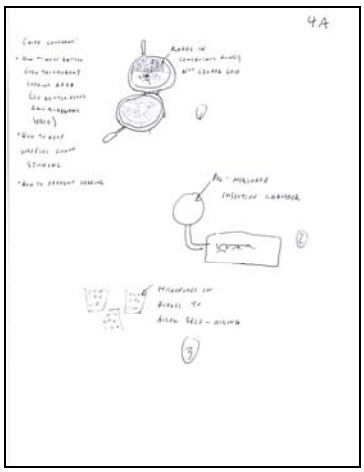

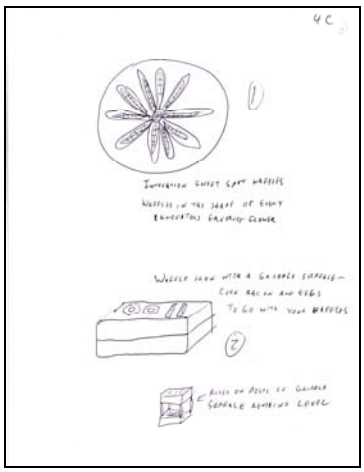

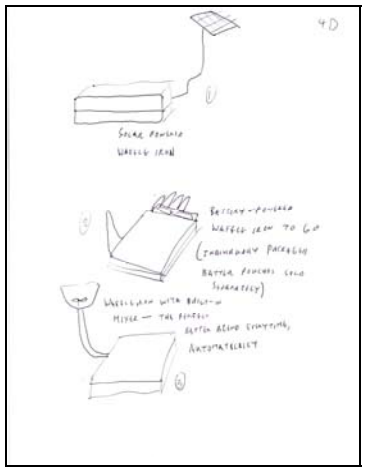

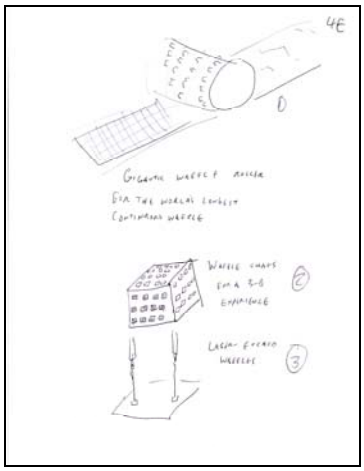

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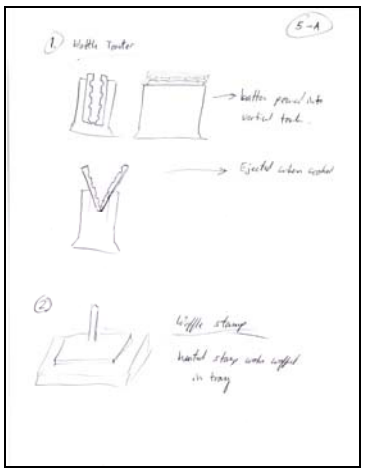

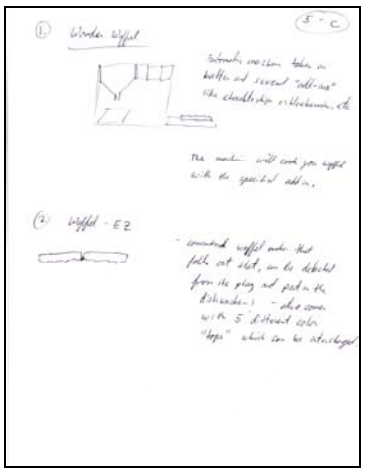

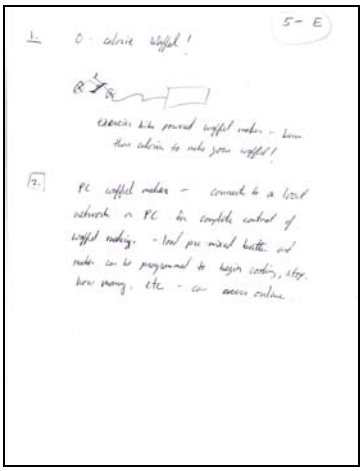

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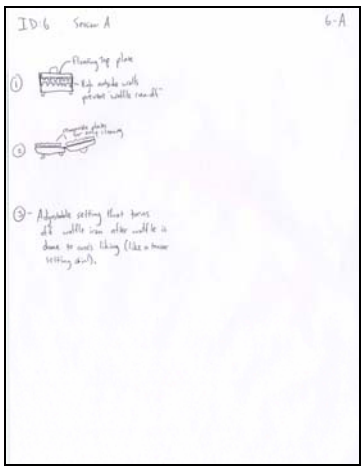

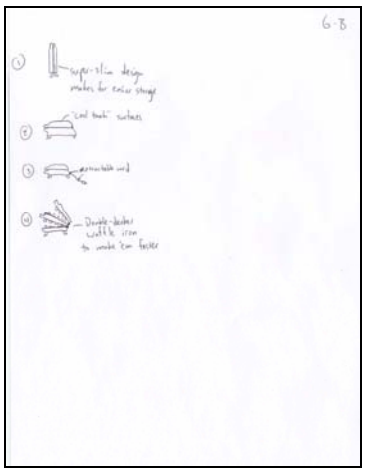

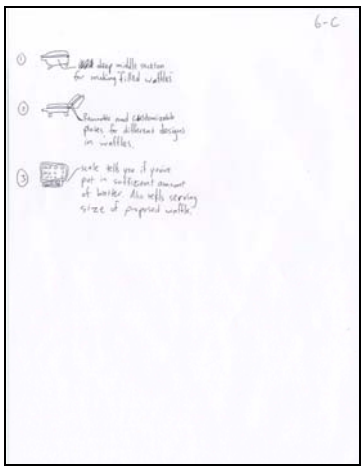

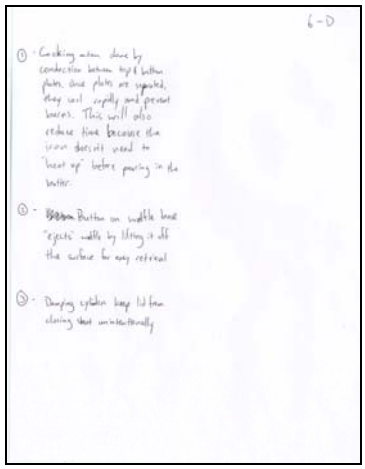

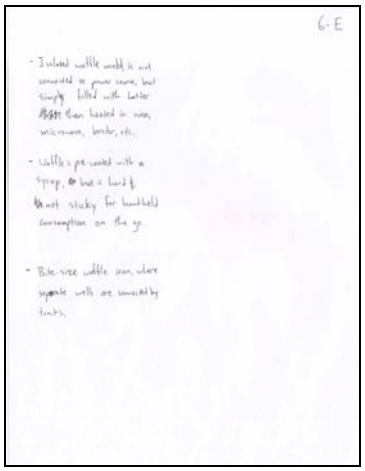

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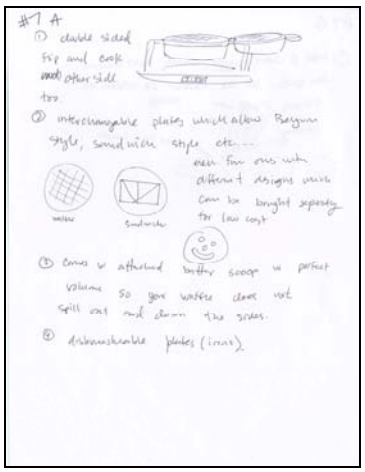

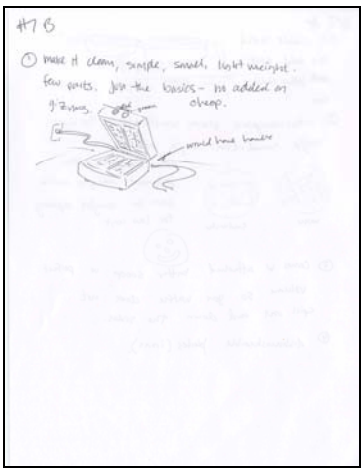

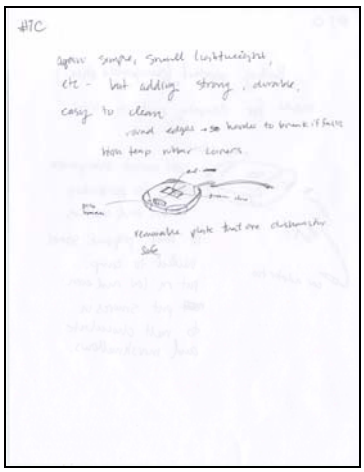

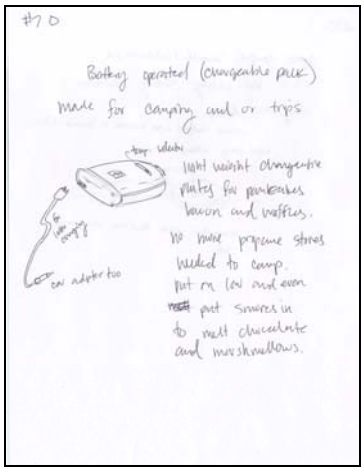

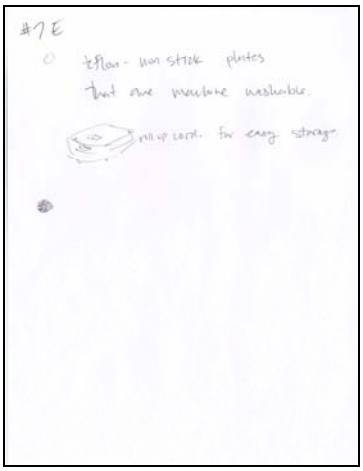

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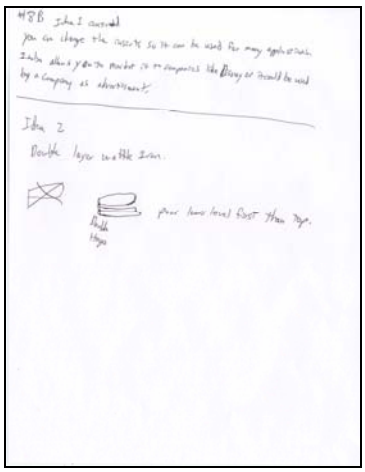
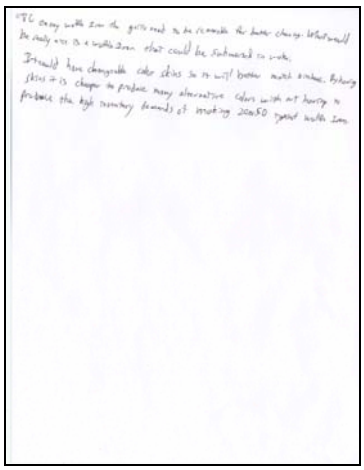
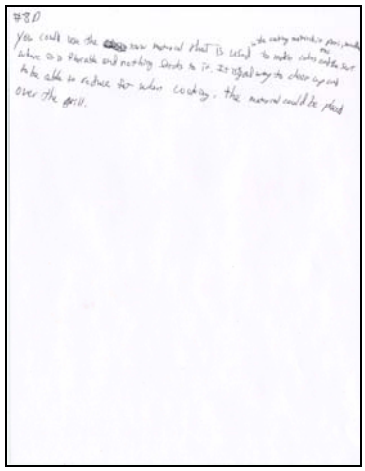
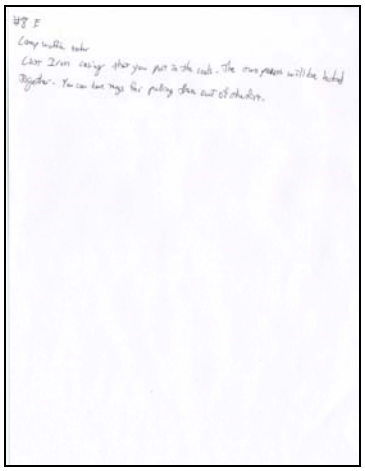
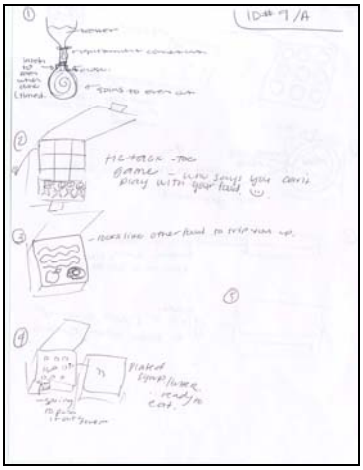


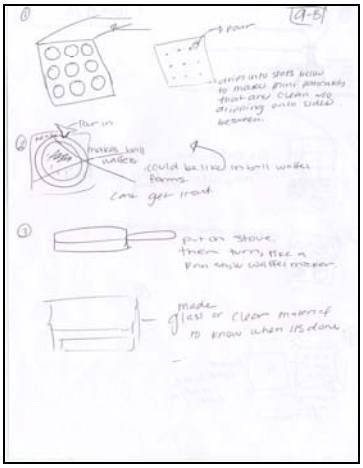


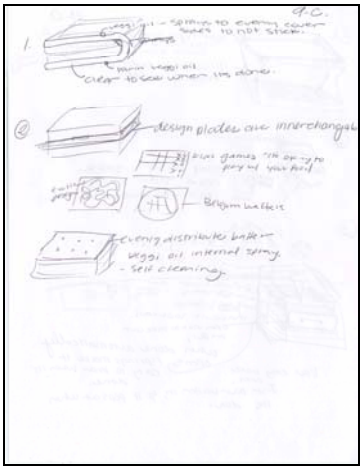


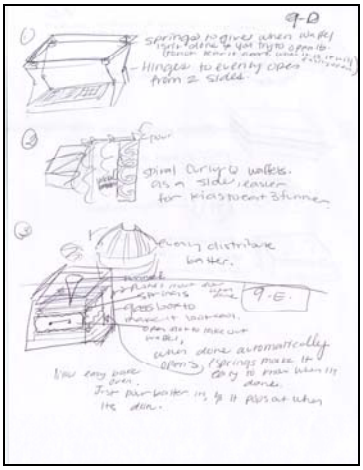


Respondent #9 (Sessions A-E)

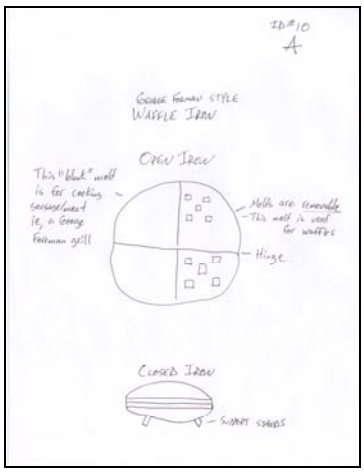


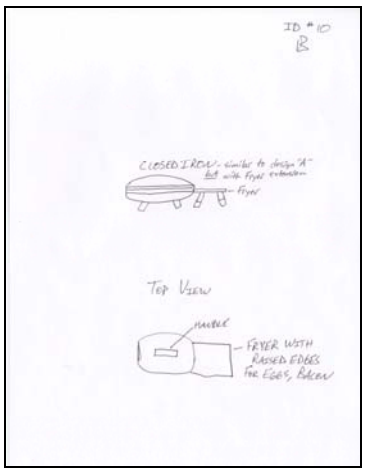


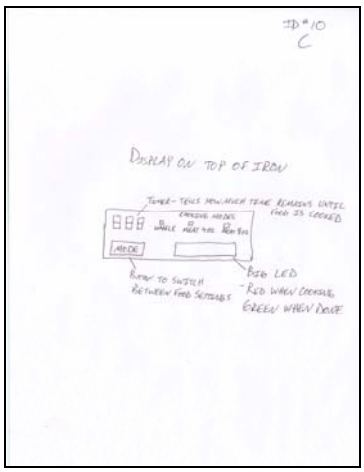


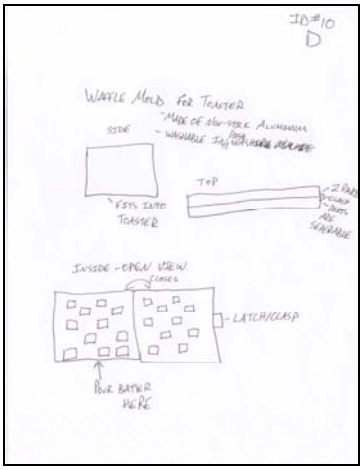


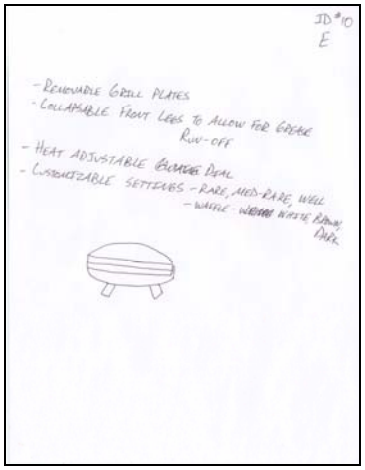
Respondent #10 (Sessions A-E)



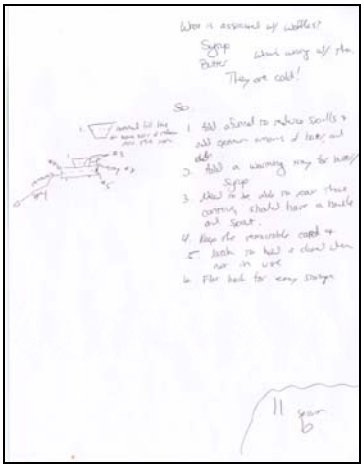


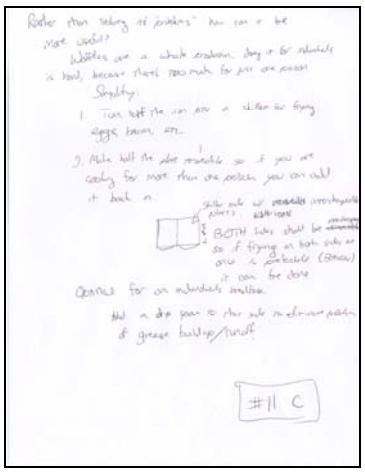


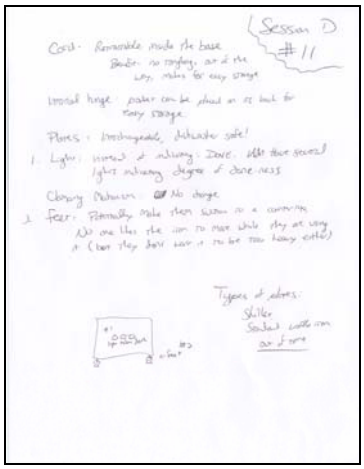


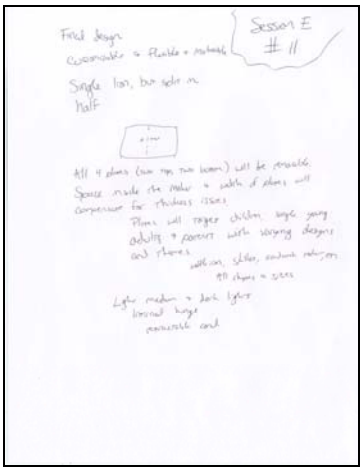


Respondent #11 (Sessions A-E)

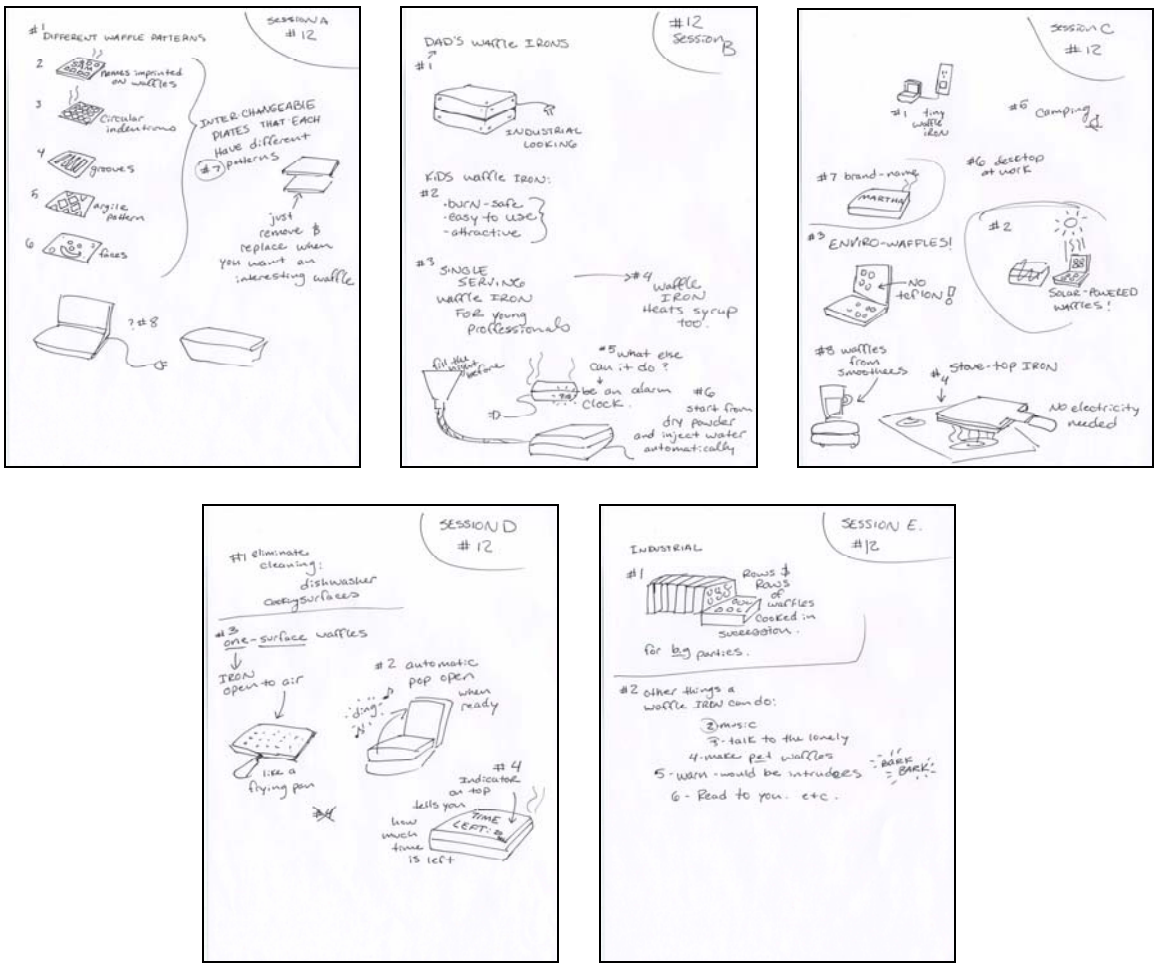




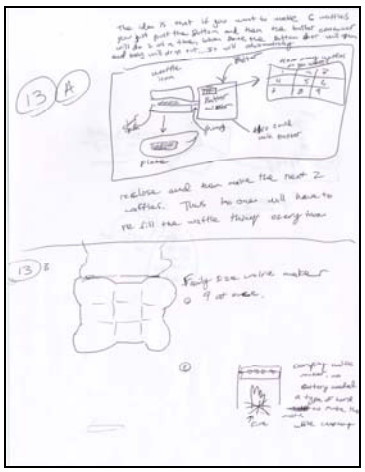


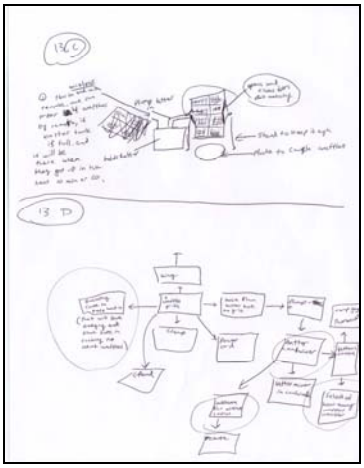


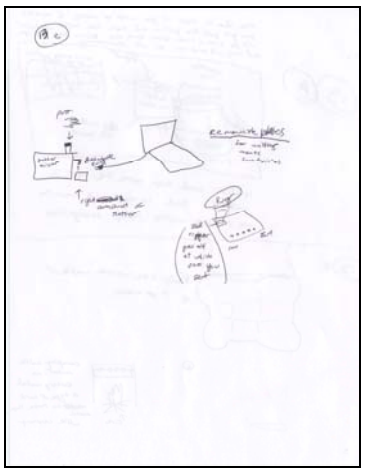
Respondent #12 (Sessions A-E)



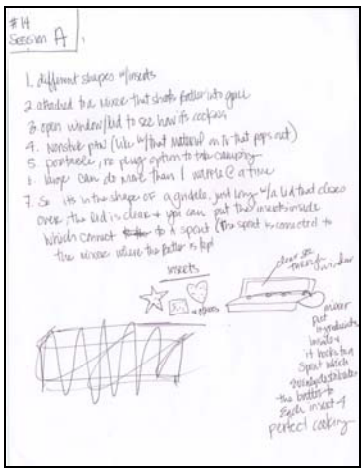
Respondent #13 (Sessions A-E)

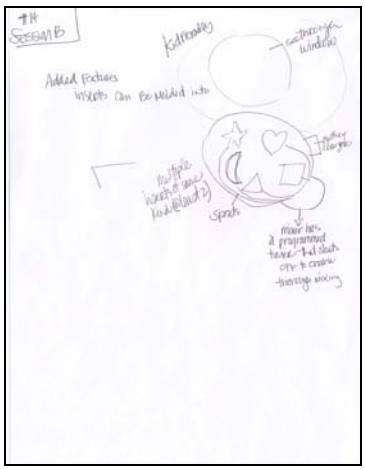


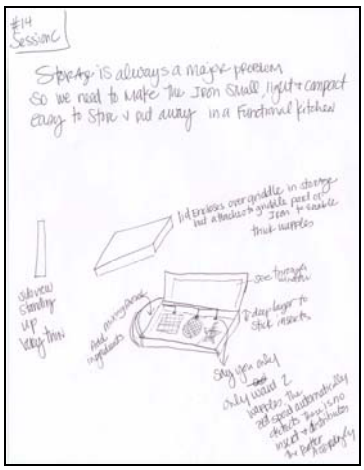


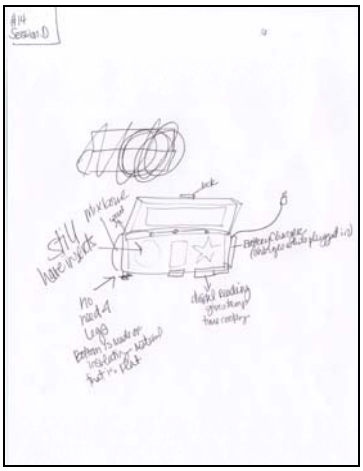


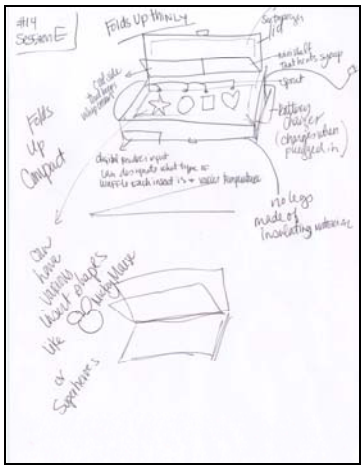
Respondent #14 (Sessions A-E)



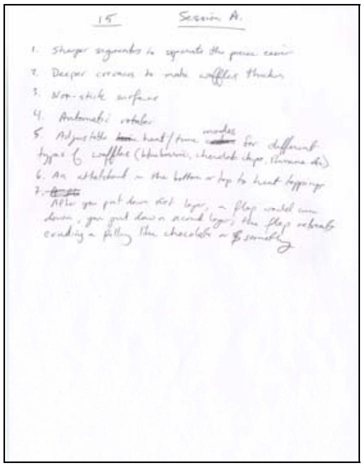


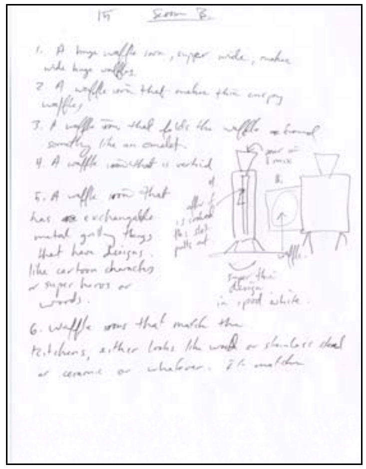


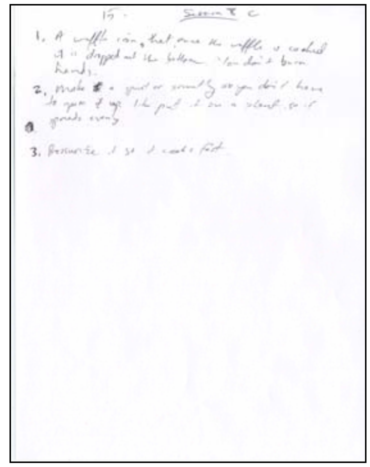


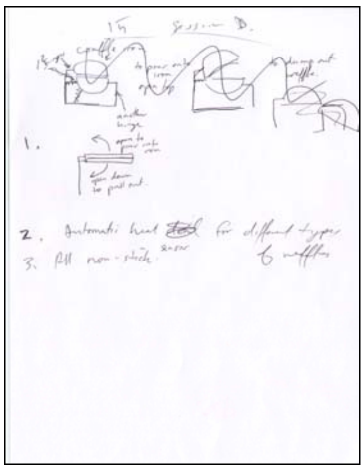


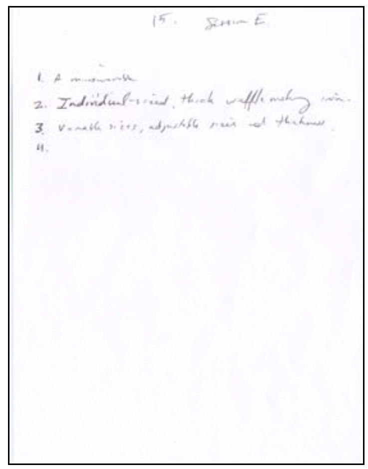
Respondent #15 (Sessions A-E)



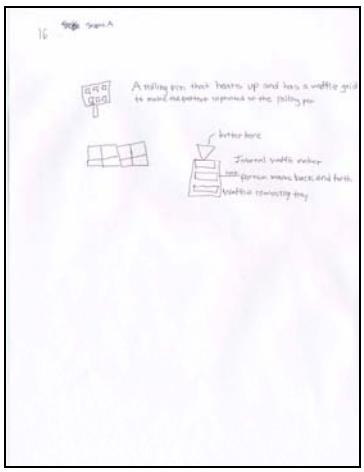


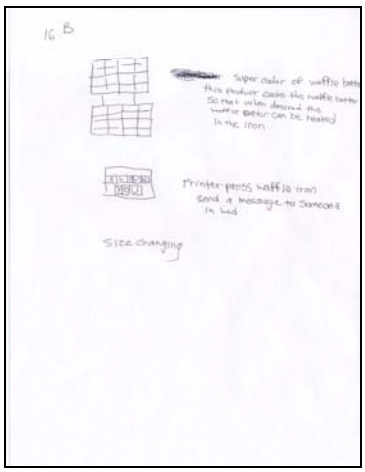


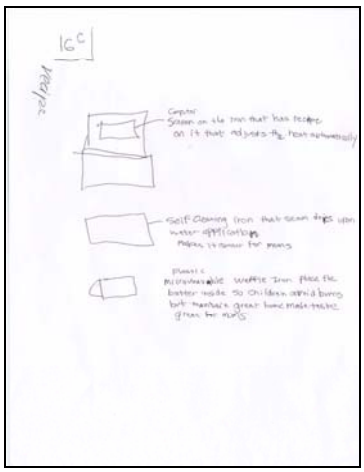


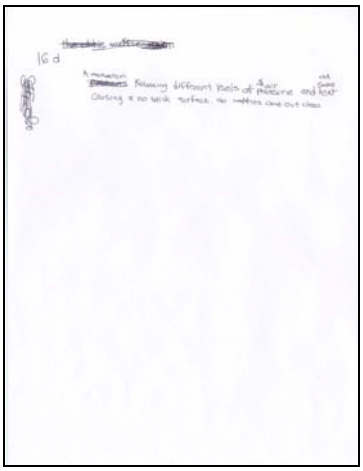


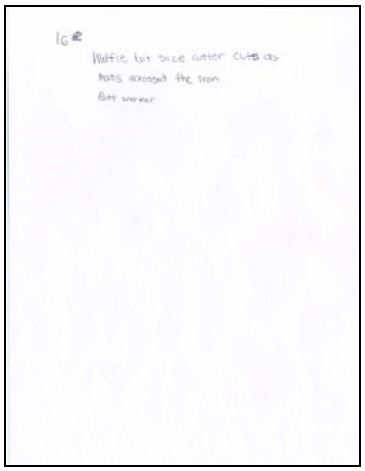
Respondent #16 (Sessions A-E)











Respondent #17 (Sessions A-E)