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A hybrid method for generating objectives.

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ABSTRACT

A HYBRID METHOD FOR GENERATING OBJECTIVES

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Decision making occurs frequently in a person's life whether it is personal life decisions or business decisions. When one decision is made, it will affect a network of decisions. Each decision made has an impact on a person's life. Problem structuring describes and organizes the decision problem and is a key element in making better decisions. Generating objectives is a key aspect of problem structuring because objectives show what the decision maker cares about/wants to achieve when making a decision. Of the objectives generated, it is important that the problem structuring method generates quality objectives; objectives that have a significant effect on the decision maker's decision. This research study focuses on increasing the number of objectives and including quality objectives that a decision maker generates when structuring a decision problem by developing a hybrid method in the form of a worksheet that uses various decision making techniques and tools such as value focused thinking, cognitive mapping, motivation, and multiple chances.

The development of this hybrid method for problem structuring was based on a nine-question worksheet administered to undergraduate engineering students for generating objectives on the decision of choosing a college major. Analysis of this

application will be used to determine the significance of each decision making technique, each question, worksheet format, and demographic characteristics on the number of objectives generated by the student participants.

Results from 84 students who completed the worksheet indicate the question using motivation technique was the most significant in generating quality objectives. Additionally, one value focused thinking and one cognitive mapping worksheet question generated significantly more quality objectives than the remaining questions. Results also indicate that the most objectives were generated by the first few questions. These results indicate a hybrid method with fewer than nine questions can lead to the generation of a significant number of objectives. The developed hybrid method makes use of three worksheet questions based on the result that the most objectives were generated in the first questions and the three questions chosen generated significantly more quality objectives than the other questions. Analysis shows that the developed hybrid method with three worksheet questions can generate approximately the same number of objectives and quality objectives as the initial worksheet with nine questions.

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CHAPTER 1 INTRODUCTION

Decision making occurs frequently in a person's life whether it is personal life decisions or business decisions. Making a decision has an impact on the future of a person's life. One decision has an impact on decisions made in the future and is linked in a network of other problems that are related. When one decision is made, it will affect a network of decisions. (Evans, 2012; Clemens, 1997)

With one decision having an effect on a network of decisions, it is important to make quality decisions. A quality decision is made when a decision maker uses decision science methods when making a decision, i.e. the decision maker will generate values and quality objectives for a decision by using decision making methods that show you how the decision outcome will have an effect. Traditionally, decision makers have tried to solve decision problems without first determining the network of how the problem is related to other decisions. It is important to see how other decisions will be affected by the current decision. (Bouyssou et al., 2011)

Once the network of decisions is determined, problem structuring is an important step in the decision process. Structuring the decision problem will describe and organize the problem and is a key element in making a more quality decision (Bowen, 2001; Mingers & Rosenhead, 2004). When structuring a problem, the decision maker's values (what the decision maker cares about) can be surmised (Bouyssou et al., 2011). The decision maker's values directly influence the decision's objectives. The objectives of a

decision show what a decision maker cares/wants to achieve for a particular decision (Bond et al., 2010). Not having objectives that help a decision maker make quality decisions or having an incomplete amount of objectives will be a main reason of not making a quality decision (Tversky & Kahneman, 1981). Most decision makers think of at most half of objectives that could have been used when making a decision (Bond et al. 2008).

Generating objectives is the beginning stage of problem structuring (Bond et al., 2010). Popular problem structuring techniques in decision analysis include: cognitive mapping, strategic choice, soft systems methodology, and value focused thinking (Bouyssou et al., 2011). The two problem structuring techniques that will be used in this research are: value focused thinking and cognitive mapping. These techniques were chosen because of the strengths that both share for deep thinking of the decision maker to generate objectives. Strategic choice and soft systems methodology both have strengths in step by step strategies for problem structuring and not as much concentration on deep thinking of the decision maker's values. Value focused thinking and cognitive mapping focus on the values of the decision maker. Value focused thinking concentrates on turning a decision maker's values into objectives that can be used to make quality decisions while cognitive mapping focuses on connecting values to show the relation of how one value can lead to another value (Eden, 1988, 1994; Eden et al., 1983; Keeney, 1992).

Along with problem structuring techniques, the following tools have been researched to help generate objectives: objective categories, motivation, multiple chances, and examples. Objective categories list titles of categories to the decision maker

to aid in generating objectives. For example, objective categories for a graduate student deciding on a first-time faculty position could include: environment objectives and research objectives. Motivation is a tool that lists a motivational quote and asks the decision maker to list a specific number of objectives to motivate the decision maker. For example, motivation for the graduate student deciding on a first-time faculty position would be that research has found that people can generate 50% more objectives by thinking deeper, please generate five more objectives. Multiple chances is a tool that gives a decision maker more than one chance to generate objectives. For example, the graduate student deciding on a first-time faculty position would be asked multiple times with different techniques and tools to generate more objectives for the decision. Examples are a tool that gives a few example objectives to the decision maker. For example, the graduate student deciding on a first-time faculty position could have examples of climate and type of research. The tools that will be used to also aid in the generation of quality objectives (the values that have a significant effect on the decision maker's decision) are: motivation and multiple chances. Prior research has shown that the tools of motivation and multiple chances have helped increase the number of quality objectives generated, whereas categories and examples do not significantly impact the generation of quality objectives. (Bond et al., 2010)

This dissertation will develop a hybrid method in the form of a worksheet that combines the problem structuring techniques of value focused thinking and cognitive mapping with the tools of motivation and multiple chances to utilize the strengths of all the techniques and tools to increase the number of quality objectives generated by the decision maker.

1.1 Problem Statement

The focus of this research is developing a hybrid problem structuring method in the form of a worksheet that uses value focused thinking, cognitive mapping, motivation, and multiple chances. This hybrid method will increase the number of quality objectives, the values that have a significant effect on the decision maker's decision, generated by the decision maker which is thought to lead to quality decisions. Previous research on problem structuring methods (Abualsamh, Carlin, & McDaniel, 1990; Belton, Ackermann, & Shepherd, 1997; Belton & Stewart, 2001; Binbasioglu, 2000; Buchanan, Henig, & Henig, 1998; Corner, Buchanan, & Henig, 2001; Courtney & Paradice, 1993; Eden, 1988, 1994; Eden, Jones, & Sims, 1983; Hector, Christensen, & Petrie, 2009; Keller & Ho, 1988; Landry, 1995; Lehaney, Martin, & Clarke, 1997; Massey & Wallace, 1996; McGregor, Lichtenstein, Baron, & Bossuyt, 1991; Mingers & Rosenhead, 2004; Norese, 1996; Pidd, 1988; Rosenhead, 1996; Smith, 1988, 1989; Sycara, 1991; Von Winterfeldt & Fasolo, 2009; White, 2009; Woolley & Pidd, 1981) has highlighted the importance of generating objectives. Two difficulties that occur when generating objectives for decisions include (Bond et al., 2010):

- Decision makers need to be more wide-ranging in variety of thoughts when thinking about decisions, instead of limiting thoughts to one particular area of the decision
- Decision makers need to think more deeply about decisions

Findings from past research on generating objectives (the decision maker's values that directly pertain to a particular decision) have concluded (Bond et al., 2010):

- On their own, decision makers think of less than half of important objectives for a decision
- Giving examples of objectives to decision makers does not significantly increase the number of objectives that are generated
- Motivation and multiple chances are important tools that will increase the number of objectives that are generated
- Giving categories to decision makers to use to generate objectives within each category is somewhat helpful in improving the generation of the number of objectives, but not as much as motivation and multiple chances

These findings help increase the number of the objectives that are generated, however, there are still a large percentage of objectives that are not generated and more research needs to be done in this area (Bond et al., 2010). Combining the techniques and tools of value focused thinking, cognitive mapping, motivation, and multiple chances has not been researched before and is thought to beneficially add to the research in the area of problem structuring by increasing the number of quality objectives that are generated. These improvements will aid in decision makers making more quality decisions.

The science of decision making has key terminology that is important when discussing the subject. The key terms include: values, objectives, quality objectives, alternatives, and quality decisions. The following lists the definition and an example for each keyword. The example used is of a graduate student deciding on which first-time faculty position offer to accept.

1. Values
    a) Definition – A value is what a person cares about in life, which can be applied to all decisions that it effects.
    b) Example – The graduate student's values include: liking a certain climate, wanting to teach a specific subject, wanting to work on specific research, passionate about a religion, and supports a political party.
2. Objectives
    a) Definition – Objectives are the decision maker's values that directly pertain to a particular decision.
    b) Example – The graduate student's objectives for the decision of choosing a faculty position would be: liking a certain climate, wanting to teach a specific subject, and wanting to work on specific research. The values of being passionate about a particular religion and political party will more than likely not have an effect on the decision of a faculty position and therefore are not objectives for this decision.
3. Quality Objectives
    a) Definition – Quality objectives are the values that have a significant effect on the decision maker's decision.
    b) Example – The graduate student's quality objectives for the decision of choosing a faculty position would be: wanting to teach a specific subject and wanting to work on specific research. The objective of a certain climate is not significant for making the decision because the jobs that the student is trying to decide on are both located in the same climate.

4. Alternatives
    a) Definition – Choices that a decision maker can choose when making a decision.
    b) Example – The graduate student can decide on the alternatives of University A or University B for a first time faculty position.
5. Quality Decisions
    a) Definition – Quality decisions are when a decision maker uses decision science methods when making a decision, i.e. the decision maker will generate values and quality objectives for a decision.
    b) Example – The graduate student generates quality objectives for making the decision on what faculty position to accept.

1.2 Research Summary

This research is focused on increasing the number of quality objectives a decision maker generates. The results of this research can be applied to a variety of personal and business decision problems. The results of generating more quality objectives will help:

To lead to solution alternatives not thought of before

1. To lead to more quality objectives to use when evaluating which alternative is the best
2. To lead to more reasons why a decision maker cares/is concerned about the decision problem

To increase the number of quality objectives that are generated, this research develops a hybrid method in the form of a worksheet that uses the problem structuring techniques and tools of cognitive mapping, motivation, multiple chances, and value

focused thinking. The development process of the hybrid method worksheet included creating an initial worksheet that was given to engineering undergraduate students for generating objectives on the decision of choosing a college major. The results of the worksheet in the development stage aided in the process of developing the hybrid method worksheet to help a decision maker generate quality objectives.

1.3 Contribution

This research makes several contributions to the field of problem structuring in decision science as outlined below:

- This research study contributes by using the combination of techniques and tools of value focused thinking, cognitive mapping, motivation, and multiple chances that have not been used before together in this area to increase the number of quality objectives generated for problem structuring of a decision.
- This research study contributes by focusing on increasing the number of quality objectives generated, where past research has focused more on increasing the number of objectives generated in general. The quality of the objective is an important part of decision making.
- This research study contributes in the application area of engineering education by increasing awareness in the area with demographic information on gender and major differences with the amount of quality objectives generated, as well as what objectives that engineering students generate the most for deciding on a college major.

- This research study contributes by comparing the problem structuring techniques and tools of value focused thinking, cognitive mapping, and motivation to analyze how the three techniques and tools generate objectives together and separately.

1.4 Dissertation Organization

The remainder of the dissertation is organized as follows. In Chapter 2, an extensive literature review is presented, including the literature related to types of decision problems, decision making approaches, generating objectives, problem structuring techniques for this research, and problem structuring tools for this research. In Chapter 3, the development of the hybrid method is discussed in great detail. In Chapter 4, the application of the development of the hybrid method will be discussed. In Chapter 5, results of the developmental stage of the hybrid method are discussed. In Chapter 6, conclusions and future research will be discussed.

CHAPTER 2 LITERATURE REVIEW

In this chapter, the relevant literature is divided into five categories: types of decision problems, decision making approaches, generating objectives problem structuring techniques for this research, and problem structuring tools for this research.

2.1 Types of Decision Problems

In decision analysis, there are three types of problems (Simon, 1960):

- Well-structured problems: Have all the data, performance measures, and alternatives to solve the problem. The problem is clear and can be easily solved.
- Semi-structured problems: Missing some data, performance measures, and alternatives to solve the problem. The problem still has some clarity and can still be solved with not much structuring of the problem, but it is not easily solved and clear like well-structured problems.
- Ill-structured problems: Data, performance measures, and alternatives are fuzzy or not defined. The problem is difficult to solve and not clear.

Ill-structured problems are the most common type of problem faced (Evans, 2012). Ill-structured problems have been defined as a "mess" (Ackoff, 1970), "wicked" (Rittel & Webber, 1973), and "swamps" (Schon, 1987). Before a decision maker begins to solve an ill-structured problem, the problem needs to be defined, formulated, and

structured (Evans, 2012). Ill-structured problems have many of the following characteristics (Evans, 2012):

- Multiple decision makers with their own opinions of the problem (usually differing opinions)
- Several different measures of performance that can conflict with each other
- A large amount of uncertainty with different parts of the problem
- A system of related problems where the problem of focus has an effect on other problems or will create other problems
- Alternative solutions are not easily evident

Problem structuring methods focus on at least one of the characteristics of the ill-structured problem. There are a variety of problem structuring methods in research. Each problem structuring method has its' own strengths and weaknesses (Bouyssou et al., 2011). This research focuses on the beginning stage of problem structuring with generating objectives. Generating objectives gives a directed purpose to the decision being made and helps clarify exactly what decisions makers want to achieve (Bond et al., 2010).

2.2 Decision Making Approaches

There are four types of decision making approaches that characterize how to solve a decision (Bouyssou et al., 2011):

- Constructive approach – the problem and solution are both constructed during the decision analysis

- Normative approach – the problem and solution do not deviate from the norm, (rational, universal)
- Descriptive approach – observes how decision makers make a decision and than applies an appropriate model
- Prescriptive approach – the model will be adapted to the decision maker

Constructive and prescriptive approaches are adapted to each problem or decision maker. Each time the method is applied to a different problem or decision maker, it is adapted to meet the particular needs of the new situation. Descriptive and normative approaches are universal and can be applied to a large variety of problems. There has been research conducted in combining the approaches, which will be done in this research as well that has shown improvements in generating objectives (Dubois & Prade, 1995; Dubois, Prade, & Sabbadin, 2001; Wakker, 1989; Belton & Stewart, 2001). It is important to have a universal method that can be applied to a variety of problems, but also one that can be adapted some for the particular problem case. The hybrid method can be applied to a wide variety of problems as well as be tailored to a specific situation.

2.3 Generating Objectives

Researchers in a variety of fields have defined the task of making a decision as an attempt by a person or group to achieve the objectives important to the person or group (Bond et al., 2010; Drucker, 1954; Payne et al., 1988; Austin & Vancouver, 1996; Keeney, 1992; Higgins, 1997; Bettman et al., 1998; Carver & Scheier, 1999; Gollwitzer, 1999; Morton & Fasolo, 2009). Objectives show what a person cares/wants to achieve (Bond et al., 2010). Researchers in decision science indicate that being confident of

objectives is highly importantly in having sound decision making (Raiffa, 1968; Smith et al., 1982; Payne et al., 1988; Kirkwood, 1997; Leon, 1999).

When making a decision, the decision maker should first think about values and not alternatives. Alternatives are traditionally what a decision maker thinks of first. However, the decision maker's values directly leads into the decision's objectives. If a decision maker focuses on values at the beginning of the process, the decision maker will have a clearer idea on what alternatives are the best representative of the decision maker's values. (Keeney, 1992)

The values that the decision maker has that will affect a particular decision turn into that decision's objectives that have many purposes including (Bond et al., 2010):

- Objectives makes clear why the person cares
- Objectives help generate better alternatives
- Objectives help put different viewpoints together
- Objectives help establish the consequences of alternatives
- Objectives help determine which alternatives are better than others
- Objectives help determine what criteria to use to evaluate alternatives
- Objectives help ascertain the pros and cons of alternatives

Most decision makers generate less than half of the possible objectives when making a decision (Bond et al., 2008). Not knowing what the objectives are or having incomplete objectives will be the main reason for not making a quality decision. (Tversky & Kahneman, 1981).

Since most decision makers cannot generate a large number of objectives, Samuel Bond, Kurt Carlson, and Ralph Keeney started doing more research on this topic of increasing the number of objectives that a decision maker generates (Bond et al., 2008, 2010). In their research, three studies were completed that focused on the generation of objectives. The three studies had five important findings (Bond et al., 2010):

1. On their own people generate less than half of important objectives for a decision.
2. Giving people examples of objectives did not make a significant difference in the number of objectives generated.
3. Motivation and multiple chances have significant effects on generating objectives, more so than providing categories.
4. Motivating people by telling them that research says that a person can come up with more objectives has a more significant effect than telling people to add more objectives.
5. Being specific in motivation makes a positive difference in generating objectives.

` The three applications in the studies listed above focused on individuals generating objectives. However, group decision-making is an important area of research as well. The process of decision-making will be different in some aspects for a group compared to an individual. However the process of generating objectives for a group decision often involves group members first generating objectives individually before discussing with the group. This process of generating objectives individually will help each person give their own contribution to the decision being made. (Keeney, 2013)

Bond, Carlson, and Keeney have shown significant findings in their research studies on generating more objectives. However, the scholars are quoted as saying: "Moreover, we believe that these interventions represent only the "tip of the iceberg," and we hope that by applying and extending the principles discussed here, researchers and practitioners will uncover a variety of powerful tools to enhance objective generation and improve the quality of resulting decisions (Bond et al., 2010, p. 254)." This dissertation will do just that by extending previous findings in this research area of generating more objectives. This study will add to this research field by developing a hybrid method to generate more objectives. The hybrid method will use the techniques and tools of value focused thinking, cognitive mapping, motivation, and multiple chances to help a person generate more objectives when making a decision. This research will also contribute to this field by increasing the number of quality objectives generated. It is important to not just look at the number of objectives, but also make sure a large percentage is quality objectives. The next four sections of the literature review will go into individual detail of the techniques and tools of the hybrid method.

2.4 Problem Structuring Techniques for this Research

The first technique discussed in this literature review is value focused thinking. This technique, developed by Ralph Keeney, focuses on using values to create better decision alternatives. It has been applied to many decision analysis applications including military, economics, and education. The main theme of value focused thinking is that if a decision maker focuses on values at the beginning of the decision process, better alternatives and opportunities can be realized than when a decision maker only focuses on alternatives (known as alternative focused thinking; the opposite of value

focused thinking). Value focused thinking can require more time and cost than alternative focused thinking, but it will pay off in the end because the decision maker will understand more of the wants/needs of the decision by having quality objectives. Alternative focused thinking is constrained thinking; where value focused thinking is constraint-free thinking. Value focused thinking should be looked at as an opportunity to generate alternatives, and not as a problem with alternatives (Keeney, 1992), with the advantages being:

- Uncovering objectives not thought of before by the decision maker
- Guiding information collection
- Improving communication
- Facilitating involvement in multiple stakeholder decisions
- Interconnecting decisions
- Evaluating alternatives
- Creating alternatives
- Identifying decision opportunities
- Guiding strategic thinking

In value focused thinking, values are defined and made clear in objectives. Five devices that help identify objectives that focus on values will be discussed with a definition for each device, as well as an example for each device that is discussing a graduate student making a decision on what first-time faculty position to accept.

Device One for Identifying Objectives: Wish List

a) Definition – The decision maker should think about if there were no limitations in the decision what would the decision maker most want out of it/care about the most.

b) Example – The graduate student's wish list for a first-time faculty position would be a great salary, friendly colleagues, many research opportunities, a highly ranked university, and a chance to be able to have tenure.

Device Two for Identifying Objectives: Alternatives

a) Definition – When weighing the pros and cons of alternatives already known, the decision maker can determine what is important and develop objectives. Alternatives already known can be changed to objectives by asking why the decision maker cares about the alternative. A decision maker can think about alternatives that have not been thought of and ask what would be a good alternative and what would be a bad alternative, by asking these questions, a decision maker can generate more objectives. It is important to note that when weighing the pros and cons of alternatives that a decision maker only looks at the existing alternatives that were known before the decision making process started. All new alternatives should be generated after the decision maker thinks about the values and quality objectives that are significant for the decision.

b) Example – A graduate student has been offered a first-time faculty position by a university, early on in the job search period. The graduate student weighs the pros and cons of this job and this helps the graduate student realize more of the

quality objectives that are important to the student such as realizing a different research area would be better.

Device Three for Identifying Objectives: Problems and Shortcomings

a) Definition – It is important for the decision maker to look at potential problems and shortcomings and turn them into objectives of how to fix or eliminate them.

b) Example – The graduate student realizes that potential problems and shortcomings when selecting a first-time faculty position include not being in the area of the country where the graduate student would want to live. The graduate student realizes these potential problems and generates them into quality objectives that are wanted in a job.

Device Four for Identifying Objectives: Consequences

a) Definition – A decision maker should look at the consequences of choosing a decision alternative. When looking at the consequences, a decision maker can determine what consequences of an alternative that the decision maker cannot have occur. This helps the decision maker realize more of what the decision maker cares about and what is significant in the decision. This realization can then be used to generate quality objectives.

b) Example – A graduate student realizes that a consequence of choosing a certain university for a first time faculty position would be not having a tenure track option. This is a consequence of choosing this university and it has made the

student realize that this is a significant want and then the student turns having a tenure track position into a quality objective.

Device Five for Identifying Objectives: Different Perspectives

a) Definition – If a decision maker considers other people's points of view, it can help generate objectives.

b) Example – A graduate student deciding on a first-time faculty position asks professors that the student trusts for points of views on what job would be the best.

The second technique discussed in this section is cognitive mapping. This technique uses a mapping process to represent what a decision maker is thinking (Eden, 2004). Cognitive mapping was developed from the theory of personal constructs, with the main theme of understanding the problem before acting on the problem (Kelly, 1955). The purpose of cognitive mapping is to structure, analyze, and understand a problem (Ackermann et al., 1990).

Past research has shown that cognitive mapping helps people to make better decisions because cognitive mapping organizes a decision maker's thoughts (Ackermann et al, 1990; Ferreira, Santos, & Rodrigues, 2011). One question will be directly connected to the next question. This will help the decision maker think more critically and creatively.

Cognitive mapping helps a decision maker think more deeply about a decision by having the decision maker start out thinking in a more general fashion and then get more

specific throughout the process. An example of instructions on generating a cognitive mapping is shown below in Figure 1 for a graduate student deciding on a first-time faculty position. As shown in Figure 1, the questions start out general and applied to all aspects of the decision maker's life and then proceed to get more specific and narrowed to the present decision of deciding on a first-time faculty position.

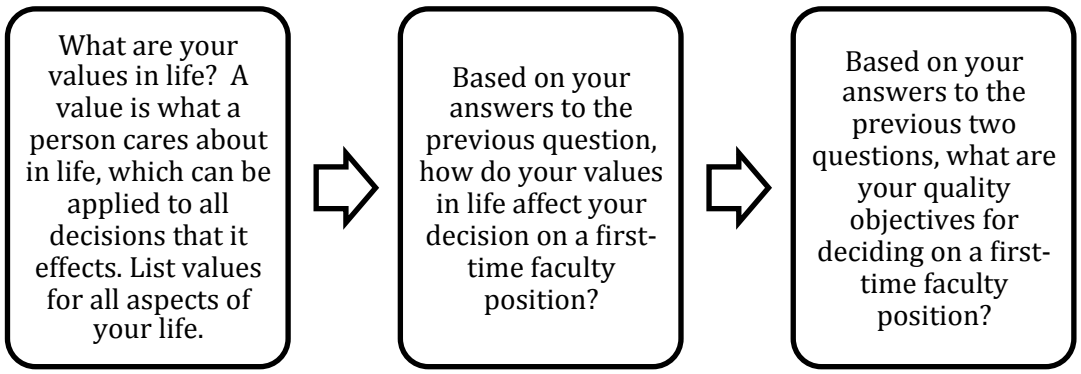

Figure 1: Cognitive Mapping Example

2.5 Problem Structuring Tools for this Research

The first tool discussed in this literature review is motivation. Bond et. al (2010) found that motivation and positive performance are correlated. If a person believes that they can do something, then it is more likely that the person will accomplish it compared to a person who does not believe (Rotter, 1966; Bandura, 1977; Eccles & Wigfield, 2002). The internal or personal motivation of a person can range anywhere on a scale from low to high. However, research has shown external ways of motivating a person can have a dramatic effect on their ability to generate objectives. (Bond et al., 2010)

One enhancing external way of motivating a person, found to be effective in the research, is to tell a person that they should work harder or think more critically (Tulving, 1966). A study on memory recall found that just asking a person to think harder would increase the person's ability to recall information. This phenomenon has also been researched for generating objectives for various types of decisions and found that motivation is a significant factor. (Bond et al., 2010)

A second way of enhancing external motivation is to make specific requests of the decision makers, such as generating a specified number of objectives. Having a specific target has been shown to have a significant positive effect (Locke et al., 1981). Past research has demonstrated that setting goals that are difficult, but achievable will have a positive effect on the person's outcome (Locke et al., 1981). Bond et al. (2010) observed this trend for decision makers provided with difficult, yet specific goals for the number of objectives to generate.

The second tool discussed in this literature review is multiple chances. The tool of multiple chances or asking people to generate objectives in different ways more than one time is important (Vul & Pashler, 2008; Tanner & Carlson, 2009, Bond et al., 2010). Offering decision makers, multiple chances to generating objectives has had a significant effect on past research studies on decision making. For example, a research study that was published in 2010 on graduate students in an MBA program deciding on an internship found that multiple chances helped the graduate student generate more objectives on what they want for an internship. The graduate students questioned what more could add to the objective list on the second and third chances and because of this increased the broadness of the objectives listed. (Bond et. al, 2010)

2.6 Research Contributions to the Literature

The work of this research fills gaps in the body of literature covered in this chapter. Highly regarded researchers in this field of Samuel Bond, Kurt Carlson, and Ralph Keeney are quoted as saying: "Moreover, we believe that these interventions represent only the "tip of the iceberg," and we hope that by applying and extending the principles discussed here, researchers and practitioners will uncover a variety of powerful tools to enhance objective generation and improve the quality of resulting decisions (Bond et al., 2010)." This research adds to the objective generation using the tools and techniques of value focused thinking, cognitive mapping, motivation, and multiple chances that were discussed in the sections above. This research also adds to the literature by concentrating on increasing not just objectives, but increasing the number of quality objectives that are generated. Quality objectives aid the decision makers into making better decisions.

CHAPTER 3 DEVELOPMENT OF THE HYBRID METHOD

This research will develop a hybrid method, in the form of a worksheet, to help a decision maker increase the number of quality objectives generated. The worksheet will consist of questions that use the problem structuring techniques and tools of value focused thinking, cognitive mapping, motivation, and multiple chances. There will be an initial worksheet created in the development stage of this research study that will aid in creating the hybrid method worksheet. This initial worksheet consists of three sections that included sections of motivation, value focused thinking, and cognitive mapping. Multiple chances are used in the worksheet by allowing decision makers three sections to generate objectives. The worksheet also includes an optional demographics section that the facilitator of the worksheet can give, if desired.

Decision makers will be able to use the worksheet to generate quality objectives as an aid in the decision making process. Quality objectives indicate the values that have a significant effect on the decision maker's decision and are important to making a quality decision. With research showing that people generate less than half of the possible objectives for a decision, scholars are quoted as saying that research needs to be added in this field of problem structuring to increase the number of objectives generated (Bond et al., 2010). The hybrid method developed here will help decision makers generate more objectives, and increase the number of quality objectives generated, which will lead to more quality decisions.

The hybrid method will use the techniques and tools of value focused thinking, cognitive mapping, motivation, and multiple chances to increase the number of quality objectives generated. This combination of techniques and tools has not been used together before to increase the increase the generation of the number of quality objectives. Each technique and tool has strengths that will aid in generating objectives.

Aiding the decision maker in thinking more deeply about the decision problem and what the decision maker wants to achieve is a major strength of value focused thinking and cognitive mapping, whereas motivation and multiple chances have this as weaknesses. Thinking deeper helps the decision maker think more creatively and generate more quality objectives than the decision maker would have before. Value focused thinking has a strength of focusing on the values of a decision maker that will affect the decision being made and then turns the values into quality objectives. This is a weakness of cognitive mapping, where cognitive mapping is not as focused and will map out all thoughts on what the decision maker is thinking.

Strengths of cognitive mapping are that the thinking processes are more structured, as well as the thoughts are connected to directly related thoughts. This is a weakness of value focused thinking because the thoughts are not structured and connected to each other. The thoughts are just focused on the one particular decision.

Motivation has a strength of helping the person do more than the person thought was possible and multiple chances has been proven that if a decision maker is asked more than once to generate objectives, there will be more the decision maker thinks of the

second time. Motivation and multiple chances do not have creative thinking or deep thinking, but the strengths they do have help the development of the hybrid method.

The techniques and tools complement each other well and the strengths of one will counteract the weaknesses of another and vice versa (Bond et. al, 2010). Table 1 below summarizes the strengths and weaknesses of the techniques and tools used in the development of the hybrid method.

Table 1: Strengths and Weaknesses of the Techniques and Tools

Techniques and Tools	Strengths	Weaknesses
Value Focused Thinking	Deep thinking and focused on concentrating on values that will affect the decision	Thinking processes are not as structured and thoughts are not connected to each other
Cognitive Mapping	Deep thinking and the decision maker's thinking process is more structured, as well as the thoughts are connected to directly related thoughts	Not as focused on one particular thought, but maps out all thoughts of what the person is thinking
Motivation	Helps the decision maker do more than the decision maker thought was possible	Not aiding the decision maker in thinking deeper about the decision problem and what the decision maker wants to achieve
Multiple Chances	Proven that if a decision maker is asked more than once to generate objectives, there will be more the decision maker thinks of the second time	Not aiding the decision maker in thinking deeper about the decision problem and what the decision maker wants to achieve

The following sections of this chapter detail the development of the hybrid method. Section 3.1 discusses the inclusion of the problem structuring techniques of value focused thinking and cognitive mapping. Section 3.2 will give details on how the problem structuring tools of motivation and multiple chances will be used in the development of the hybrid method. Section 3.3 will discuss the research questions of the development of the hybrid method.

3.1 Problem Structuring Techniques: Value Focused Thinking and Cognitive Mapping

The first technique to be discussed is value focused thinking. The technique of value focused thinking is an important aspect of the developing hybrid method. Decision makers will use five devices of value focused thinking to aid with the other techniques and tools of the developing hybrid method to increase the number of quality objectives generated. Research has shown that these devices are highly effective with helping decision makers define and make clear the values important to the decision maker that then translate into objectives (Keeney, 1992). The five devices used in this study are: wish list, alternatives, problems and shortcomings, consequences, and different perspectives and are listed below with the device definitions (Keeney, 1992):

1. Wish List
    a. Definition – The decision maker should think about if there were no limitations in the decision, what would the decision maker most want out of it/care about the most.

b. How device will be used in the development of the hybrid method – Ask the decision maker to create a wish list by thinking about if there were no limitations to the decision and then have the decision makers list any quality objectives that were thought of when thinking about no limitations.

2. Alternatives

a. Definition – When weighing the pros and cons of alternatives already known, the decision maker can determine what is important and develop objectives. Alternatives already known can be changed to objectives by asking why the decision maker cares about the alternative. A decision maker can think about alternatives that have not been thought of and ask what would be a good alternative and what would be a bad alternative; by asking these questions, a decision maker can generate more objectives. It is important to note that when weighing the pros and cons of alternatives that a decision maker only considers the existing alternatives that were known before the decision making process started. All new alternatives should be generated after the decision maker thinks about the values and quality objectives that are significant for the decision.

b. How device will be used in the development of the hybrid method – Ask the decision maker to think about the pros and cons of decision alternatives that are already known to the decision maker and then have the decision maker list any quality objectives that were thought of when thinking about the pros and cons of alternatives known.

3. Problems and Shortcomings

    a. Definition – It is important for the decision maker to consider potential problems and shortcomings and turn them into objectives of how to fix or eliminate them.

    b. How device will be used in the development of the hybrid method – Ask the decision maker to think about strengths and weaknesses of the decision maker that will affect the decision and then have the decision maker list any quality objectives that were thought of when thinking about strengths and weaknesses.

4. Consequences

    a. Definition – A decision maker should consider the consequences of choosing a decision alternative. When looking at the consequences, a decision maker can determine what consequences of an alternative that the decision maker cannot have occur. This helps the decision maker realize more of what the decision maker cares about and is significant in the decision. This realization can then be used to generate quality objectives.

    b. How device will be used in the development of the hybrid method – Ask the decision maker to think about consequences of deciding one decision alternative over another and then have the decision maker list any quality objectives that were thought of when thinking about consequences.

5. Different Perspectives

    a. Definition – If a decision maker considers other people's points of view, it can help generate objectives.

    b. How device will be used in the development of the hybrid method – Ask the decision maker to think about other people's perspectives that the decision maker trusts for guidance and then have the decision maker lists any quality objectives that were thought of when taking into account other people's perspectives.

The second technique to be discussed is cognitive mapping. The technique of cognitive mapping is an important aspect of the developing hybrid method. Decision makers will complete a set of three questions that have decision makers think about values for life in general and no specific decision and then, the questions become more specific and focused on the decision application that the developmental hybrid method is being used for (more information on the decision application used in this study can be found in Chapter 4). This will aid with the other techniques and tools of the developing hybrid method to increase the number of quality objectives generated. Cognitive mapping is used in developing the hybrid method by asking the decision maker to complete a set of three questions that have decision makers think about values for life in general and no specific decision and then, the questions become more specific and focused on the particular decision that the developing hybrid method is being used for. The strengths of cognitive mapping focus and make clear specific objectives and how the

specific objectives relate to the general objectives, where value focused thinking strengths are more into deeper thinking and thinking creatively. (Ackermann et al., 1990)

The decision maker is instructed to answer three sets of questions in the cognitive mapping section. The questions start off general and then get more specific. The first question asks the decision maker what the decision maker's main values are in life. The second question asks how the answers to the first question, the decision maker's values in life, affect the decision that the decision maker is deciding on. The third question has the decision maker think deeper about the specific decision by thinking of quality objectives that the decision maker can generate for the specific decision.

3.2 Problem Structuring Tools: Motivation and Multiple Chances

The first tool to be discussed is motivation. The tool of motivation is an important aspect of the developing hybrid method. This tool will use motivational techniques that past research has found to be helpful in generating more objectives (Bond et. al, 2010) to aid with the other techniques and tools of the developing hybrid method to increase the number of quality objectives generated. Bond et al. (2010) found in the research study that motivation has a significant effect on increasing the number of objectives generated. Research also finds that motivation and positive performance are correlated (Rotter, 1966; Bandura, 1977; Eccles & Wigfield, 2002; Bond et al., 2010). The motivation used in this research, which was found to have a positive effect in earlier research (Bond et al., 2010), is: Research shows that people generate less than 50% of objectives on their own. However, research also shows that if people think more deeply, they can generate more than 50% of the objectives.

When motivating, however, it is important to ask for a specific target, such as generate a certain number of objectives (Locke et al., 1981). Bond et al. (2010) found that MBA students deciding on an internship, when asked to generate a certain number of objectives, were able to generate more objectives as the target number of objectives increased. It is important that the motivation be stated first and then instructs the decision maker to list a certain number of quality objectives. The target number of quality objectives to generate is left to the discretion of the facilitator. It is important that the number asked is reasonable, but challenging to the decision maker as well. (Bond et. al, 2010)

The second tool to be discussed is multiple chances. The tool of multiple chances is an important aspect of the developing hybrid method. This tool has been shown in past research to help in generating objectives with it giving decision makers more than one time to think about objectives (Bond et. al, 2010). Multiple chances will be used in the development of the hybrid method to give decision makers three chances to generate objectives through three different techniques and tools of value focused thinking, cognitive mapping, and motivation. This provides the decision makers with three different times to generate objectives.

3.3 Research Questions of the Developing Hybrid Method

This chapter discusses the development of the hybrid method. With the development of the hybrid method, the main purpose of this research as discussed is to increase the number of objectives, as well as the number of quality objectives

generated by decision makers. For that purpose to be accomplished, the research questions of this research are listed below.

1. Do the sections of value focused thinking, cognitive mapping, and motivation in the worksheet have a significant effect on the number of objectives generated?
2. Does each worksheet question have a significant effect on the number of objectives generated?
3. Does the order of the sections of value focused thinking, cognitive mapping, and motivation in the worksheet have a significant effect on the number of objectives generated?
4. Does the order of the worksheet questions have an effect on the number of objectives generated?
5. Can a reduced number of worksheet questions generate a significant number of objectives?
6. Do the demographic factors have a significant effect on the number of objectives generated?
7. Are there specific worksheet questions that increase the number of quality objectives generated?
8. Are there specific worksheet sections that increase the number of quality objectives generated?
9. Are there specific orders of worksheet sections that increase the number of quality objectives generated?

10. Are there specific orders of worksheet sections that increase the number of quality objectives generated?
11. Are there specific demographic factors that increase the number of quality objectives generated?

CHAPTER 4 APPLICATION OF THE HYBRID METHOD

In an attempt to address the research questions presented in the previous chapter, the problem structuring techniques and tools of value focused thinking, cognitive mapping, motivation, and multiple chances are combined together in an initial worksheet that has been created in the development stage of this research study to be given to decision makers. This worksheet consists of three sections using the problem structuring tools and techniques of motivation, value focused thinking, and cognitive mapping. By including three sections to generate objectives, the tool of multiple chances is employed. Each section has question(s) that will aid the decision maker in generating quality objectives with the motivation section having one question, the value focused thinking section containing five questions, and the cognitive mapping section consisting of three questions. There can also be a fourth optional section on demographics of the decision makers involved if the facilitator wants to analyze the effects of demographics on generating objectives. The worksheet will be administered to decision makers using the Survey Monkey Website and the results analyzed to determine the most significant questions and layout for increasing the number of quality objectives.

This chapter goes into great detail about each section of the initial worksheet. Section 4.1 gives information on the motivation section of the worksheet. Section 4.2 gives information on the value focused thinking section of the worksheet. Section 4.3 gives information on the cognitive mapping section of the worksheet. Section 4.4 gives

information on the pre-testing of the worksheet. Section 4.5 gives information on the administration of the worksheet. The chapter concludes with Section 4.6 that gives information on the worksheet for the specific application.

4.1 Motivation Section of the Worksheet

The motivation section gives a motivation to decision makers to generate more quality objectives and also gives a challenge to the decision maker to name more quality objectives and is discussed in more detail in Section 3.2.

The steps for creating the motivation section of the worksheet are listed below. Also, an example application of the worksheet can be seen in Section 4.4.

1. State the motivation to generate quality objectives: Research shows that people generate less than 50% of quality objectives on their own. However, research also shows that if people think more deeply, they can generate more than 50% of the objectives.
2. List the number of quality objectives in question format, the decision maker is asked to generate after reading the motivation above such as the following: What quality objectives can you think of for making this decision? Can you name (specific amount related to the decision) or more? Below, please list any quality objectives that you think of for making this decision.

4.2 Value Focused Thinking Section of the Worksheet

This section has the decision makers complete five devices of the problem structuring technique of value focused thinking for generating objectives. This technique is discussed in more detail in Section 3.1.

The steps for creating the value focused thinking section of the worksheet are listed below. Also, an example application of the worksheet can be seen in Section 4.4.

1. Instruct the decision maker to create a wish list by thinking about if there were no limitations to the decision and then have the decision makers, list any quality objectives that were thought of when thinking about no limitations.

2. Instruct the decision maker to think about the pros and cons of decision alternatives that are already known to the decision maker and then have the decision maker list any quality objectives that were thought of when thinking about the pros and cons of alternatives known.

3. Instruct the decision maker to think about strengths and weaknesses that will affect the decision and then have the decision maker list any quality objectives that were thought of when thinking about strengths and weaknesses.

4. Instruct the decision maker to think about consequences of deciding one decision alternative over another and then have the decision maker list any quality objectives that were thought of when thinking about consequences.

5. Instruct the decision maker to think about other perspectives that the decision maker trusts for guidance and then have the decision maker lists any quality

objectives that were thought of when taking into account other people's perspectives.

4.3 Cognitive Mapping Section of the Worksheet

Cognitive mapping is used in this worksheet by asking the decision maker to complete a set of three questions that have the decision maker think about values for life in general and no specific decision and then, the questions become more specific and focused on deciding on the specific decision. For more details about the cognitive mapping section, refer to Section 3.1.

The steps for creating the cognitive mapping section of the worksheet are listed below. Also, an example application of the worksheet can be seen in Section 4.4.

1. Instruct the decision maker to list what their main values are in life and include the definition of a value.

2. Instruct the decision maker to think about how the answers to the first question, the decision maker's values in life, affect the decision that the decision maker is deciding on.

3. Instruct the decision maker to think deeper about the specific decision by thinking of quality objectives that the decision maker can generate for the specific decision and include examples of quality objectives.

4.4 Pre-Testing of the Worksheet

In an effort to gage the readability of the worksheet instructions and questions as well as conduct a 'dry run' of the worksheet application, two groups of people who are

similar to the decision makers who will be doing the main study, but none of whom who would be participating in the main study, need to be asked to complete the worksheet on the Survey Monkey Website and provide feedback on the worksheet tool itself before the main study takes place. The participants who agree to participate in the pre-testing should be sent an e-mail link to the worksheet on the Survey Monkey Website.

The participants are asked to complete the worksheet and after completing the worksheet, the participants are asked to give feedback on the worksheet through e-mail. After the worksheet is given once to the participants, any necessary changes needed, should be made based on the feedback. The number of objectives generated by the participants need to also be analyzed to see if the worksheet was completing its' purpose of generating objectives. Then, the worksheet needs to be given a second time, in the same manner, to participants to a second group who are not used in the main study. If the feedback from the second time comes back with a majority of positive information and positive objective results, then it is time for the administration of the worksheet that will be discussed in the next section.

4.5 Administration of the Worksheet

There are six different versions of the worksheet that were randomly chosen by the Survey Monkey Website. This helps with answering the third research question found in Section 3.3 that asks: Does the order of the sections of value focused thinking, cognitive mapping, and motivation in the worksheet have a significant effect on the number of objectives generated?

The first three sections of the worksheet of motivation, value focused thinking, and cognitive mapping were randomized, with the fourth section, demographics, not being randomized, since it is not a part of the generating objectives aspect of the worksheet. The six versions of the worksheet are shown in Table 2.

Table 2. Ordering of Worksheet Sections by Version

Ordering of Worksheet Sections by Version				
Version	Section Ordered First in the Worksheet	Section Ordered Second in the Worksheet	Section Ordered Third in the Worksheet	Section Ordered Fourth in the Worksheet
CMV	Cognitive Mapping	Motivation	Value Focused Thinking	Demographics
MVC	Motivation	Value Focused Thinking	Cognitive Mapping	Demographics
VCM	Value Focused Thinking	Cognitive Mapping	Motivation	Demographics
VMC	Value Focused Thinking	Motivation	Cognitive Mapping	Demographics
CVM	Cognitive Mapping	Value Focused Thinking	Motivation	Demographics
MCV	Motivation	Cognitive Mapping	Value Focused Thinking	Demographics

Once the worksheet has been administered, results should be downloaded in a Microsoft Excel file format from the Survey Monkey Website. The results were anonymous, so therefore each set of responses to the worksheet are assigned a number from the Survey Monkey website. From the number that is given, the researcher can get on the Survey Monkey website and find the version of the worksheet that the decision maker was given randomly by the Survey Monkey Website.

After each decision maker's responses are assigned a specific version, the objectives need to be organized and prepared for analysis. There are many objectives that a decision maker could generate that are similar in meaning. To be able to analyze the results effectively, it is important to group the similar objectives together. For, this analysis each decision maker's objective responses from each question need to be read individually and put into a group with similar objectives from other decision makers by the researcher in a subjective manner based on the researcher's opinion. Once all objectives are placed in a group, group names are created and the group names become the objectives that are used throughout the analysis of the results of the worksheet. After the objectives are grouped into keywords, statistical analyses need to be performed in Minitab to answer the first six research questions presented in Section 3.3.

The next step in analyzing the results is to look at the quality of the objectives generated to answer the quality objective research questions presented in Section 3.3. To analyze the quality objectives, several members of an expert panel who are trusted with the knowledge of the decision at hand need to be asked to rate the quality of the objectives that are generated by the decision maker. A survey for the experts needs to be setup on the Survey Monkey Website and e-mailed to the expert panel. In the survey, the experts are asked to rate how important each objective is for the decision based on three levels: high importance, mid importance, and low importance. The high importance objectives are known as quality objectives, where the low importance objectives have low quality. Once the survey is completed, statistical analyses can be performed in Minitab by analyzing the factors to see what factors have a significant effect on the number of quality objectives generated.

4.6 Worksheet Given for Specific Application

For this research study, the initial worksheet was applied to the decision of an undergraduate student choosing a college major. This application was chosen because many students find this to be a difficult decision and often end up changing their major many times. Choosing a college major is a significant decision in a person's life affecting job satisfaction, job stability, and opportunities throughout life (Porter & Umbach, 2006).

Engineering students at the University of Louisville's Speed School of Engineering were used in this study. There were 231 students enrolled in the Spring 2013 Engineering Fundamentals Department Calculus I course that were asked to voluntarily participate in this study. Students enroll in the Engineering Fundamentals Department courses in the first two years of engineering school, so therefore making it an opportune time to discuss college major decisions. This research study was submitted and approved in November 2012 by the University of Louisville IRB committee (IRB #12.0428).

Before the worksheet was presented to the students, a pre-testing of the worksheet took place. Two groups of advanced level students, none of whom who would be participating in the main study, were asked to complete the worksheet in Survey Monkey and provide feedback on the worksheet tool itself. The worksheet was first given to the first group that included three students on November 27, 2012. The three students were sent an e-mail link to the worksheet on the Survey Monkey Website. The students were asked to complete the worksheet and after completing the worksheet, the students were asked to give feedback on the worksheet through e-mail. After the worksheet was given

once to the students, some changes were made to the worksheet based on the feedback. The changes included changing wording and adjusting questions to make them more universally understood. The objectives generated by the students were also analyzed to see if the worksheet was completing its' purpose and it was found to be achieving the purpose with each student generating numerous objectives. Then, the worksheet was given a second time to nine students who were not used in the actual study. The revised worksheet was administered via Survey Monkey Website on December 20, 2012. Again these nine students completed the worksheet and gave feedback through e-mail. The feedback supplied by this second test group indicated the worksheet was clearly worded and ready to give to the students in the Calculus I classes.

The worksheet was presented by the researcher of this paper and explained to the students in the Calculus I classes on January 16, 2013. There were three Calculus I classes for the spring semester of 2013 and the worksheet was explained for 10 minutes at the beginning of each class. The three course sections met at 8:00 am, 9:00 am, and 10:00 am. It was explained to the students by the researcher what the worksheet was about, how the worksheet would not affect the student's grade and how to access the worksheet that was on the Survey Monkey Website. The students also were e-mailed a message that gave the link to the Survey Monkey Website, as well as a summary of the research information that was presented during the Calculus I classes. The students were able to access and complete the worksheet from January 16, 2013 to January 28, 2013.

Below is the worksheet that is presented to the undergraduate engineering students for the decision of deciding on a college major. The general format of the worksheet will be the same for all of the applications that this worksheet is used for,

except for three differences: the instructions explain the specific decision of deciding on a college major, most of the questions will ask the engineering students to list quality objectives for deciding on a college major at the end of the question, and the demographic section is added for this specific application on undergraduate engineering students. Below lists the worksheet in its entirety:

Instructions

This exercise is designed to study how students develop and use quality objectives to decide which college major to pursue. College majors at the J.B. Speed School of Engineering include: Bioengineering, Chemical Engineering, Civil Engineering, Computer Engineering and Computer Science, Electrical Engineering, Industrial Engineering, and Mechanical Engineering.

Quality objectives are the values (a value is what a person cares about in life, which can be applied to all decisions that it effects) that have a significant effect on the student's decision. For example, two quality objectives for deciding which car to buy are the safety of the car and the cost of the car.

This worksheet will consist of three different sections that will help generate quality objectives for deciding on a college major and a fourth section that asks demographic questions to help with the analysis of this study.

Do not put your name on any part of this exercise. If you do not feel comfortable answering any part of this exercise, you do not have to answer that part.

Unless otherwise stated, treat each question independently. Also, any quality objectives you list for one question do not need to be repeated for subsequent questions.

Section 1 – Motivation

Unless otherwise stated, treat each question independently. Also, any quality objectives you list for one question do not need to be repeated for subsequent questions. Remember, examples of two quality objectives for deciding which car to buy are the safety of the car and the cost of the car.

M1. Research shows that people generate less than half of the quality objectives on their own. However, research also shows that if people think more deeply, they can generate more quality objectives. What quality objectives can you think of for deciding which college major to

pursue? Can you name 10 or more? Below, please list any quality objectives that you think of for deciding on your college major.

Section 2 – Value Focused Thinking

Unless otherwise stated, treat each question independently. Also, any quality objectives you list for one question do not need to be repeated for subsequent questions. Remember, examples of two quality objectives for deciding which car to buy are the safety of the car and the cost of the car.

V1. Think about if there were no limitations when deciding on your college major. Some examples of no limitations when deciding which car to buy are not needing to consider purchase price or availability of the car. Below, please list any quality objectives that you think of for deciding on your college major if there were no limitations.

V2. Think about the pros and cons of different college majors. With those pros and cons in mind, please list below any quality objectives that you think of for deciding on your college major.

V3. Think about your own personal strengths and weaknesses. With those strengths and weaknesses in mind, please list below any quality objectives that you think of for deciding on your college major.

V4. Think about consequences of choosing one college major over another. With those consequences in mind, please list below any quality objectives that you think of for deciding on your college major.

V5. Think about the preferences and perspectives of other people, such as your parent/academic advisor/coach/mentor/someone you look up to in life, for your college major. Consider what college major they think you should choose. With those preferences and perspectives in mind, please list below any quality objectives that you think of for deciding on your college major.

Section 3 – Cognitive Mapping

Unless otherwise stated, treat each question independently. Also, any quality objectives you list for one question do not need to be repeated for subsequent questions.

C1. What are your values in life? A value is what a person cares about in life, which can be applied to all decisions that it effects. List values for all aspects of your life.

C2. Based on your answers to the previous question, how do your values in life affect your college major decision?

C3. Based on your answers to the previous two questions, what are your quality objectives for deciding on a college major? Remember, examples of two quality objectives for deciding which car to buy are the safety of the car and the cost of the car.

Section 4 – Demographics

1. What is your current college major?
    - Bioengineering
    - Chemical Engineering
    - Civil Engineering
    - Computer Engineering and Computer Science
    - Electrical Engineering
    - Industrial Engineering
    - Mechanical Engineering
    - Undecided Engineering
    - Other

2. Sex
    - Female
    - Male

3. Race/Ethnicity
    A. (Check one) Latino or Hispanic?
        - Yes
        - No
    B. (Check one or more)
        - White
        - Black or African American
        - Asian
        - American Indian or Alaska Native
        - Native Hawaiian or Pacific Islander

4. At this point in time, do you plan to stay with your current college major or do you plan on switching to another college major? If you are planning on switching college majors, is your new college major based within the J.B. Speed School of Engineering?
    - Stay with current college major
    - Switch to another major that is based within the J.B. Speed School of Engineering
    - Other

CHAPTER 5 RESULTS OF THE WORKSHEET APPLICATION

In Chapter 4, the worksheet for the development process of the hybrid method that was given to beginning engineering students was discussed in great detail. Students from the University of Louisville Speed School of Engineering's Calculus I classes for the spring of 2013 completed the worksheet from January 16, 2013 to January 28, 2013. There were 84 students that completed the worksheet with 231 students in the three Calculus I classes combined. This gives a 36.4% rate of completion of the worksheet.

Demographic information for the students, listed in the tables below, includes information on college major, gender, and race. Table 3 shows the percentage of students for each major with the highest percentage being mechanical engineering. Table 4 shows the percentage of students for each gender with the highest percentage being male. Table 5 shows the percentage of students for each race/ethnicity; with the highest percentage being the race/ethnicity of white.

Table 3: Student Major Statistics

Major	Percent
Bioengineering	14%
Chemical Engineering	11%
Civil Engineering	12%
Computer Engineering and Computer Science	18%
Electrical Engineering	14%
Industrial Engineering	7%
Mechanical Engineering	24%
Undecided Engineering	1%
Other	0%

Table 4: Student Gender Statistics

Gender	Percent
Female	26%
Male	74%

Table 5: Student Race/Ethnicity Statistics

Race/Ethnicity	Percent
White	91.7%
Black/African American	8.3%
Asian	4.2%
American Indian or Alaska Native	2.8%
Native Hawaiian or Pacific Islander	0.0%

Results of the worksheets completed by the students are shown in detail in this chapter. Section 5.1 discusses grouping of objectives generated by students to facilitate analysis. Section 5.2 will evaluate the effects of version, question, and section on number of objectives generated. Section 5.3 will evaluate the effects of several demographic factors on number of objectives generated. Finally, Section 5.4 will discuss the analysis of quality objectives.

5.1 Grouping of Objectives Results

With 84 students completing the worksheet, the results showed many different ways of writing the same objective or a closely similar objective. Similar objectives were grouped together in a subjective manner based on the opinion of the researcher, as discussed in Section 4.5. There were 44 groups of objectives that were made from the grouping of the similar objectives. The 44 objectives are the basis for the analysis of the worksheet results and are used for all analysis for objectives generated in this research. When grouping the objectives, no objectives were discarded, with each objective being

put in the best-fit group. If there was more than objective listed for a question that would be fit into the same group, only one of the duplicate objectives were counted per question. However, objectives would be counted more than once if the objectives were generated on different questions.

This section gives general statistical information on the number of objectives generated. First, the average number of objectives each student generated was 20.21 objectives. The median number of objectives that the students generated was 20 objectives. The standard deviation of the number of objectives each student generated was 9.78 objectives. The information described above is shown in Table 6 below.

Table 6: Overall Objectives Results

Statistic Categories	Objectives Generated With Duplicates	Objectives Generated With No Duplicates
Numbers of Students	84 Students	84 Students
Average Number of Objectives Each Student Generated	20.21 Objectives	12.06 Objectives
Median Number of Objectives Each Student Generated	20 Objectives	12 Objectives
Standard Deviation of the Number of Objectives Each Student Generated	9.58 Objectives	4.62 Objectives

Next, Table 7 below lists the top 5 objectives including count of the number of students with the objective and the percent of the number of students with the objective.

Table 7: Statistics on the Top 5 Objectives

Top 5 Keyword Objectives	Count of Students (of 84) with the Objective	% Of Students with the Objective
salary	73	86.90%
interest in subject and field	70	83.33%
family's preference for major	65	77.38%
job availability after graduation	54	64.29%
interesting professional applications	52	61.90%

5.2 The Effect of Version, Question, and Section on Objectives Generated

This section addresses the first five research questions presented in Section 3.3. The research questions focus on how the factors of version, question, and section have an effect the number of objectives generated. Each research question is resolved using a statistical analysis that includes an ANOVA and a Tukey test.

The first research question to be addressed is: Do the sections of value focused thinking, cognitive mapping, and motivation in the worksheet have a significant effect on the number of objectives generated? To find the answer to this research question, an ANOVA was first conducted on the number of objectives generated versus section with a block on the student. This was done to see if the factor of section had a significant impact on the number of objectives generated. Section (p-value = 0.000) and student (p-value = 0.000) both have p-values lower than 0.05, the alpha value used in Minitab to determine significance, and are shown in Table 8, along with other ANOVA information. With the p-values both equaling 0.000, this shows that section does have a significant effect on the number of objectives generated. A Tukey test was then done that grouped the sections by order of the effect that the section used had on the number of objectives generated. Motivation was found to have significantly generated more objectives than the other two sections with the higher group letter. The Tukey test analysis is shown in Table 9.

Table 8: ANOVA for Objectives vs. Section and Block on Student

Source of Variation	DF	Seq SS	Adj SS	Adj MS	F	P
Section	2	1.327721	1.327721	0.663860	123.97	0.000
Student	83	2.590688	2.590688	0.031213	5.83	0.000
Error	670	3.587754	3.587754	0.005355		
Total	755	7.506163				

Table 9: Tukey for Objectives vs. Section and Block on Student

Section	N	Mean	Grouping
Motivation	84	1.229	A
Cognitive Mapping	252	1.179	B
Value Focused Thinking	420	1.112	C

The next research question to be answered in this section is: Does each worksheet question have a significant effect on the number of objectives generated? To find the answer to this research question, an ANOVA was performed on objectives versus question with a block on the student. This was done to see if the factor of question had a significant impact on the number of objectives generated. Similarly to above, question (p-value = 0.000) and student (p-value = 0.000) both have p-values lower than 0.05 (the alpha value used to determine significance) and are shown in Table 10, along with other ANOVA information. With the p-values both equaling 0.000, this shows that the individual question does have a significant effect on the number of objectives generated. A Tukey test was then done that grouped the questions by order of the effect that the question used had on the number of objectives generated. Questions M1 and C1 were found to have significantly generated more objectives than the other questions with both having the highest group letter. The Tukey test analysis is shown in Table 11. Those questions, which share the same grouping letter, are not significantly different in terms of number of objectives generated.

Table 10: ANOVA for Objectives vs. Question and Block on Student

Source of Variation	DF	Seq SS	Adj SS	Adj MS	F	P
Question	8	1.655618	1.655618	0.206952	42.15	0.000
Student	83	2.590688	2.590688	0.031213	6.36	0.000
Error	664	3.259857	3.259857	0.004909		
Total	755	7.506163				

Table 11: Tukey for Objectives vs. Question and Block on Student

Question	N	Mean	Grouping
M1	84	1.229	A
C1	84	1.219	A
C2	84	1.162	B
C3	84	1.156	B
V2	84	1.140	B, C
V3	84	1.118	C, D
V1	84	1.114	C, D
V5	84	1.096	D
V4	84	1.092	D

The next research question to be answered in this section is: Does the order of the sections of value focused thinking, cognitive mapping, and motivation in the worksheet have a significant effect on the number of objectives generated? To find the answer to this research question, an ANOVA was done on the objectives versus version. This was done to see if the factor of version had a significant impact on the number of objectives generated. It was found that version (p-value = 0.002) has a p-value lower than 0.05 (the alpha value used to determine significance) and is shown in Table 12, along with other ANOVA information. This shows that version does have a significant effect on the number of objectives generated. A Tukey test was then done that grouped the different versions by order of the effect that the version used had on the number of objectives generated. There were many versions in the top group of the number of objectives

generated, as seen in the Tukey test analysis is shown in Table 13. The only version that was not in the top group was CMV. Those versions, which share the same grouping letter, are not significantly different in terms of number of objectives generated.

Table 12: ANOVA for Objectives vs. Version

Source of Variation	DF	Seq SS	Adj SS	Adj MS	F	P
Version	5	0.186501	0.186501	0.037300	3.82	0.002
Error	750	7.319662	7.319662	0.009760		
Total	755	7.506163				

Table 13: Tukey for Objectives vs. Version

Version	N	Mean	Grouping
VCM	72	1.176	A
VMC	81	1.175	A
MVC	171	1.148	A, B
MCV	108	1.146	A, B
CVM	135	1.138	A, B
CMV	189	1.131	B

The last two research questions to be answered in this section are: Does the order of the worksheet questions have an effect on the number of objectives generated and can a reduced number of worksheet questions generate a significant number of objectives? To find the answer to these research questions, an ANOVA was done on the objectives versus question order with a block on the student. This was done to see if the order the questions were given had a significant impact on the number of objectives generated. Question order (p-value = 0.000) and student (p-value = 0.000) both have p-values lower than 0.05 (the alpha value used to determine significance) and are shown in Table 14, along with other ANOVA information. With both of the p-values being equal to 0.000, this shows that the question order does have a significant effect on the number of

objectives generated. A Tukey test was then completed to see what order of questions generated the most objectives. The first question in the order, no matter which of the nine questions, was found to have significantly generated more objectives than the questions later in the order. The Tukey test analysis is shown in Table 15. Those questions, which share the same grouping letter, are not significantly different in terms of number of objectives generated. This shows that a reduction of questions could be considered since most objectives are generated with the beginning questions.

Table 14: ANOVA for Objectives vs. Question Order and Block on Student

Source of Variation	DF	Seq SS	Adj SS	Adj MS	F	P
Question Order	8	0.970613	0.970613	0.121327	20.42	0.000
Student	83	2.590688	2.590688	0.031213	5.25	0.000
Error	664	3.944862	3.944862	0.005941		
Total	755	7.506163				

Table 15: Tukey for Objectives vs. Question Order and Block on Student

Question Order	N	Mean	Grouping
1st	84	1.228	A
2nd	84	1.170	B
3rd	84	1.166	B
4th	84	1.150	B, C
6th	84	1.138	B, C, D
7th	84	1.135	B, C, D
9th	84	1.120	C, D
5th	84	1.115	C, D
8th	84	1.102	D

5.3 The Effect of Demographics on Objectives Generated

This section answers the demographic research question of if the demographic factors have a significant effect on the number of objectives generated. The demographic factors of college major and gender are analyzed to answer this research question. The

demographic of race/ethnicity was not analyzed because the percentage in the White race/ethnicity category was too high for the results to be valid.

The demographic factor of college major will be first be analyzed to help in answering the research question of: Do the demographic factors have a significant effect on the number of objectives generated? To find the answer to this research question, an ANOVA was done on the objectives versus major and question. This was done to see if major had a significant impact on the number of objectives generated. Major (p-value = 0.000) and question (p-value = 0.000) both have p-values lower than 0.05 (the alpha value used to determine significance) and are shown in Table 16, along with other ANOVA information. With both of the p-values being equal to 0.000, this shows that major does have a significant effect on the number of objectives generated. A Tukey test was then done that grouped major by order of the effect that the each major had on the number of objectives generated. The majors of civil engineering and computer engineering and computer science were found to have significantly generated more objectives than the other majors with the majors of civil engineering and computer engineering and computer science being grouped only in Group A and the other majors being grouped, all though some are in Group A as well, they are also listed in lower alphabetically ordered groups. The Tukey test analysis is shown in Table 17. Those questions, which share the same grouping letter, are not significantly different in terms of number of objectives generated.

Table 16: ANOVA for Objectives vs. Major and Question

Source of Variation	DF	Seq SS	Adj SS	Adj MS	F	P
Major	9	0.31788	0.31788	0.03974	5.31	0.000
Question	8	1.65562	1.65562	0.20695	27.64	0.000
Error	739	5.53266	5.53266	0.00749		
Total	755	7.50616				

Table 17: Tukey for Objectives vs. Major and Question

Major	N	Mean	Grouping
Civil engineering	81	1.177	A
Computer engineering and computer science	117	1.176	A
Bioengineering	81	1.157	A, B
Chemical Engineering	54	1.151	A, B
Industrial Engineering	45	1.149	A, B
Mechanical Engineering	153	1.137	B
Undecided Engineering	9	1.131	A, B
Electrical Engineering	90	1.129	B

The demographic factor of gender will be analyzed next to help in answering the research question of: Do the demographic factors have a significant effect on the number of objectives generated? To find the answer to this research question, an ANOVA was done on the objectives versus gender and question. This was done to see if gender had a significant impact on the number of objectives generated. Gender (p-value = 0.000) and question (p-value = 0.000) both have p-values lower than 0.05 (the alpha value used to determine significance) and are shown in Table 18, along with other ANOVA information. With both of the p-values being equal to 0.000, this shows that gender does have a significant effect on the number of objectives generated. A Tukey test was then done that grouped gender by order of the effect that the gender had on the number of objectives generated. The female gender was found to have significantly generated more

objectives than the male gender with being by itself in Group A. The Tukey test analysis is shown in Table 19.

Table 18: ANOVA for Objectives vs. Gender and Question

Source of Variation	DF	Seq SS	Adj SS	Adj MS	F	P
Gender	2	0.16920	0.16920	0.08460	11.09	0.000
Question	8	1.65562	1.65562	0.20695	27.14	0.000
Error	745	5.68134	5.68134	0.00763		
Total	755	7.50616				

Table 19: Tukey for Objectives vs. Gender and Question

Gender	N	Mean	Grouping
Female	144	1.169	A
Male	486	1.148	B

5.4 The Effect of Question on Quality Objectives Generated

This section answers the research questions related to quality objectives generated. The research questions are answered by first doing a quality of objectives analysis, as discussed in Section 4.5. This quality objectives analysis uses a panel of eight experts that are engineering graduates and working in either the field of industry or academia for engineering. For each of the 44 keywords, the experts were asked to rate how important each objective was for deciding on a college major based on three levels: High Importance, Mid Importance, and Low Importance. The full survey results for each of the experts are shown in Appendix C. Table 20 shows the 3 out of 44 objectives that 6 or more of the eight experts rated as high importance, as well as the percentage of students who generated the high importance objectives. Table 21 shows the percentage of students with quality objectives generated from each of the questions with question M1 having the highest percentage of quality objectives.

Table 20: Quality Objectives Rated by Expert Panel

High Importance	% of Students with High Importance
Interest in Subject and Field	83.33%
Job Availability After Graduation	64.29%
Future Employability of Major	5.95%

Table 21: Percent of Quality Objectives by Question

Question and Method	% With Interest in Subject and Field	% With Job Availability After Graduation	% With Future Employability of Major
M1	58.33%	36.90%	2.38%
V1	33.33%	8.33%	0.00%
V2	27.38%	27.38%	0.00%
V3	27.38%	1.19%	1.19%
V4	14.29%	10.71%	0.00%
V5	13.10%	5.95%	0.00%
C1	17.86%	1.19%	0.00%
C2	20.24%	7.14%	0.00%
C3	29.76%	25.00%	2.38%

Now each student's responses were reviewed and the number of low quality objectives and high quality objectives generated for each question were recorded. The analysis presented in this section was conducted using these numbers of low quality objectives and high quality objectives for each question on each student's worksheet. Next, a non-parametric analysis was completed on the data using the tests of Kruskal-Wallis and Dunn's Test. Non-parametric tests were used with the data being not normally distributed because of the small list of low and high quality objectives The Kruskal-Wallis test was used to identify the factor groups that generated a large number of quality objectives.

The first research question to be answered in this section is: Are there specific worksheet questions that increase the number of quality objectives generated? Table 22 shows the Kruskal-Wallis results with the p-value of 0.000 that indicates the significance of the factor of question on the response of high quality objectives. The results also show that question M1, followed by question C3, and then V2 were shown to have the highest positive Z scores from the Kruskal-Wallis test for generating quality objectives, which shows that those questions generate a higher number of quality objectives than the other questions. Next, the Dunn's test performed pairwise comparisons between the questions to see which questions were significantly different over another question in increasing the number of quality objectives generated. Table 23 shows the pairwise comparisons that had significant differences, along with p-values, with question M1 having the most significance in increasing the number of quality objectives generated.

Table 22: Kruskal-Wallis: Quality Objectives vs. Question

Group	N	Median	Ave Rank	Z
M1	84	1.000000000	533.9	6.92
V1	84	0.000000000	385.5	0.31
V2	84	0.000000000	413.5	1.56
V3	84	0.000000000	348.5	-1.33
V4	84	0.000000000	331.6	-2.09
V5	84	0.000000000	310.5	-3.03
C1	84	0.000000000	313.1	-2.91
C2	84	0.000000000	340.1	-1.71
C3	84	0.000000000	429.9	2.29
Overall	756		378.5	
H = 73.16	DF = 8	P = 0.000		

Table 23: Dunn's Test: Quality Objectives vs. Question

Pairwise Comparisons with Significant Differences	P-Value
M1 vs. V5	0.0000
M1 vs. C1	0.0000
M1 vs. V4	0.0000
M1 vs. C2	0.0000
M1 vs. V3	0.0000
M1 vs. V1	0.0000
M1 vs. V2	0.0000
V5 vs. C3	0.0000
C1 vs. C3	0.0000
M1 vs. C3	0.0002
V2 vs. V5	0.0003
V2 vs. C1	0.0004
V4 vs. C3	0.0005
C2 vs. C3	0.0015
V2 vs. V4	0.0038
V3 vs. C3	0.0040

The second research question to be answered in this section is: Are there specific worksheet sections that increase the number of quality objectives generated? Table 24 shows the Kruskal-Wallis results with the p-value of 0.000 that indicates the significance of the factor of section on the response of high quality objectives. The results also show that the section of Motivation is the only section with a positive Z score from the Kruskal-Wallis test for generating quality objectives, which shows that that the motivation section generates a higher number of quality objectives than the other sections. Next, the Dunn's test performed pairwise comparisons between the sections to see which sections were significantly different over another section in increasing the number of quality objectives generated. Table 25 shows the pairwise comparisons that had significant differences, along with p-values, with the section of Motivation having the positive significance in increasing the number of quality objectives generated.

Table 24: Kruskal-Wallis: Quality Objectives vs. Section

Group	N	Median	Ave Rank	Z
Motivation	84	1.000000000	533.9	6.92
Value Focused Thinking	420	0.000000000	357.9	-2.90
Cognitive Mapping	252	0.000000000	361.0	-1.56
Overall	756		378.5	
H = 47.89	DF = 2	P = 0.000		

Table 25: Dunn's Test: Quality Objectives vs. Section

Pairwise Comparisons with Significant Differences	P-Value
Motivation vs. Value Focused Thinking	0.0000
Motivation vs. Cognitive Mapping	0.0000

The third research question to be answered in this section is: Are there specific orders of worksheet sections that increase the number of quality objectives generated? Table 26 shows the Kruskal-Wallis results with the p-value of 0.702. With the p-value being greater than the test statistic of 0.05, this shows that the order of worksheet questions is not significant in increasing the number of quality objectives generated.

Table 26: Kruskal-Wallis: Quality Objectives vs. Version

Group	N	Median	Ave Rank	Z
CMV	189	0.000000000	384.7	6.92
MVC	171	0.000000000	355.5	0.31
VMC	81	0.000000000	393.9	1.56
CVM	135	0.000000000	377.6	-1.33
VCM	72	0.000000000	378.0	-2.09
MCV	108	0.000000000	394.6	-3.03
Overall	756		378.5	
H = 2.99	DF = 5	P = 0.702		

The fourth research question to be answered in this section is: Are there specific orders of worksheet questions that increase the number of quality objectives generated?

Table 27 shows the Kruskal-Wallis results with the p-value of 0.000 that indicates the significance of the factor of question order on the response of high quality objectives. The results also show that the first question in order, no matter which of the nine questions, was shown to have the highest positive Z score from the Kruskal-Wallis test for generating quality objectives, which shows that the first question in order generates a higher number of quality objectives than the other questions. Next, the Dunn's test performed pairwise comparisons between the question orders to see which question orders were significantly different over another question order in increasing the number of quality objectives generated. Table 28 shows the pairwise comparisons that had significant differences, along with p-values, with the first question in order having the most significance in increasing the number of quality objectives generated.

Table 27: Kruskal-Wallis: Quality Objectives vs. Question Order

Group	N	Median	Ave Rank	Z
4th	84	0.000000000	417.2	1.72
1st	84	1.000000000	474.8	4.28
6th	84	0.000000000	373.3	-0.23
9th	84	0.000000000	377.6	-0.04
5th	84	0.000000000	364.4	-0.63
2nd	84	0.000000000	355.9	-1.01
3rd	84	0.000000000	429.9	2.29
7th	84	0.000000000	308.9	-3.10
8th	84	0.000000000	304.7	-3.29
Overall	756		378.5	
H = 43.03	DF = 8	P = 0.000		

Table 28: Dunn's Test: Quality Objectives vs. Question Order

Pairwise Comparisons with Significant Differences	P-Value
1st vs. 8th	0.0000
1st vs. 7th	0.0000
3rd vs. 8th	0.0000
3rd vs. 7th	0.0000
1st vs. 2nd	0.0000
4th vs. 8th	0.0001
1st vs. 5th	0.0001
4th vs. 7th	0.0001
1st vs. 6th	0.0003
1st vs. 9th	0.0006

The last research question to be answered in this section is: Are there specific demographic factors that increase the number of quality objectives generated? This question is studied on the factors of college major and gender. Tables 29 and 30 show the Kruskal-Wallis results with the p-value of 0.660 for college major and a p-value of 0.384 for gender. With the p-values being greater than the test statistics of 0.05, this shows that the demographic factors are not significant in increasing the number of quality objectives generated.

Table 29: Kruskal-Wallis: Quality Objectives vs. Major

Group	N	Median	Ave Rank	Z
Computer Engineering and Computer Science	117	0.000000000	404.8	1.42
Civil Engineering	81	0.000000000	368.8	-0.42
Mechanical Engineering	153	0.000000000	381.5	0.19
Chemical Engineering	54	0.000000000	378.6	0.00
Undecided Engineering	9	1.000000000	457.5	1.09
Industrial Engineering	45	0.000000000	338.2	-1.28
Electrical Engineering	81	0.000000000	356.4	-1.02
Bioengineering	90	0.000000000	368.8	-0.42
Overall	756		378.5	
H = 5.89	DF = 8	P = 0.660		

Table 30: Kruskal-Wallis: Quality Objectives vs. Gender

Group	N	Median	Ave Rank	Z
Male	486	0.000000000	382.8	0.73
Female	144	0.000000000	356.1	-1.37
Overall	756		378.5	
H = 1.91	DF = 2	P = 0.384		

CHAPTER 6 CONCLUSIONS AND FUTURE RESEARCH

This chapter will discuss the conclusions and future research for this dissertation. As Bond, Carlson, and Keeney have quoted: "Moreover, we believe that these interventions represent only the "tip of the iceberg," and we hope that by applying and extending the principles discussed here, researchers and practitioners will uncover a variety of powerful tools to enhance objective generation and improve the quality of resulting decisions (Bond et al., 2010)." There is still much work that needs to be done in the field of generating quality objectives, however the contributions made in this dissertation will significantly aid in future research. The chapter is laid out as follows: Section 6.1 will discuss the conclusions and Section 6.2 will discuss future research.

6.1 Conclusions

The main purpose of this research, as discussed in Section 3.3, is to increase the number of objectives, as well as the number of quality objectives generated by decision makers. This main purpose was successfully accomplished by having statistically conclusive results for each of the research questions introduced in Section 3.3. Listed below are the research questions with an explanation of how each question had positive results and therefore accomplishing the main purpose of this research study.

1. Do the sections of value focused thinking, cognitive mapping, and motivation in the worksheet have a significant effect on the number of objectives generated? -

Yes, the sections do have a significant effect by the results discussed in Section 5.2. The ANOVA performed showed that sections had a significant effect on the number of objectives generated and the Tukey Test showed that the section of Motivation significantly produced more objectives than the other two methods.

2. Does each worksheet question have a significant effect on the number of objectives generated? - Yes, the worksheet questions do have a significant effect by the results discussed in Section 5.2. The ANOVA performed showed that worksheet questions had a significant effect on the number of objectives generated and the Tukey Test showed that the question in the Motivation section (M1) and the first question in the Cognitive Mapping section (C1) significantly produced more objectives than the other worksheet questions.
3. Does the order of the sections of value focused thinking, cognitive mapping, and motivation in the worksheet have a significant effect on the number of objectives generated? - Yes, the order of the sections does have a significant effect by the results discussed in Section 5.2. The ANOVA performed showed that the order of the sections had a significant effect on the number of objectives generated and the Tukey Test showed that all six versions except for CMV were in the top grouping. However, VCM and VMC were the only versions just in the top grouping.
4. Does the order of the worksheet questions have an effect on the number of objectives generated? - Yes, the order of the worksheet questions does have a significant effect by the results discussed in Section 5.2. The ANOVA performed showed that the order of the worksheet questions had a significant effect on the

number of objectives generated and the Tukey Test showed that the first question significantly produced more objectives than the other questions that were listed later in the order.

5. Can a reduced number of worksheet questions generate a significant number of objectives? - The number of questions needed in order to have significant results is discussed in the results of Section 5.2 and is shown that the questions listed earlier in the worksheet have the most objectives generated. The Tukey test on question order, as discussed above in the fourth research question, shows that the first question listed significantly produced more objectives than the other questions listed later in the order. Shown in the next grouping below the first question in order are the second, third, fourth, sixth, and seventh question listed in order. From the results of the Tukey, it can be determined that having three worksheet questions can have significant results since the questions listed higher in the order generate more objectives than the questions that are lower in the question order.
6. Do the demographic factors have a significant effect on the number of objectives generated? - Yes, the demographic factors of college major and gender do have a significant effect by the results discussed in Section 5.3. The ANOVA first performed showed that college major had a significant effect on the number of objectives generated and the Tukey Test showed that the majors of civil engineering and computer engineering and computer science significantly produced more objectives than the other majors. The second ANOVA performed for the demographic factors showed that gender does have a significant effect on

the number of objectives generated and the Tukey Test showed that females significantly produced more objectives than males.

7. Are there specific worksheet questions that increase the number of quality objectives generated? - Yes, there are specific worksheet questions that increase the number of quality objectives generated more than other worksheet questions. As shown in Section 5.4, it was found that question M1, followed by question C3, and then V2 was shown to have the highest positive Z scores from the Kruskal-Wallis test for generating quality objectives, which shows that those questions generate a higher number of quality objectives than the other questions. It was also shown that question M1 had the most significance in pairwise comparisons of the Dunn's Test. This was different than the results of generating objectives vs. question from the second research question where it is show that questions M1 and C1 significantly produce more objectives. From these results, it is concluded that the questions M1, C3, and V2 should be used to increase the number of quality objectives generated.
8. Are there specific worksheet sections that increase the number of quality objectives generated? - Yes, there is a worksheet section that increases the number of quality objectives generated. As shown in Section 5.4, it was found that the section of Motivation has the only positive Z score from the Kruskal-Wallis test for generating quality objectives, which shows that the section of Motivation generates a higher number of quality objectives than the other sections. It was also shown that the section of Motivation had the positive significance in pairwise comparisons of the Dunn's Test. This was the same as

the results of generating objectives vs. section from the first research question where it is show that the Motivation section significantly produces more objectives. From these results, it is concluded that the Motivation section should be used to generate quality objectives.

9. Are there specific orders of worksheet sections that increase the number of quality objectives generated? - No, there is not an order of a worksheet section that increases the number of quality objectives generated more than another order. As shown in Section 5.4, it was found that the p-value from the Kruskal-Wallis test was 0.702, much higher than the test statistic of significance of 0.05. This was different than the results for generating objectives vs. order of section. With that study from research question three showing significance in generating objectives with a p-value of 0.002. From these results, it is concluded that for generating quality objectives that the order of the sections is not a significant factor.
10. Are there specific orders of worksheet questions that increase the number of quality objectives generated? - Yes, there is a specific order of worksheet questions that increase the number of quality objectives generated. As shown in Section 5.4, it was found that the first question in the order has the highest positive Z score from the Kruskal-Wallis test for generating quality objectives, which shows that the first question in order generates a higher number of quality objectives. It was also shown that the first question in order had the most positive significance results in pairwise comparisons of the Dunn's Test. This was the same as the results of generating objectives vs. question order from the fourth and fifth research questions where it shows that the first question in order produces

more objectives. From these results, it is concluded that the most quality objectives will be generated with the first question of the hybrid method.

11. Are there specific demographic factors that increase the number of quality objectives generated? - No, the demographic factors of college major and gender do not significantly increase the number of quality objectives generated. As shown in Section 5.4, it was found that the p-value from the Kruskal-Wallis test was 0.660 for college major and 0.384 for gender, much higher than the test statistic of significance of 0.05. This was different than the results for generating objectives vs. order of section. With that study from research question six showing significance in generating objectives with both demographic factors of college major and gender. From these results, it is concluded that for generating quality objectives the demographic factors are not a significant factor

With the positive results of the research questions, the hybrid method was created. First, question order shows that number of objectives generated is the most at the beginning of the worksheet. Therefore, reducing the number of questions asked will help with this. Secondly, with question M1, then C3, followed by V2 having the most significant difference on the number of quality objectives generated, it is important that these questions are used. These three questions cover all three sections (M1 – Motivation, C3 – Cognitive Mapping, and V2 – Value Focused Thinking). With question M1 generating the most objectives and the most quality objectives, the section of Motivation containing question M1 should go first. This should be followed by the section of value focused thinking containing question V2 with the two versions showing the most significance in generating objectives having the value focus thinking section at

the beginning. The developed hybrid method will then end with the section of cognitive mapping section containing C3 (this will be version MVC). Question C3 should be modified to incorporate the other two questions in the section of cognitive mapping with this question relying on answers from questions C1 and C2. The hybrid method questions are shown below for the application of choosing a college major:

Question M1: Research shows that people generate less than half of the quality objectives on their own. However, research also shows that if people think more deeply, they can generate more quality objectives. What quality objectives can you think of for deciding which college major to pursue? Can you name 10 or more? Below, please list any quality objectives that you think of for deciding on your college major.

Question V2: Think about the pros and cons of different college majors. With those pros and cons in mind, please list below any quality objectives that you think of for deciding on your college major.

Combination of Questions C1, C2, and C3: Think about what your values are in life and how these values have an effect on your college major decision. A value is what a person cares about in life, which can be applied to all decisions that it effects. With how your values affect your college major decision in mind, please list any quality objectives that you think of for deciding on your college major.

An analysis of the hybrid method was completed to compare the means of the developed hybrid method to the methods individually for generating objectives and for generating quality objectives. The two-sample t-test was done for this analysis. The data for the developed hybrid method used the students' data that completed the initial

worksheet with the MVC version, the same order of questions that the developed hybrid method follows. The objectives generated for the questions that are not included in the developed hybrid were not used in this analysis. The data for the individual methods was used from the initial worksheet data from all the versions and questions from each method. The following combinations were tested:

- Developed Hybrid Method vs. Motivation
- Developed Hybrid Method vs. Value Focused Thinking
- Developed Hybrid Method vs. Cognitive Mapping

The results, which can be seen in Table 31, show that all three combinations for generating objectives have p-values lower than the significance level of 0.05. This shows that the developed hybrid method has a significant difference in means for generating objectives from each method individually. Next, the results show that two out of three combinations for generating quality objectives have p-values lower than the test statistic of 0.05. This shows that the developed hybrid method has a significant difference in means for generating quality objectives from the Motivation and Cognitive Mapping sections. The Value Focused Thinking comparison has a p-value higher than 0.05 for generating quality objectives. This shows that there is not a significant difference for generating quality objectives between the Developed Hybrid Method and Value Focused Thinking Section; however, there is more quality objectives generated in the Developed Hybrid Method.

Table 31: Two-Sample T-Test: Developed Hybrid Method vs. Methods

Methods Compared	P-Value and Means for Generating Objectives	P-Value and Means for Generating Quality Objectives
Developed Hybrid Method vs. Motivation	P-Value = 0.000 Means = 14.00 vs. 4.48	P-Value = 0.001 Means = 2.05 vs. 0.976
Developed Hybrid Method vs. Value Focused Thinking	P-Value = 0.001 Means = 14.00 vs. 7.60	P-Value = 0.261 Means = 2.05 vs. 1.70
Developed Hybrid Method vs. Cognitive Mapping	P-Value = 0.001 Means = 14.00 vs. 8.14	P-Value = 0.001 Means = 2.05 vs. 1.04

A second analysis was conducted to compare the means of the developed hybrid method to the means of the initial worksheet (all nine questions). Table 32 shows the results of this second analysis. For this analysis, there were no duplicate objectives used; i.e. each objective was only counted once, even if it was listed for multiple questions. The p-value calculated for generating objectives and the p-value for generating quality objectives were both greater than the significance level of 0.05. This shows that there is no significant difference between the hybrid method with five questions and the nine question initial worksheet in terms of the number of unique quality objectives generated. This shows that the developed hybrid method with fewer questions can generate approximately the same number of objectives and quality objectives as the nine question initial worksheet.

Table 32: Two-Sample T-Test: Developed Hybrid Method vs. Initial Worksheet

Methods Compared	P-Value and Means for Generating Objectives	P-Value and Means for Generating Quality Objectives
Developed Hybrid Method vs. Initial Worksheet (No Duplicate Objectives)	P-Value = 0.085 Means = 10.11 vs. 12.06	P-Value = 0.229 Means = 1.316 vs. 1.524

This research, as discussed in Section 1.3, makes several contributions to the field of problem structuring in decision science as proven by the answers to the research questions above. The contributions are outlined below:

- This research study contributes by evaluating the individual and combined contributions of problem structuring techniques and tools of value focused thinking, cognitive mapping, and motivation in terms of the number of objectives generated.
- This research study contributes by using the combination of techniques and tools of value focused thinking, cognitive mapping, motivation, and multiple chances that have previously not been used together to increase the number of quality objectives generated for problem structuring of a decision.
- This research study contributes by focusing on increasing the number of quality objectives generated, where past research has focused more on increasing the number of objectives generated. The quality of the objective is an important part of decision making.
- This research study contributes in the application area of engineering education by increasing awareness in the area with demographic information on gender and major differences with the amount of quality objectives generated, as well as what objectives that engineering students generate the most for deciding on a college major.

6.2 Future Research

Future research needs to expand the application of the hybrid method to other areas. The results of the worksheet showed significant findings in the application are of engineering education and other applications can benefit from the hybrid method as well. Having the application completed in areas such as healthcare decisions, business team group decisions, and in high school education decisions are the suggested first areas that the application be applied. In healthcare decisions, the hybrid method can be used to aid in patients and doctors working together to generate quality objectives to aid in deciding on the best courses of action to take medically. Also, in healthcare, the hybrid method can be used when planning and organizing how to improve the quality of patient safety, patient throughput time, and patient satisfaction during the process in a hospital, clinic, or doctor's office. In business team group decisions, team members from different backgrounds can use the hybrid method to help generate quality objectives that are focused on the particular decision at hand. In high school education decisions, the hybrid method can help with generating quality objectives on how to improve the college readiness of students. These are just some areas that this research can be applied in the future. This field of generating quality objectives will help make better, more informed decisions for the future.

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APPENDIX A: OBJECTIVE KEYWORDS

Table 33: Count of Students with the Objective

Keyword Objectives	Count of Students with the Objective
salary	73
interest in subject and field	70
family's preference for major	65
job availability after graduation	54
interesting professional applications	52
ease of attaining professional success with this major	51
ability to finish degree and not have to transfer to another major	50
the major chosen fits student's strengths	37
amount of effort needed to finish degree	36
job security	35
friend's opinions of major	34
the major/job is accepted with the student's religion and beliefs	34
dedication to completing the degree	31
the major offers the student the opportunity to gain significant knowledge	30
years needed to complete required degrees	29
tuition for getting the degree	28
live comfortably with the job chosen	26
make a difference with the job	26
a major/job in a field that will help people	25
respect of major	25
growth	21
the need of the student to work hard on the job and while getting the degree	21
challenging major that uses critical thinking	20
quality of school that offers the major	20

location of where many jobs will be for that major	16
variety of industries the major can be used in	13
vacation/time in job	12
ethics of major and job	10
amount of job travel	8
environment of the job	7
interesting classes	7
popularity of major with peers	7
creative thinking with major/job	6
being able to live healthy while on the job (work/life balance)	6
the job's amount of time being around people	5
future employability of major	5
quality of faculty and students in the department	5
amount of stress in major	4
amount of hours per week for job	3
physical conditions of job	2
stress of major/job	1
minority in major	1
structure of major (classes, semesters, internships)	1
types of classes taken in major	1

Table 34: Percent of Students with the Objective

Keyword Objectives	% of Students with the Objective
salary	86.90%
interest in subject and field	83.33%
family's preference for major	77.38%
job availability after graduation	64.29%
interesting professional applications	61.90%
ease of attaining professional success with this major	60.71%
ability to finish degree and not have to transfer to another major	59.52%
the major chosen fits student's strengths	44.05%
amount of effort needed to finish degree	42.86%
job security	41.67%

friend's opinions of major	40.48%
the major/job is accepted with the student's religion and beliefs	40.48%
dedication to completing the degree	36.90%
the major offers the student the opportunity to gain significant knowledge	35.71%
years needed to complete required degrees	34.52%
tuition for getting the degree	33.33%
live comfortably with the job chosen	30.95%
make a difference with the job	30.95%
a major/job in a field that will help people	29.76%
respect of major	29.76%
growth	25.00%
the need of the student to work hard on the job and while getting the degree	25.00%
challenging major that uses critical thinking	23.81%
quality of school that offers the major	23.81%
location of where many jobs will be for that major	19.05%
variety of industries the major can be used in	15.48%
vacation/time in job	14.29%
ethics of major and job	11.90%
amount of job travel	9.52%
environment of the job	8.33%
interesting classes	8.33%
popularity of major with peers	8.33%
creative thinking with major/job	7.14%
being able to live healthy while on the job (work/life balance)	7.14%
the job's amount of time being around people	5.95%
future employability of major	5.95%
quality of faculty and students in the department	5.95%
amount of stress in major	4.76%
amount of hours per week for job	3.57%
physical conditions of job	2.38%
stress of major/job	1.19%
minority in major	1.19%
structure of major (classes, semesters, internships)	1.19%
types of classes taken in major	1.19%

Table 35: Sum of Times the Student Listed the Objective

Keyword Objectives	Sum of Times the Student Listed the Objective
salary	202
interest in subject and field	203
family's preference for major	111
job availability after graduation	103
interesting professional applications	100
ease of attaining professional success with this major	98
ability to finish degree and not have to transfer to another major	78
the major chosen fits student's strengths	55
amount of effort needed to finish degree	46
job security	69
friend's opinions of major	39
the major/job is accepted with the student's religion and beliefs	45
dedication to completing the degree	42
the major offers the student the opportunity to gain significant knowledge	42
years needed to complete required degrees	45
tuition for getting the degree	36
live comfortably with the job chosen	34
make a difference with the job	30
a major/job in a field that will help people	38
respect of major	31
growth	30
the need of the student to work hard on the job and while getting the degree	33
challenging major that uses critical thinking	28
quality of school that offers the major	26
location of where many jobs will be for that major	27
variety of industries the major can be used in	16
vacation/time in job	17
ethics of major and job	11
amount of job travel	11
environment of the job	10
interesting classes	8

popularity of major with peers	8
creative thinking with major/job	6
being able to live healthy while on the job (work/life balance)	6
the job's amount of time being around people	6
future employability of major	5
quality of faculty and students in the department	5
amount of stress in major	4
amount of hours per week for job	4
physical conditions of job	2
stress of major/job	1
minority in major	2
structure of major (classes, semesters, internships)	1
types of classes taken in major	1

APPENDIX B: ANOVA FOR OBJECTIVE GENERATION

Table 36: Questions of the Worksheet

Question Number	Section of the Worksheet
M1	Motivation
V1	Value Focused Thinking
V2	Value Focused Thinking
V3	Value Focused Thinking
V4	Value Focused Thinking
V5	Value Focused Thinking
C1	Cognitive Mapping
C2	Cognitive Mapping
C3	Cognitive Mapping

Table 37: Sections of the Worksheet

Section Number	Section
1	Motivation
2	Value Focused Thinking
3	Cognitive Mapping

Table 38: ANOVA Input

Obj	Section	Ver	Ques	Student	Box-Cox	Ques Order	Major	Sex
7	1	CMV	1	87	1.33	4	computer engineering	male
4	1	CMV	1	86	1.24	4	civil engineering	male
0	1	CMV	1	82	1	4	mechanical engineering	female
8	1	CMV	1	81	1.35	4	computer	male

							engineering	
4	1	CMV	1	79	1.24	4	mechanical engineering	male
3	1	CMV	1	73	1.21	4	0	0
4	1	CMV	1	65	1.24	4	civil engineering	male
11	1	CMV	1	57	1.4	4	mechanical engineering	female
1	1	CMV	1	56	1.1	4	mechanical engineering	male
6	1	CMV	1	52	1.3	4	0	0
0	1	CMV	1	51	1	4	0	0
6	1	CMV	1	40	1.3	4	chemical engineering	male
5	1	CMV	1	39	1.28	4	undecided engineering	male
0	1	CMV	1	35	1	4	computer engineering	male
3	1	CMV	1	30	1.21	4	industrial engineering	male
3	1	CMV	1	14	1.21	4	mechanical engineering	male
5	1	CMV	1	12	1.28	4	electrical engineering	male
5	1	CMV	1	9	1.28	4	0	0
4	1	CMV	1	7	1.24	4	electrical engineering	male
3	1	CMV	1	4	1.21	4	mechanical engineering	male
0	1	CMV	1	1	1	4	computer engineering	male
2	2	CMV	2	87	1.16	5	computer engineering	male
1	2	CMV	2	86	1.1	5	civil engineering	male
0	2	CMV	2	82	1	5	mechanical engineering	female
0	2	CMV	2	81	1	5	computer engineering	male
0	2	CMV	2	79	1	5	mechanical engineering	male
0	2	CMV	2	73	1	5	0	0
2	2	CMV	2	65	1.16	5	civil engineering	male

3	2	CMV	2	57	1.21	5	mechanical engineering	female
1	2	CMV	2	56	1.1	5	mechanical engineering	male
0	2	CMV	2	52	1	5	0	0
0	2	CMV	2	51	1	5	0	0
1	2	CMV	2	40	1.1	5	chemical engineering	male
1	2	CMV	2	39	1.1	5	undecided engineering	male
0	2	CMV	2	35	1	5	computer engineering	male
1	2	CMV	2	30	1.1	5	industrial engineering	male
3	2	CMV	2	14	1.21	5	mechanical engineering	male
4	2	CMV	2	12	1.24	5	electrical engineering	male
0	2	CMV	2	9	1	5	0	0
2	2	CMV	2	7	1.16	5	electrical engineering	male
0	2	CMV	2	4	1	5	mechanical engineering	male
1	2	CMV	2	1	1.1	5	computer engineering	male
5	2	CMV	3	87	1.28	6	computer engineering	male
2	2	CMV	3	86	1.16	6	civil engineering	male
0	2	CMV	3	82	1	6	mechanical engineering	female
0	2	CMV	3	81	1	6	computer engineering	male
2	2	CMV	3	79	1.16	6	mechanical engineering	male
0	2	CMV	3	73	1	6	0	0
1	2	CMV	3	65	1.1	6	civil engineering	male
4	2	CMV	3	57	1.24	6	mechanical engineering	female
1	2	CMV	3	56	1.1	6	mechanical engineering	male
0	2	CMV	3	52	1	6	0	0
0	2	CMV	3	51	1	6	0	0

0	2	CMV	3	40	1	6	chemical engineering	male
2	2	CMV	3	39	1.16	6	undecided engineering	male
0	2	CMV	3	35	1	6	computer engineering	male
2	2	CMV	3	30	1.16	6	industrial engineering	male
1	2	CMV	3	14	1.1	6	mechanical engineering	male
4	2	CMV	3	12	1.24	6	electrical engineering	male
0	2	CMV	3	9	1	6	0	0
2	2	CMV	3	7	1.16	6	electrical engineering	male
2	2	CMV	3	4	1.16	6	mechanical engineering	male
4	2	CMV	3	1	1.24	6	computer engineering	male
2	2	CMV	4	87	1.16	7	computer engineering	male
2	2	CMV	4	86	1.16	7	civil engineering	male
0	2	CMV	4	82	1	7	mechanical engineering	female
0	2	CMV	4	81	1	7	computer engineering	male
0	2	CMV	4	79	1	7	mechanical engineering	male
0	2	CMV	4	73	1	7	0	0
2	2	CMV	4	65	1.16	7	civil engineering	male
3	2	CMV	4	57	1.21	7	mechanical engineering	female
1	2	CMV	4	56	1.1	7	mechanical engineering	male
0	2	CMV	4	52	1	7	0	0
0	2	CMV	4	51	1	7	0	0
1	2	CMV	4	40	1.1	7	chemical engineering	male
1	2	CMV	4	39	1.1	7	undecided engineering	male
0	2	CMV	4	35	1	7	computer engineering	male

3	2	CMV	4	30	1.21	7	industrial engineering	male
3	2	CMV	4	14	1.21	7	mechanical engineering	male
1	2	CMV	4	12	1.1	7	electrical engineering	male
0	2	CMV	4	9	1	7	0	0
1	2	CMV	4	7	1.1	7	electrical engineering	male
0	2	CMV	4	4	1	7	mechanical engineering	male
2	2	CMV	4	1	1.16	7	computer engineering	male
2	2	CMV	5	87	1.16	8	computer engineering	male
1	2	CMV	5	86	1.1	8	civil engineering	male
0	2	CMV	5	82	1	8	mechanical engineering	female
0	2	CMV	5	81	1	8	computer engineering	male
0	2	CMV	5	79	1	8	mechanical engineering	male
0	2	CMV	5	73	1	8	0	0
1	2	CMV	5	65	1.1	8	civil engineering	male
1	2	CMV	5	57	1.1	8	mechanical engineering	female
1	2	CMV	5	56	1.1	8	mechanical engineering	male
0	2	CMV	5	52	1	8	0	0
0	2	CMV	5	51	1	8	0	0
0	2	CMV	5	40	1	8	chemical engineering	male
1	2	CMV	5	39	1.1	8	undecided engineering	male
0	2	CMV	5	35	1	8	computer engineering	male
2	2	CMV	5	30	1.16	8	industrial engineering	male
1	2	CMV	5	14	1.1	8	mechanical engineering	male
1	2	CMV	5	12	1.1	8	electrical engineering	male

0	2	CMV	5	9	1	8	0	0
2	2	CMV	5	7	1.16	8	electrical engineering	male
0	2	CMV	5	4	1	8	mechanical engineering	male
1	2	CMV	5	1	1.1	8	computer engineering	male
2	2	CMV	6	87	1.16	9	computer engineering	male
1	2	CMV	6	86	1.1	9	civil engineering	male
0	2	CMV	6	82	1	9	mechanical engineering	female
0	2	CMV	6	81	1	9	computer engineering	male
0	2	CMV	6	79	1	9	mechanical engineering	male
0	2	CMV	6	73	1	9	0	0
1	2	CMV	6	65	1.1	9	civil engineering	male
1	2	CMV	6	57	1.1	9	mechanical engineering	female
1	2	CMV	6	56	1.1	9	mechanical engineering	male
0	2	CMV	6	52	1	9	0	0
0	2	CMV	6	51	1	9	0	0
0	2	CMV	6	40	1	9	chemical engineering	male
1	2	CMV	6	39	1.1	9	undecided engineering	male
0	2	CMV	6	35	1	9	computer engineering	male
2	2	CMV	6	30	1.16	9	industrial engineering	male
1	2	CMV	6	14	1.1	9	mechanical engineering	male
1	2	CMV	6	12	1.1	9	electrical engineering	male
0	2	CMV	6	9	1	9	0	0
2	2	CMV	6	7	1.16	9	electrical engineering	male
0	2	CMV	6	4	1	9	mechanical engineering	male
1	2	CMV	6	1	1.1	9	computer	male

							engineering	
3	3	CMV	7	87	1.21	1	computer engineering	male
3	3	CMV	7	86	1.21	1	civil engineering	male
3	3	CMV	7	82	1.21	1	mechanical engineering	female
3	3	CMV	7	81	1.21	1	computer engineering	male
6	3	CMV	7	79	1.3	1	mechanical engineering	male
1	3	CMV	7	73	1.1	1	0	0
4	3	CMV	7	65	1.24	1	civil engineering	male
5	3	CMV	7	57	1.28	1	mechanical engineering	female
5	3	CMV	7	56	1.28	1	mechanical engineering	male
4	3	CMV	7	52	1.24	1	0	0
4	3	CMV	7	51	1.24	1	0	0
3	3	CMV	7	40	1.21	1	chemical engineering	male
4	3	CMV	7	39	1.24	1	undecided engineering	male
4	3	CMV	7	35	1.24	1	computer engineering	male
2	3	CMV	7	30	1.16	1	industrial engineering	male
4	3	CMV	7	14	1.24	1	mechanical engineering	male
9	3	CMV	7	12	1.37	1	electrical engineering	male
3	3	CMV	7	9	1.21	1	0	0
4	3	CMV	7	7	1.24	1	electrical engineering	male
3	3	CMV	7	4	1.21	1	mechanical engineering	male
5	3	CMV	7	1	1.28	1	computer engineering	male
3	3	CMV	8	87	1.21	2	computer engineering	male
1	3	CMV	8	86	1.1	2	civil engineering	male
3	3	CMV	8	82	1.21	2	mechanical	female

							engineering	
2	3	CMV	8	81	1.16	2	computer engineering	male
6	3	CMV	8	79	1.3	2	mechanical engineering	male
2	3	CMV	8	73	1.16	2	0	0
1	3	CMV	8	65	1.1	2	civil engineering	male
1	3	CMV	8	57	1.1	2	mechanical engineering	female
2	3	CMV	8	56	1.16	2	mechanical engineering	male
3	3	CMV	8	52	1.21	2	0	0
3	3	CMV	8	51	1.21	2	0	0
0	3	CMV	8	40	1	2	chemical engineering	male
1	3	CMV	8	39	1.1	2	undecided engineering	male
1	3	CMV	8	35	1.1	2	computer engineering	male
1	3	CMV	8	30	1.1	2	industrial engineering	male
1	3	CMV	8	14	1.1	2	mechanical engineering	male
3	3	CMV	8	12	1.21	2	electrical engineering	male
2	3	CMV	8	9	1.16	2	0	0
1	3	CMV	8	7	1.1	2	electrical engineering	male
4	3	CMV	8	4	1.24	2	mechanical engineering	male
6	3	CMV	8	1	1.3	2	computer engineering	male
3	3	CMV	9	87	1.21	3	computer engineering	male
2	3	CMV	9	86	1.16	3	civil engineering	male
2	3	CMV	9	82	1.16	3	mechanical engineering	female
3	3	CMV	9	81	1.21	3	computer engineering	male
3	3	CMV	9	79	1.21	3	mechanical engineering	male
2	3	CMV	9	73	1.16	3	0	0

2	3	CMV	9	65	1.16	3	civil engineering	male
5	3	CMV	9	57	1.28	3	mechanical engineering	female
2	3	CMV	9	56	1.16	3	mechanical engineering	male
3	3	CMV	9	52	1.21	3	0	0
2	3	CMV	9	51	1.16	3	0	0
2	3	CMV	9	40	1.16	3	chemical engineering	male
0	3	CMV	9	39	1	3	undecided engineering	male
3	3	CMV	9	35	1.21	3	computer engineering	male
2	3	CMV	9	30	1.16	3	industrial engineering	male
4	3	CMV	9	14	1.24	3	mechanical engineering	male
3	3	CMV	9	12	1.21	3	electrical engineering	male
3	3	CMV	9	9	1.21	3	0	0
3	3	CMV	9	7	1.21	3	electrical engineering	male
2	3	CMV	9	4	1.16	3	mechanical engineering	male
2	3	CMV	9	1	1.16	3	computer engineering	male
2	1	MVC	1	85	1.16	1	mechanical engineering	male
10	1	MVC	1	75	1.39	1	computer engineering	female
1	1	MVC	1	69	1.1	1	mechanical engineering	female
4	1	MVC	1	66	1.24	1	mechanical engineering	male
6	1	MVC	1	61	1.3	1	bioengineering	male
3	1	MVC	1	59	1.21	1	bioengineering	female
5	1	MVC	1	55	1.28	1	0	0
3	1	MVC	1	37	1.21	1	mechanical engineering	male
7	1	MVC	1	34	1.33	1	electrical engineering	male

4	1	MVC	1	23	1.24	1	computer engineering	male
5	1	MVC	1	21	1.28	1	0	0
4	1	MVC	1	19	1.24	1	industrial engineering	female
3	1	MVC	1	18	1.21	1	0	0
7	1	MVC	1	16	1.33	1	civil engineering	male
4	1	MVC	1	15	1.24	1	civil engineering	female
6	1	MVC	1	11	1.3	1	0	0
6	1	MVC	1	10	1.3	1	computer engineering	male
8	1	MVC	1	3	1.35	1	computer engineering	male
9	1	MVC	1	2	1.37	1	civil engineering	male
1	2	MVC	2	85	1.1	2	mechanical engineering	male
1	2	MVC	2	75	1.1	2	computer engineering	female
0	2	MVC	2	69	1	2	mechanical engineering	female
0	2	MVC	2	66	1	2	mechanical engineering	male
2	2	MVC	2	61	1.16	2	bioengineering	male
2	2	MVC	2	59	1.16	2	bioengineering	female
2	2	MVC	2	55	1.16	2	0	0
0	2	MVC	2	37	1	2	mechanical engineering	male
3	2	MVC	2	34	1.21	2	electrical engineering	male
1	2	MVC	2	23	1.1	2	computer engineering	male
0	2	MVC	2	21	1	2	0	0
1	2	MVC	2	19	1.1	2	industrial engineering	female
1	2	MVC	2	18	1.1	2	0	0
3	2	MVC	2	16	1.21	2	civil engineering	male
3	2	MVC	2	15	1.21	2	civil engineering	female

0	2	MVC	2	11	1	2	0	0
3	2	MVC	2	10	1.21	2	computer engineering	male
2	2	MVC	2	3	1.16	2	computer engineering	male
5	2	MVC	2	2	1.28	2	civil engineering	male
1	2	MVC	3	85	1.1	3	mechanical engineering	male
6	2	MVC	3	75	1.3	3	computer engineering	female
0	2	MVC	3	69	1	3	mechanical engineering	female
0	2	MVC	3	66	1	3	mechanical engineering	male
2	2	MVC	3	61	1.16	3	bioengineering	male
4	2	MVC	3	59	1.24	3	bioengineering	female
2	2	MVC	3	55	1.16	3	0	0
0	2	MVC	3	37	1	3	mechanical engineering	male
3	2	MVC	3	34	1.21	3	electrical engineering	male
3	2	MVC	3	23	1.21	3	computer engineering	male
0	2	MVC	3	21	1	3	0	0
2	2	MVC	3	19	1.16	3	industrial engineering	female
1	2	MVC	3	18	1.1	3	0	0
2	2	MVC	3	16	1.16	3	civil engineering	male
3	2	MVC	3	15	1.21	3	civil engineering	female
0	2	MVC	3	11	1	3	0	0
2	2	MVC	3	10	1.16	3	computer engineering	male
4	2	MVC	3	3	1.24	3	computer engineering	male
4	2	MVC	3	2	1.24	3	civil engineering	male
0	2	MVC	4	85	1	4	mechanical engineering	male
4	2	MVC	4	75	1.24	4	computer	female

							engineering	
0	2	MVC	4	69	1	4	mechanical engineering	female
2	2	MVC	4	66	1.16	4	mechanical engineering	male
2	2	MVC	4	61	1.16	4	bioengineering	male
4	2	MVC	4	59	1.24	4	bioengineering	female
5	2	MVC	4	55	1.28	4	0	0
0	2	MVC	4	37	1	4	mechanical engineering	male
2	2	MVC	4	34	1.16	4	electrical engineering	male
2	2	MVC	4	23	1.16	4	computer engineering	male
0	2	MVC	4	21	1	4	0	0
1	2	MVC	4	19	1.1	4	industrial engineering	female
2	2	MVC	4	18	1.16	4	0	0
2	2	MVC	4	16	1.16	4	civil engineering	male
2	2	MVC	4	15	1.16	4	civil engineering	female
0	2	MVC	4	11	1	4	0	0
4	2	MVC	4	10	1.24	4	computer engineering	male
2	2	MVC	4	3	1.16	4	computer engineering	male
2	2	MVC	4	2	1.16	4	civil engineering	male
2	2	MVC	5	85	1.16	5	mechanical engineering	male
3	2	MVC	5	75	1.21	5	computer engineering	female
0	2	MVC	5	69	1	5	mechanical engineering	female
0	2	MVC	5	66	1	5	mechanical engineering	male
1	2	MVC	5	61	1.1	5	bioengineering	male
2	2	MVC	5	59	1.16	5	bioengineering	female
2	2	MVC	5	55	1.16	5	0	0

0	2	MVC	5	37	1	5	mechanical engineering	male
1	2	MVC	5	34	1.1	5	electrical engineering	male
1	2	MVC	5	23	1.1	5	computer engineering	male
0	2	MVC	5	21	1	5	0	0
2	2	MVC	5	19	1.16	5	industrial engineering	female
1	2	MVC	5	18	1.1	5	0	0
2	2	MVC	5	16	1.16	5	civil engineering	male
4	2	MVC	5	15	1.24	5	civil engineering	female
0	2	MVC	5	11	1	5	0	0
2	2	MVC	5	10	1.16	5	computer engineering	male
2	2	MVC	5	3	1.16	5	computer engineering	male
2	2	MVC	5	2	1.16	5	civil engineering	male
1	2	MVC	6	85	1.1	6	mechanical engineering	male
3	2	MVC	6	75	1.21	6	computer engineering	female
0	2	MVC	6	69	1	6	mechanical engineering	female
0	2	MVC	6	66	1	6	mechanical engineering	male
0	2	MVC	6	61	1	6	bioengineering	male
0	2	MVC	6	59	1	6	bioengineering	female
2	2	MVC	6	55	1.16	6	0	0
0	2	MVC	6	37	1	6	mechanical engineering	male
1	2	MVC	6	34	1.1	6	electrical engineering	male
2	2	MVC	6	23	1.16	6	computer engineering	male
0	2	MVC	6	21	1	6	0	0
0	2	MVC	6	19	1	6	industrial engineering	female
1	2	MVC	6	18	1.1	6	0	0

2	2	MVC	6	16	1.16	6	civil engineering	male
3	2	MVC	6	15	1.21	6	civil engineering	female
0	2	MVC	6	11	1	6	0	0
3	2	MVC	6	10	1.21	6	computer engineering	male
2	2	MVC	6	3	1.16	6	computer engineering	male
3	2	MVC	6	2	1.21	6	civil engineering	male
4	3	MVC	7	85	1.24	7	mechanical engineering	male
4	3	MVC	7	75	1.24	7	computer engineering	female
3	3	MVC	7	69	1.21	7	mechanical engineering	female
3	3	MVC	7	66	1.21	7	mechanical engineering	male
5	3	MVC	7	61	1.28	7	bioengineering	male
1	3	MVC	7	59	1.1	7	bioengineering	female
5	3	MVC	7	55	1.28	7	0	0
3	3	MVC	7	37	1.21	7	mechanical engineering	male
6	3	MVC	7	34	1.3	7	electrical engineering	male
3	3	MVC	7	23	1.21	7	computer engineering	male
0	3	MVC	7	21	1	7	0	0
3	3	MVC	7	19	1.21	7	industrial engineering	female
0	3	MVC	7	18	1	7	0	0
3	3	MVC	7	16	1.21	7	civil engineering	male
4	3	MVC	7	15	1.24	7	civil engineering	female
0	3	MVC	7	11	1	7	0	0
6	3	MVC	7	10	1.3	7	computer engineering	male
2	3	MVC	7	3	1.16	7	computer engineering	male
4	3	MVC	7	2	1.24	7	civil	male

							engineering	
1	3	MVC	8	85	1.1	8	mechanical engineering	male
2	3	MVC	8	75	1.16	8	computer engineering	female
1	3	MVC	8	69	1.1	8	mechanical engineering	female
4	3	MVC	8	66	1.24	8	mechanical engineering	male
4	3	MVC	8	61	1.24	8	bioengineering	male
1	3	MVC	8	59	1.1	8	bioengineering	female
3	3	MVC	8	55	1.21	8	0	0
1	3	MVC	8	37	1.1	8	mechanical engineering	male
3	3	MVC	8	34	1.21	8	electrical engineering	male
1	3	MVC	8	23	1.1	8	computer engineering	male
0	3	MVC	8	21	1	8	0	0
1	3	MVC	8	19	1.1	8	industrial engineering	female
0	3	MVC	8	18	1	8	0	0
2	3	MVC	8	16	1.16	8	civil engineering	male
2	3	MVC	8	15	1.16	8	civil engineering	female
0	3	MVC	8	11	1	8	0	0
6	3	MVC	8	10	1.3	8	computer engineering	male
3	3	MVC	8	3	1.21	8	computer engineering	male
2	3	MVC	8	2	1.16	8	civil engineering	male
3	3	MVC	9	85	1.21	9	mechanical engineering	male
2	3	MVC	9	75	1.16	9	computer engineering	female
1	3	MVC	9	69	1.1	9	mechanical engineering	female
2	3	MVC	9	66	1.16	9	mechanical engineering	male
2	3	MVC	9	61	1.16	9	bioengineer	male

							ing	
0	3	MVC	9	59	1	9	bioengineering	female
2	3	MVC	9	55	1.16	9	0	0
1	3	MVC	9	37	1.1	9	mechanical engineering	male
2	3	MVC	9	34	1.16	9	electrical engineering	male
3	3	MVC	9	23	1.21	9	computer engineering	male
0	3	MVC	9	21	1	9	0	0
1	3	MVC	9	19	1.1	9	industrial engineering	female
0	3	MVC	9	18	1	9	0	0
3	3	MVC	9	16	1.21	9	civil engineering	male
2	3	MVC	9	15	1.16	9	civil engineering	female
0	3	MVC	9	11	1	9	0	0
5	3	MVC	9	10	1.28	9	computer engineering	male
2	3	MVC	9	3	1.16	9	computer engineering	male
3	3	MVC	9	2	1.21	9	civil engineering	male
9	1	VCM	1	76	1.37	9	bioengineering	male
0	1	VCM	1	70	1	9	electrical engineering	male
0	1	VCM	1	67	1	9	electrical engineering	male
0	1	VCM	1	48	1	9	mechanical engineering	male
6	1	VCM	1	38	1.3	9	bioengineering	female
2	1	VCM	1	27	1.16	9	chemical engineering	female
0	1	VCM	1	8	1	9	computer engineering	male
10	1	VCM	1	6	1.39	9	chemical engineering	female
1	2	VCM	2	76	1.1	1	bioengineering	male
2	2	VCM	2	70	1.16	1	electrical	male

							engineering	
2	2	VCM	2	67	1.16	1	electrical engineering	male
1	2	VCM	2	48	1.1	1	mechanical engineering	male
3	2	VCM	2	38	1.21	1	bioengineering	female
1	2	VCM	2	27	1.1	1	chemical engineering	female
3	2	VCM	2	8	1.21	1	computer engineering	male
3	2	VCM	2	6	1.21	1	chemical engineering	female
4	2	VCM	3	76	1.24	2	bioengineering	male
3	2	VCM	3	70	1.21	2	electrical engineering	male
0	2	VCM	3	67	1	2	electrical engineering	male
3	2	VCM	3	48	1.21	2	mechanical engineering	male
7	2	VCM	3	38	1.33	2	bioengineering	female
2	2	VCM	3	27	1.16	2	chemical engineering	female
4	2	VCM	3	8	1.24	2	computer engineering	male
4	2	VCM	3	6	1.24	2	chemical engineering	female
6	2	VCM	4	76	1.3	3	bioengineering	male
1	2	VCM	4	70	1.1	3	electrical engineering	male
0	2	VCM	4	67	1	3	electrical engineering	male
3	2	VCM	4	48	1.21	3	mechanical engineering	male
4	2	VCM	4	38	1.24	3	bioengineering	female
1	2	VCM	4	27	1.1	3	chemical engineering	female
5	2	VCM	4	8	1.28	3	computer engineering	male
6	2	VCM	4	6	1.3	3	chemical engineering	female

6	2	VCM	5	76	1.3	4	bioengineering	male
0	2	VCM	5	70	1	4	electrical engineering	male
0	2	VCM	5	67	1	4	electrical engineering	male
2	2	VCM	5	48	1.16	4	mechanical engineering	male
5	2	VCM	5	38	1.28	4	bioengineering	female
2	2	VCM	5	27	1.16	4	chemical engineering	female
1	2	VCM	5	8	1.1	4	computer engineering	male
4	2	VCM	5	6	1.24	4	chemical engineering	female
4	2	VCM	6	76	1.24	5	bioengineering	male
4	2	VCM	6	70	1.24	5	electrical engineering	male
0	2	VCM	6	67	1	5	electrical engineering	male
3	2	VCM	6	48	1.21	5	mechanical engineering	male
1	2	VCM	6	38	1.1	5	bioengineering	female
2	2	VCM	6	27	1.16	5	chemical engineering	female
2	2	VCM	6	8	1.16	5	computer engineering	male
6	2	VCM	6	6	1.3	5	chemical engineering	female
5	3	VCM	7	76	1.28	6	bioengineering	male
4	3	VCM	7	70	1.24	6	electrical engineering	male
1	3	VCM	7	67	1.1	6	electrical engineering	male
3	3	VCM	7	48	1.21	6	mechanical engineering	male
7	3	VCM	7	38	1.33	6	bioengineering	female
3	3	VCM	7	27	1.21	6	chemical engineering	female
3	3	VCM	7	8	1.21	6	computer	male

							engineering	
6	3	VCM	7	6	1.3	6	chemical engineering	female
6	3	VCM	8	76	1.3	7	bioengineering	male
3	3	VCM	8	70	1.21	7	electrical engineering	male
0	3	VCM	8	67	1	7	electrical engineering	male
3	3	VCM	8	48	1.21	7	mechanical engineering	male
3	3	VCM	8	38	1.21	7	bioengineering	female
1	3	VCM	8	27	1.1	7	chemical engineering	female
3	3	VCM	8	8	1.21	7	computer engineering	male
4	3	VCM	8	6	1.24	7	chemical engineering	female
0	3	VCM	9	76	1	8	bioengineering	male
2	3	VCM	9	70	1.16	8	electrical engineering	male
0	3	VCM	9	67	1	8	electrical engineering	male
1	3	VCM	9	48	1.1	8	mechanical engineering	male
3	3	VCM	9	38	1.21	8	bioengineering	female
2	3	VCM	9	27	1.16	8	chemical engineering	female
2	3	VCM	9	8	1.16	8	computer engineering	male
5	3	VCM	9	6	1.28	8	chemical engineering	female
4	1	VMC	1	83	1.24	6	0	0
4	1	VMC	1	80	1.24	6	bioengineering	male
4	1	VMC	1	78	1.24	6	industrial engineering	male
12	1	VMC	1	74	1.42	6	0	0
3	1	VMC	1	47	1.21	6	industrial engineering	male
5	1	VMC	1	44	1.28	6	mechanical	female

							engineering	
10	1	VMC	1	36	1.39	6	computer engineering	male
7	1	VMC	1	31	1.33	6	electrical engineering	female
6	1	VMC	1	26	1.3	6	mechanical engineering	male
3	2	VMC	2	83	1.21	1	0	0
4	2	VMC	2	80	1.24	1	bioengineering	male
1	2	VMC	2	78	1.1	1	industrial engineering	male
1	2	VMC	2	74	1.1	1	0	0
1	2	VMC	2	47	1.1	1	industrial engineering	male
3	2	VMC	2	44	1.21	1	mechanical engineering	female
3	2	VMC	2	36	1.21	1	computer engineering	male
3	2	VMC	2	31	1.21	1	electrical engineering	female
2	2	VMC	2	26	1.16	1	mechanical engineering	male
1	2	VMC	3	83	1.1	2	0	0
1	2	VMC	3	80	1.1	2	bioengineering	male
2	2	VMC	3	78	1.16	2	industrial engineering	male
4	2	VMC	3	74	1.24	2	0	0
3	2	VMC	3	47	1.21	2	industrial engineering	male
4	2	VMC	3	44	1.24	2	mechanical engineering	female
4	2	VMC	3	36	1.24	2	computer engineering	male
2	2	VMC	3	31	1.16	2	electrical engineering	female
2	2	VMC	3	26	1.16	2	mechanical engineering	male
1	2	VMC	4	83	1.1	3	0	0
1	2	VMC	4	80	1.1	3	bioengineering	male
1	2	VMC	4	78	1.1	3	industrial engineering	male

4	2	VMC	4	74	1.24	3	0	0
1	2	VMC	4	47	1.1	3	industrial engineering	male
2	2	VMC	4	44	1.16	3	mechanical engineering	female
2	2	VMC	4	36	1.16	3	computer engineering	male
2	2	VMC	4	31	1.16	3	electrical engineering	female
3	2	VMC	4	26	1.21	3	mechanical engineering	male
1	2	VMC	5	83	1.1	4	0	0
1	2	VMC	5	80	1.1	4	bioengineering	male
2	2	VMC	5	78	1.16	4	industrial engineering	male
2	2	VMC	5	74	1.16	4	0	0
0	2	VMC	5	47	1	4	industrial engineering	male
2	2	VMC	5	44	1.16	4	mechanical engineering	female
1	2	VMC	5	36	1.1	4	computer engineering	male
0	2	VMC	5	31	1	4	electrical engineering	female
3	2	VMC	5	26	1.21	4	mechanical engineering	male
3	2	VMC	6	83	1.21	5	0	0
2	2	VMC	6	80	1.16	5	bioengineering	male
0	2	VMC	6	78	1	5	industrial engineering	male
2	2	VMC	6	74	1.16	5	0	0
2	2	VMC	6	47	1.16	5	industrial engineering	male
2	2	VMC	6	44	1.16	5	mechanical engineering	female
2	2	VMC	6	36	1.16	5	computer engineering	male
0	2	VMC	6	31	1	5	electrical engineering	female
3	2	VMC	6	26	1.21	5	mechanical engineering	male
3	3	VMC	7	83	1.21	7	0	0

2	3	VMC	7	80	1.16	7	bioengineering	male
5	3	VMC	7	78	1.28	7	industrial engineering	male
4	3	VMC	7	74	1.24	7	0	0
5	3	VMC	7	47	1.28	7	industrial engineering	male
4	3	VMC	7	44	1.24	7	mechanical engineering	female
1	3	VMC	7	36	1.1	7	computer engineering	male
4	3	VMC	7	31	1.24	7	electrical engineering	female
7	3	VMC	7	26	1.33	7	mechanical engineering	male
2	3	VMC	8	83	1.16	8	0	0
1	3	VMC	8	80	1.1	8	bioengineering	male
2	3	VMC	8	78	1.16	8	industrial engineering	male
1	3	VMC	8	74	1.1	8	0	0
0	3	VMC	8	47	1	8	industrial engineering	male
1	3	VMC	8	44	1.1	8	mechanical engineering	female
2	3	VMC	8	36	1.16	8	computer engineering	male
2	3	VMC	8	31	1.16	8	electrical engineering	female
4	3	VMC	8	26	1.24	8	mechanical engineering	male
2	3	VMC	9	83	1.16	9	0	0
1	3	VMC	9	80	1.1	9	bioengineering	male
2	3	VMC	9	78	1.16	9	industrial engineering	male
6	3	VMC	9	74	1.3	9	0	0
2	3	VMC	9	47	1.16	9	industrial engineering	male
3	3	VMC	9	44	1.21	9	mechanical engineering	female
1	3	VMC	9	36	1.1	9	computer engineering	male
4	3	VMC	9	31	1.24	9	electrical	female

							engineering	
2	3	VMC	9	26	1.16	9	mechanical engineering	male
0	1	CVM	1	77	1	9	electrical engineering	male
0	1	CVM	1	72	1	9	bioengineering	male
5	1	CVM	1	71	1.28	9	industrial engineering	female
5	1	CVM	1	62	1.28	9	mechanical engineering	male
4	1	CVM	1	58	1.24	9	electrical engineering	male
0	1	CVM	1	50	1	9	civil engineering	male
8	1	CVM	1	49	1.35	9	0	0
0	1	CVM	1	45	1	9	mechanical engineering	male
6	1	CVM	1	43	1.3	9	computer engineering	male
3	1	CVM	1	41	1.21	9	chemical engineering	female
3	1	CVM	1	33	1.21	9	0	0
0	1	CVM	1	32	1	9	chemical engineering	male
9	1	CVM	1	24	1.37	9	computer engineering	male
0	1	CVM	1	20	1	9	electrical engineering	male
6	1	CVM	1	5	1.3	9	mechanical engineering	male
0	2	CVM	2	77	1	4	electrical engineering	male
0	2	CVM	2	72	1	4	bioengineering	male
1	2	CVM	2	71	1.1	4	industrial engineering	female
3	2	CVM	2	62	1.21	4	mechanical engineering	male
1	2	CVM	2	58	1.1	4	electrical engineering	male
0	2	CVM	2	50	1	4	civil engineering	male
4	2	CVM	2	49	1.24	4	0	0

0	2	CVM	2	45	1	4	mechanical engineering	male
3	2	CVM	2	43	1.21	4	computer engineering	male
1	2	CVM	2	41	1.1	4	chemical engineering	female
2	2	CVM	2	33	1.16	4	0	0
0	2	CVM	2	32	1	4	chemical engineering	male
3	2	CVM	2	24	1.21	4	computer engineering	male
4	2	CVM	2	20	1.24	4	electrical engineering	male
2	2	CVM	2	5	1.16	4	mechanical engineering	male
0	2	CVM	3	77	1	5	electrical engineering	male
0	2	CVM	3	72	1	5	bioengineering	male
5	2	CVM	3	71	1.28	5	industrial engineering	female
4	2	CVM	3	62	1.24	5	mechanical engineering	male
2	2	CVM	3	58	1.16	5	electrical engineering	male
0	2	CVM	3	50	1	5	civil engineering	male
2	2	CVM	3	49	1.16	5	0	0
0	2	CVM	3	45	1	5	mechanical engineering	male
3	2	CVM	3	43	1.21	5	computer engineering	male
2	2	CVM	3	41	1.16	5	chemical engineering	female
3	2	CVM	3	33	1.21	5	0	0
0	2	CVM	3	32	1	5	chemical engineering	male
4	2	CVM	3	24	1.24	5	computer engineering	male
4	2	CVM	3	20	1.24	5	electrical engineering	male
2	2	CVM	3	5	1.16	5	mechanical engineering	male
0	2	CVM	4	77	1	6	electrical	male

							engineering	
0	2	CVM	4	72	1	6	bioengineering	male
1	2	CVM	4	71	1.1	6	industrial engineering	female
2	2	CVM	4	62	1.16	6	mechanical engineering	male
4	2	CVM	4	58	1.24	6	electrical engineering	male
0	2	CVM	4	50	1	6	civil engineering	male
1	2	CVM	4	49	1.1	6	0	0
0	2	CVM	4	45	1	6	mechanical engineering	male
3	2	CVM	4	43	1.21	6	computer engineering	male
1	2	CVM	4	41	1.1	6	chemical engineering	female
2	2	CVM	4	33	1.16	6	0	0
0	2	CVM	4	32	1	6	chemical engineering	male
2	2	CVM	4	24	1.16	6	computer engineering	male
1	2	CVM	4	20	1.1	6	electrical engineering	male
2	2	CVM	4	5	1.16	6	mechanical engineering	male
0	2	CVM	5	77	1	7	electrical engineering	male
0	2	CVM	5	72	1	7	bioengineering	male
2	2	CVM	5	71	1.16	7	industrial engineering	female
1	2	CVM	5	62	1.1	7	mechanical engineering	male
0	2	CVM	5	58	1	7	electrical engineering	male
0	2	CVM	5	50	1	7	civil engineering	male
2	2	CVM	5	49	1.16	7	0	0
0	2	CVM	5	45	1	7	mechanical engineering	male
3	2	CVM	5	43	1.21	7	computer engineering	male

1	2	CVM	5	41	1.1	7	chemical engineering	female
1	2	CVM	5	33	1.1	7	0	0
0	2	CVM	5	32	1	7	chemical engineering	male
2	2	CVM	5	24	1.16	7	computer engineering	male
0	2	CVM	5	20	1	7	electrical engineering	male
2	2	CVM	5	5	1.16	7	mechanical engineering	male
0	2	CVM	6	77	1	8	electrical engineering	male
0	2	CVM	6	72	1	8	bioengineering	male
1	2	CVM	6	71	1.1	8	industrial engineering	female
2	2	CVM	6	62	1.16	8	mechanical engineering	male
0	2	CVM	6	58	1	8	electrical engineering	male
0	2	CVM	6	50	1	8	civil engineering	male
2	2	CVM	6	49	1.16	8	0	0
0	2	CVM	6	45	1	8	mechanical engineering	male
3	2	CVM	6	43	1.21	8	computer engineering	male
4	2	CVM	6	41	1.24	8	chemical engineering	female
3	2	CVM	6	33	1.21	8	0	0
0	2	CVM	6	32	1	8	chemical engineering	male
2	2	CVM	6	24	1.16	8	computer engineering	male
0	2	CVM	6	20	1	8	electrical engineering	male
2	2	CVM	6	5	1.16	8	mechanical engineering	male
4	3	CVM	7	77	1.24	1	electrical engineering	male
2	3	CVM	7	72	1.16	1	bioengineering	male
2	3	CVM	7	71	1.16	1	industrial	female

							engineering	
2	3	CVM	7	62	1.16	1	mechanical engineering	male
3	3	CVM	7	58	1.21	1	electrical engineering	male
3	3	CVM	7	50	1.21	1	civil engineering	male
1	3	CVM	7	49	1.1	1	0	0
2	3	CVM	7	45	1.16	1	mechanical engineering	male
5	3	CVM	7	43	1.28	1	computer engineering	male
7	3	CVM	7	41	1.33	1	chemical engineering	female
3	3	CVM	7	33	1.21	1	0	0
6	3	CVM	7	32	1.3	1	chemical engineering	male
3	3	CVM	7	24	1.21	1	computer engineering	male
3	3	CVM	7	20	1.21	1	electrical engineering	male
2	3	CVM	7	5	1.16	1	mechanical engineering	male
1	3	CVM	8	77	1.1	2	electrical engineering	male
1	3	CVM	8	72	1.1	2	bioengineering	male
3	3	CVM	8	71	1.21	2	industrial engineering	female
3	3	CVM	8	62	1.21	2	mechanical engineering	male
1	3	CVM	8	58	1.1	2	electrical engineering	male
2	3	CVM	8	50	1.16	2	civil engineering	male
4	3	CVM	8	49	1.24	2	0	0
1	3	CVM	8	45	1.1	2	mechanical engineering	male
4	3	CVM	8	43	1.24	2	computer engineering	male
7	3	CVM	8	41	1.33	2	chemical engineering	female
1	3	CVM	8	33	1.1	2	0	0
5	3	CVM	8	32	1.28	2	chemical	male

							engineering	
1	3	CVM	8	24	1.1	2	computer engineering	male
9	3	CVM	8	20	1.37	2	electrical engineering	male
1	3	CVM	8	5	1.1	2	mechanical engineering	male
0	3	CVM	9	77	1	3	electrical engineering	male
2	3	CVM	9	72	1.16	3	bioengineering	male
2	3	CVM	9	71	1.16	3	industrial engineering	female
3	3	CVM	9	62	1.21	3	mechanical engineering	male
2	3	CVM	9	58	1.16	3	electrical engineering	male
2	3	CVM	9	50	1.16	3	civil engineering	male
2	3	CVM	9	49	1.16	3	0	0
2	3	CVM	9	45	1.16	3	mechanical engineering	male
5	3	CVM	9	43	1.28	3	computer engineering	male
4	3	CVM	9	41	1.24	3	chemical engineering	female
2	3	CVM	9	33	1.16	3	0	0
2	3	CVM	9	32	1.16	3	chemical engineering	male
2	3	CVM	9	24	1.16	3	computer engineering	male
1	3	CVM	9	20	1.1	3	electrical engineering	male
2	3	CVM	9	5	1.16	3	mechanical engineering	male
9	1	MCV	1	68	1.37	1	civil engineering	male
5	1	MCV	1	64	1.28	1	electrical engineering	male
1	1	MCV	1	60	1.1	1	bioengineering	male
10	1	MCV	1	54	1.39	1	bioengineering	male
5	1	MCV	1	46	1.28	1	civil	male

							engineering	
5	1	MCV	1	42	1.28	1	chemical engineering	female
9	1	MCV	1	29	1.37	1	civil engineering	female
4	1	MCV	1	28	1.24	1	bioengineering	male
6	1	MCV	1	25	1.3	1	computer engineering	male
3	1	MCV	1	22	1.21	1	0	0
5	1	MCV	1	17	1.28	1	mechanical engineering	male
4	1	MCV	1	13	1.24	1	0	0
2	2	MCV	2	68	1.16	5	civil engineering	male
0	2	MCV	2	64	1	5	electrical engineering	male
1	2	MCV	2	60	1.1	5	bioengineering	male
0	2	MCV	2	54	1	5	bioengineering	male
2	2	MCV	2	46	1.16	5	civil engineering	male
1	2	MCV	2	42	1.1	5	chemical engineering	female
2	2	MCV	2	29	1.16	5	civil engineering	female
1	2	MCV	2	28	1.1	5	bioengineering	male
1	2	MCV	2	25	1.1	5	computer engineering	male
1	2	MCV	2	22	1.1	5	0	0
1	2	MCV	2	17	1.1	5	mechanical engineering	male
0	2	MCV	2	13	1	5	0	0
4	2	MCV	3	68	1.24	6	civil engineering	male
0	2	MCV	3	64	1	6	electrical engineering	male
4	2	MCV	3	60	1.24	6	bioengineering	male
0	2	MCV	3	54	1	6	bioengineering	male
3	2	MCV	3	46	1.21	6	civil	male

							engineering	
1	2	MCV	3	42	1.1	6	chemical engineering	female
2	2	MCV	3	29	1.16	6	civil engineering	female
2	2	MCV	3	28	1.16	6	bioengineering	male
2	2	MCV	3	25	1.16	6	computer engineering	male
2	2	MCV	3	22	1.16	6	0	0
1	2	MCV	3	17	1.1	6	mechanical engineering	male
0	2	MCV	3	13	1	6	0	0
3	2	MCV	4	68	1.21	7	civil engineering	male
0	2	MCV	4	64	1	7	electrical engineering	male
2	2	MCV	4	60	1.16	7	bioengineering	male
0	2	MCV	4	54	1	7	bioengineering	male
3	2	MCV	4	46	1.21	7	civil engineering	male
0	2	MCV	4	42	1	7	chemical engineering	female
1	2	MCV	4	29	1.1	7	civil engineering	female
1	2	MCV	4	28	1.1	7	bioengineering	male
1	2	MCV	4	25	1.1	7	computer engineering	male
2	2	MCV	4	22	1.16	7	0	0
3	2	MCV	4	17	1.21	7	mechanical engineering	male
0	2	MCV	4	13	1	7	0	0
2	2	MCV	5	68	1.16	8	civil engineering	male
0	2	MCV	5	64	1	8	electrical engineering	male
1	2	MCV	5	60	1.1	8	bioengineering	male
0	2	MCV	5	54	1	8	bioengineering	male
1	2	MCV	5	46	1.1	8	civil	male

							engineering	
0	2	MCV	5	42	1	8	chemical engineering	female
1	2	MCV	5	29	1.1	8	civil engineering	female
1	2	MCV	5	28	1.1	8	bioengineering	male
1	2	MCV	5	25	1.1	8	computer engineering	male
2	2	MCV	5	22	1.16	8	0	0
2	2	MCV	5	17	1.16	8	mechanical engineering	male
0	2	MCV	5	13	1	8	0	0
2	2	MCV	6	68	1.16	9	civil engineering	male
0	2	MCV	6	64	1	9	electrical engineering	male
3	2	MCV	6	60	1.21	9	bioengineering	male
0	2	MCV	6	54	1	9	bioengineering	male
2	2	MCV	6	46	1.16	9	civil engineering	male
0	2	MCV	6	42	1	9	chemical engineering	female
2	2	MCV	6	29	1.16	9	civil engineering	female
0	2	MCV	6	28	1	9	bioengineering	male
0	2	MCV	6	25	1	9	computer engineering	male
2	2	MCV	6	22	1.16	9	0	0
1	2	MCV	6	17	1.1	9	mechanical engineering	male
0	2	MCV	6	13	1	9	0	0
4	3	MCV	7	68	1.24	2	civil engineering	male
3	3	MCV	7	64	1.21	2	electrical engineering	male
3	3	MCV	7	60	1.21	2	bioengineering	male
5	3	MCV	7	54	1.28	2	bioengineering	male
4	3	MCV	7	46	1.24	2	civil	male

							engineering	
4	3	MCV	7	42	1.24	2	chemical engineering	female
2	3	MCV	7	29	1.16	2	civil engineering	female
4	3	MCV	7	28	1.24	2	bioengineering	male
4	3	MCV	7	25	1.24	2	computer engineering	male
4	3	MCV	7	22	1.24	2	0	0
3	3	MCV	7	17	1.21	2	mechanical engineering	male
4	3	MCV	7	13	1.24	2	0	0
5	3	MCV	8	68	1.28	3	civil engineering	male
1	3	MCV	8	64	1.1	3	electrical engineering	male
3	3	MCV	8	60	1.21	3	bioengineering	male
9	3	MCV	8	54	1.37	3	bioengineering	male
2	3	MCV	8	46	1.16	3	civil engineering	male
1	3	MCV	8	42	1.1	3	chemical engineering	female
3	3	MCV	8	29	1.21	3	civil engineering	female
2	3	MCV	8	28	1.16	3	bioengineering	male
1	3	MCV	8	25	1.1	3	computer engineering	male
2	3	MCV	8	22	1.16	3	0	0
5	3	MCV	8	17	1.28	3	mechanical engineering	male
1	3	MCV	8	13	1.1	3	0	0
5	3	MCV	9	68	1.28	4	civil engineering	male
0	3	MCV	9	64	1	4	electrical engineering	male
2	3	MCV	9	60	1.16	4	bioengineering	male
5	3	MCV	9	54	1.28	4	bioengineering	male
3	3	MCV	9	46	1.21	4	civil	male

							engineering	
1	3	MCV	9	42	1.1	4	chemical engineering	female
3	3	MCV	9	29	1.21	4	civil engineering	female
0	3	MCV	9	28	1	4	bioengineering	male
2	3	MCV	9	25	1.16	4	computer engineering	male
3	3	MCV	9	22	1.21	4	0	0
1	3	MCV	9	17	1.1	4	mechanical engineering	male
0	3	MCV	9	13	1	4	0	0

APPENDIX C: QUALITY OBJECTIVES

Table 39: Quality Objectives Analysis by Expert Panel

Quality Objectives Analysis by Expert Panel				
Objective	6 or more judges Agree	High	Mid	Low
salary	0	1	6	1
interest in subject and field	High	8	0	0
years needed to complete required degrees	0	1	4	3
job availability after graduation	High	6	2	0
family's preference for major	Low	0	0	8
ease of attaining professional success with this major	0	3	4	1
ability to finish degree and not have to transfer to another major	0	1	3	3
amount of effort needed to finish degree	0	1	3	4
job security	0	5	3	0
tuition for getting the degree	0	0	3	5
interesting professional applications	0	3	5	0
dedication to completing the degree	0	2	4	2
quality of school that offers the major	0	3	4	1
location of where many jobs will be for that major	0	2	5	1
respect of major	0	0	8	0
the need of the student to work hard on the job and while getting the degree	0	1	5	2
variety of industries the major can be used in	0	3	5	0
the major chosen fits student's strengths	0	4	4	0
the major/job is accepted with the student's religion and beliefs	0	5	2	1
the major offers the student the opportunity to gain significant knowledge	0	4	4	0
a major/job in a field that will help people	0	3	4	1
job advancement with the degree obtained	0	5	3	0
vacation/time in job	Low	0	2	6

amount of job travel	0	1	5	2
environment of the job	0	2	5	0
interesting classes	0	5	3	0
popularity of major with peers	Low	0	0	8
creative thinking with major/job	0	2	5	0
future employability of major	High	6	2	0
physical conditions of job	0	0	5	2
friend's opinions of major	Low	0	0	8
live comfortably with the job chosen	0	4	4	0
make a difference with the job	0	3	5	0
challenging major that uses critical thinking	0	4	4	0
ethics of major and job	0	5	3	0
being able to live healthy while on the job (work/life balance)	0	4	4	0
the job's amount of time being around people	0	1	6	1
quality of faculty and students in the department	0	4	3	1
amount of stress in major	0	1	3	4
amount of hours per week for job	0	0	6	2
stress of major/job	0	2	4	2
minority in major	Low	0	2	6
structure of major (classes, semesters, internships)	0	0	5	3
types of classes taken in major	0	3	5	0

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EDUCATION

University of Louisville, Louisville, Kentucky

***Ph.D in Industrial Engineering*,** August 2013
Dissertation Title: A Hybrid Problem Structuring Method to Generate Quality Objectives
Advisor: Gail W. DePuy, Ph.D, P.E.

***M. Eng. in Industrial Engineering*,** December 2009
Thesis Title: Analysis of Patient Throughput Time at Kosair Children's Hospital Emergency Room
Advisor: Gail W. DePuy, Ph.D, P.E.

***B.S. in Industrial Engineering*,** August 2008

CURRENT PROJECTS

Generating Quality Objectives in the Decision Making Process
The objective of the study is developing and testing a hybrid method that helps decision makers for a variety of decision applications to generate quality objectives. Past research has shown that generating quality objectives is an important beginning step in the decision making process that will lead the decision maker to making well-informed decisions.

The Application of Generating Quality Objectives for the Decision of Undergraduate Students' College Major Choice
The objective of the study is to test and implement the hybrid method developed to generate quality objectives in the area of education. Undergraduate college students will be using the hybrid method developed when making a decision on a college major. The results will be analyzed and used to improve the generation of quality objectives.

TEACHING EXPERIENCE

1. Taught IE 515 Operations Research Recitation, Fall 2012
2. Taught Select Classes of IE 642 Analysis of Decision Making, Spring 2012
3. Taught Select Classes of EM 613, Operations Management, Fall 2011
4. Taught ENGR 100 Introduction to Engineering Recitation, Fall 2008
5. Teaching Assistant for the following classes: EM 694 Transportation Logistics, IE 570 Engineering Economic Analysis, IE 563 Design of Experiments, IE 515 Operations Research, IE 425 Production and Inventory Control, ENGR 102 Calculus II, ENGR 100 Introduction to Engineering

PUBLICATIONS

Manuscripts in Draft:
1. Gentry, E. A. & DePuy, G. W. Generating Quality Objectives in the Decision Making Process.
2. Gentry, E. A. & DePuy, G. W. The Application of Generating Quality Objectives for the Decision of Undergraduate Students' College Major Choice.

PRESENTATIONS

Presentations & Posters

1. Gentry, E. A., Wooldridge, A. R., DePuy, G. W., 2011. "Improving the Logistics of Patient Throughput in a Hospital Emergency Room." *Society for Health Systems Conference 2011*, February 17 – 20, Orlando, Florida.
2. Gentry, E. A., 2010. "Logistics and Decision Making in an Emergency Room Process." *Logistics and Distribution Institute Fall Research Reception*, November 18, Louisville, Kentucky.
3. Gentry, E. A., 2010. "Logistics of Patient Throughput." *Logistics and Distribution Institute Spring Research Reception*, April 22, Louisville, Kentucky.
4. Gentry, E. A., 2009. "Improving Patient Throughput in the Emergency Room at Kosair Children's Hospital." *Kosair Children's Hospital*, November 3, Louisville, Kentucky.

PROFESSIONAL ACTIVITIES

Scientific and Honorary Societies

Institute of Industrial Engineers
Alpha Pi Mu Industrial Engineering Honors Society
Institute for Operations Research and the Management Sciences
Institute for Operations Research and the Management Sciences Sports Society National Secretary
Society of Women Engineers
Society of Health Systems
American Society of Engineering Education
Human Factors and Ergonomics Society

Awards

University of Louisville Athletics Tutor of the Year, 2011
University of Louisville Logistics and Distribution Institute Fellowship Recipient, 2009 - 2011

SERVICE

Community

Southeast Christian Church Shine Disabilities Prom, 2011 – Present
American Cancer Society Heart Walk, 2010 – Present
Sigma Kappa Sorority Greater Louisville Alumnae, 2009 - Present
Panhellenic Alumnae Society, Sigma Kappa Alumnae Delegate, 2009 - 2012
Southeast Christian Church New Member Services Volunteer, 2009 – 2011
Adopt a Highway Volunteer, 2006 - 2009
Sigma Kappa Kick in the Grass, 2006 – 2009
Alzheimer's Memory Walk, 2006 – 2008

University

Graduate School Student Ambassador, 2012 - Present
Co-Chair of Fryberger Greek Sing, 2008 – 2009
Sigma Kappa Sorority Standards Council, 2008 – 2009
Greeks Advocating the Mature Management of Alcohol, 2006 – 2009
Sigma Kappa Sorority Executive Council, 2007 – 2008
Sigma Kappa Sorority Webmaster, 2006 – 2008

Professional

Speaker at High School Career of Engineering Days, 2009 – 2011
Developed Improvements in Patient Throughput Time at Kosair Children's Hospital, 2009

EMPLOYMENT

University of Louisville Speed School Department of Industrial Engineering
Graduate Research and Teaching Assistant, August 2009 - Present

University of Louisville Men's Basketball Team
Academic Intern, August 2009 - Present

University of Louisville Speed School Department of Engineering Fundamentals
Graduate Teaching Assistant and Student Assistant, March 2006 – June 2009

United Parcel Service
Industrial Engineering Co-op, May 2006 – December 2007