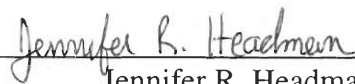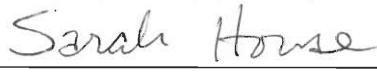A Psychometric Study of the KAI, GCSI and MBTI and the Class of 2001 Major
Changing Study

An Interactive Qualifying Project Report
submitted to the Faculty
of the
WORCESTER POLYTECHNIC INSTITUTE
in partial fulfillment of the requirements for the
Degree of Bachelor of Science

Submitted by :

Jennifer R. Headman
Jennifer R. Headman

Sarah House
Sarah House

Approved by:

John M. Wilkes
John M. Wilkes, Ph.D.

Department of Social Sciences and Policy Studies
Worcester Polytechnic Institute
Worcester, Ma

March 24, 2000

Abstract

This project served two purposes: To explore how students' tolerance of change as measured by the KAI translated into patterns of major changing in the WPI Class of 2001 and to explore the psychometrics of cognitive style as measured by three indicators, the KAI, GCSI, and MBTI. Data on perceptions of majors was obtained through a survey. A data set of cognitive types (MBTI and GCSI) was available. The KAI had to be administered. It was found that GCSI Integrators and MBTI Introverts were least likely to change majors. An unexpectedly powerful correlation was found between the KAI and J/P dimension (MBTI). There was no relationship between remote association and the KAI, despite theory-based hypotheses to the contrary.

Table of Contents:

Acknowledgements:

All of the Authors and Scholars mentioned within are acknowledged with great appreciation

Special Thanks to:

List of Tables

i.i.i.

Introduction

This study is partly an examination of perceptions of and reactions to change and partly a psychometric analysis of the relationship between three cognitive style indicators. Specifically, the research project focused on individual tolerance of change by people with different cognitive styles as measured by the Kirton Adaptation Innovation Indicator (KAI), Myers-Briggs Type Indicator (MBTI), and Gordon's Cognitive Style Indicator (GCSI). The Index of Learning Styles (ILS) was also going to be included, but when data collection stalled, it was dropped as an avoidable complication. This was to reduce what we were asking of prospective respondents. The sample, originally intended to be 100-150 members of the WPI Class of 2001 (now Juniors), was also to be given our own modest survey regarding choice of major, change of major and satisfaction with WPI. A variation of this was sent to those members of the Class of 2001 who had left WPI i.e., made a big change in plans. A prior study of the class, carried out during freshman orientation, provided MBTI data for 545 members of the class. GCSI data were available for over 600, but we were interested in those people who had taken both measures and planned to administer the KAI to at least 100 of them.

Unfortunately, the response rate for our Class of 2001 sub-sample getting the KAI was not good. Only about thirty members of the class of 2001 took part in round one of data collection for this study (out of the random 300 that were invited). At that point the project was divided into two efforts. One would involve collecting KAI data from more easily attainable samples, which had taken the GCSI and MBTI, or were then doing so,

for the psychometric comparison of measures. The study of major changing would stick with the Class of 2001, but now be asking so little that the survey could be distributed over the campus e-mail system. The psychometric sample was then supplemented by about sixty students enrolled in two social science courses at WPI and ten to fifteen more people were added to that sample by including graduate students at WPI attending a summer course.

The remainder of the sample is made up of two groups. The first is about fifty mechanical engineering majors from Boston University. The second is a group of about 30 professionals from the Gillette Corporation. These groups make up the opportunistic sample of the psychometric study, where the limiting element was our ability to administer the 8-minute KAI forms to people who had already taken, or were then taking, the GCSI and MBTI.

The change in the sample design affected the project dramatically. The research strategy was now constrained by lack of overlap. The two samples were linked by a common group of only thirty WPI students who took all of the measures and the survey. Major changing at BU and career choice at Gillette were of no real interest to us even if the subjects had been willing to take our survey. Freshman and sophomores included in the class at WPI taking the KAI were not yet experienced enough to be of interest. Hence, we do not have KAI data for all of the cases in which we are studying major changing. This was a problem, given that our theory about who was most likely to change majors, and make large changes, was based on the logic of the KAI. The first part of the project is now more strictly a psychometric study of the relationship between the KAI, MBTI, and GCSI. Each member of the psychometric sample has taken the KAI and

at least one of the other two measures, the GCSI and the MBTI. Our goal is to determine what, if any, relations exist between KAI type, "remote association", cognitive type, psychological (as measured by the MBTI) type, and career choice. The GCSI-KAI study is a first, as this analysis has never been done before on this scale or in this way. The KAI literature mentions prior MBTI-KAI studies, and even one remote association-KAI study. In that modest one class sample of thirty, however, it seems the remote association measure was considered as a continuous variable, and it is best treated as a dichotomous variable.

The second part of the project specifically involves the Class of 2001 and its pattern of major changing. A random sample of members of this class who filled out the MBTI and GCSI during freshman orientation was to be contacted in waves of follow-up (asking them to take the student-produced survey) until a 50% response rate was reached. The target was a sample size of about 150 (50%response), but some class members have surely left WPI, and thus a 10% reduction in sample frame (300 to 270) and thus the resulting sample, is to be expected. Thus, a sample of 135 may be all that is required for a 50% response rate. In the end we fell a bit short, with 110 respondents contacted in four waves of requests.

The major changing part of the project had several objectives. The primary goal was to see how the Class of 2001 has changed aspirations since matriculating at WPI. We plan to uncover students' views of their majors, and tie that to their cognitive types to predict the likelihood of who would change their plans (majors). Finally, we planned to determine how satisfied the Class of 2001 is with WPI. A separate study of those who have left WPI was strongly considered, but the expected response rate was so low that it

was not made a central focus of the study. A survey was sent out in hopes of getting some response, but it was, as expected, largely ignored, and we let the matter drop. By then, we had a bigger problem to be concerned with, how to get KAI proxy data from the WPI sample over the e-mail system. The form is copyrighted and therefore could not be put online. Thus, the main concept was paraphrased and sent out as a one item self report question. This e-mail message went out to the WPI people who had already filled out the real KAI for us as well. When their responses did not validate the proxy at a high enough level (only a 0.5 correlation and we needed a 0.8 or better), we still had a problem, but did not know that until it was too late to do much about it.

Another aspect of the major changing study (in addition to theory testing) was to assess the accuracy of student records by comparing them to what the students say they are doing and why based on survey data. Having done that the survey would also reveal to us whether the students view the different fields they are leaving and entering as dynamic or stable working environments. This would help us only if it were combined with a KAI proxy measure. However, those students whose views were out of sync with the majority view may have acted differently from the rest, so it would provide us with a way to control for outlying student perceptions that would change the hypothesis. We expected to find that there were majority types in each major and focus on the cognitive minority (with this comparison of perception of the degree of turbulence in the field).

The original study proposal is included at the end of this report. In order to conduct a successful study, every effort was made to collect data useful to at least one part of the larger study. In the end, we hoped to have an increased information pool regarding major change and to have thoroughly explored any possible correlation

between the three cognitive style measures administered to most members of our psychometric study sample.

This IQP relates society to perceptions of technology fields in order to explain career choices of technical professionals. When learning styles and cognitive types are studied, it is really the way a person processes information and comes to decisions that is being studied. This project also involves some classic social science methodology in the psychometric calibration of three cognitive style indicators devised to measure different things, but which we suspect measure the same things. In essence, this IQP examines how people will interact with each other. Human Interaction of this kind is a very important part of society, and the relationship to the technological use in the engineering profession is clear. Thus, we think it qualifies as an IQP, which should study the technology- society interface.

Chapter 1: Literature Review

The KAI

Adaptation-Innovation Theory

Adaptation-Innovation Personality Theory was developed by Michael Kirton in 1976(*KAI Manual*). His theory is one of cognitive style. It is considered a measure of creativity, but it purports to describe a person's style of creativity rather than trying to assess an individual's degree (or level) of creativity. The question 'how creative is this individual?' is not asked, but rather 'what method of creativity does this individual employ when being creative?' is asked and presumably answered. All persons are viewed as being capable of creativity, though different parts of the process come more easily than others to a given individual, and some individuals are not naturally inclined to innovate.

Unlike some theories in which a person is classified as either one type or another, the Adaptation-Innovation theory offers no distinct lines of discrimination. An individual can fall anywhere along the scale, from extreme Adaptor, to moderate, to extreme Innovator. No range is viewed as positive or negative; rather the theory describes characteristics, including both advantages and disadvantages that have been characterized for each range. These can be found in the KAI Manual. However, the measure can be, and commonly is, dealt with as having anywhere from two to eight discrete types relative to one another. The population norm score is reported to facilitate breaking a sample into A's and I's (Adaptors and Innovators), with some typical proportions of each found in professions ranging from accountants to R&D scientists. The KAI was developed

primarily for use in business and industrial settings. It deals with how comfortable one is in departing from established ways of doing things in incremental steps as opposed to major or massive watershed events that transform the system.

A description of the extremes

<u>*The Adaptor*</u>

According to the Kirton Adaptation- Innovation Theory, an Adaptor is a person who likes to work within the realm of what is already known. He or she is a person who likes to remain in a relatively consistent task environment. While capable of producing novel, creative ideas, an Adaptor tends to be aimed at doing things better along existing lines of development as opposed to making substantial changes in the processes. It is often difficult for such people to break out of the existing mold, but creative tinkering and incremental innovation is continuous. Over time, great change can be accomplished. Hence, well-established or structured work situations are much preferred by the Adaptor because these provide a stable framework from which to work.

New data is eagerly embraced by an Adaptor when it can be incorporated into an existing structure or policy, but is resisted if it is anomalous. The Adaptor is essential to the continuation of ongoing functions. He or she often finds it difficult to move out of the established role in times of unexpected change, but is exceedingly good at ensuring that things continue along their original path, and will not give up too soon on a promising established line of inquiry.

High Adaptors focus on efficiency. Immediate high efficiency is the main goal for them. The long haul is not examined very often, but rather the effect of decisions on

the here and now is salient. Adaptors are good at producing results quickly, but they are not always good at planning for a sustained yield.

The Innovator

The Innovator is a person who enjoys change for its own sake and likes to be different. Typically, he or she takes an old problem and redefines it rather than just solving it. The innovator likes to ignore commonly perceived restraints. Ideas produced by an Innovator are often not acceptable to others because of this tendency to downplay feasibility and implementation problems. Other times it is not easy for others to understand the ideas produced by an innovator since they are "off the wall" and even "outside of the box", not fitting the established paradigm or program. When the point of their departure is discernable, or problems in the established technology are acknowledged, these ideas are often capable of giving insight into seemingly stuck or mature technological applications or processes. As the problems inherent to the old approach are revealed, progress can be made in improving them. In dealing with choke points which were not yet considered problematic, they are the ones who can break the mold and show how the constraints can be removed from the process, therefore the latent problem can be avoided or solved.

Innovators prefer unstructured situations. When given new data, the Innovator tends to create new structures and policies around these possibilities rather than to apply previously existing ones to the case at hand. This often puts him or her at risk both politically and economically, but they are willing to accept this cost in return for the possibility of a breakthrough.

Innovators are essential in times of change or crisis. They are able to work (and even make progress) under conditions in which others would figuratively shut down. The innovator, however, may run into problems when there is no perceived need for change by those around them. Their particular type of creativity may seem threatening, and therefore be stifled at times such as this. Innovators also may have trouble applying themselves to the ongoing everyday organizational demands for productivity.

Collaboration and Perception

Adaptors and Innovators often have problems getting along with each other. This is especially apparent when their scores fall into opposite extremes of the scale. This is where people who fall into the moderate group are especially appreciated. The moderate scorer can act as a bridge between the extremes. These are people who have qualities of both Adaptors and Innovators. They can work with both groups of people and pull the best out of a clash between people who score in the extreme ranges. Kirton reports that score differences of even twenty points are associated with communication difficulties.

The moderate scorer is also somewhat disadvantaged, however. He or she finds it much more difficult to reach heights of innovation or production than someone who scores more to one extreme. On the other hand, however, he or she is more capable of performing either organizational role as needed to balance groups too well staffed with one type in the absence of the other. Relating to the extremes is their forte.

An Adaptor is perceived by an Innovator as being conservative, risk averse and therefore safety minded. Managers see Adaptors as being sound, conforming, and predictable. The Innovator is often annoyed by an Adaptor's tendency to be inflexible and wedded to the system. The Adaptor's intolerance of ambiguity also often grates against the nerves of the Innovator.

The Innovator often shocks the Adaptor. He is viewed by the Adaptor as erratic and possessed of unsound views. The Innovator often takes risks that the Adaptor sees as

excessive or unnecessary. He is also considered impractical and abrasive, creating

dissonance wherever he works by championing change whether or not there is evident

need for it by the standards of an Adaptor.

In the previous section, collaboration between extreme Adaptors and extreme Innovators (at least 20 points apart and on opposite sides of the median score of 96) was examined. In this part, we will look at collaboration between people of like style. When an Adaptor works with another Adaptor, the difference between their scores becomes very important.

When two people who are Adaptors (or two Innovators) work together, they do not experience the extreme clash that is found with an extreme Adaptor and an extreme Innovator. One person, however, will take on the role of the innovator (or Adaptor in the case of two Innovators). This will be the person with the score that falls closer to the other side of the scale.

This is where the adaptation- innovation theory differs largely from other cognitive theories. A person's "type" is not set in stone. Peoples' behavior varies back and forth depending on the people with whom they are working, and is not tied to their type per se. The other measures explain the divergence between preference (MBTI) or ability (GCSI) in very different ways, which are not so concise or elegant.

The Kirton Adaptation Innovation indicator is composed of 32 questions. For each question the individual marks how easy it would be for him to maintain that image for a prolonged time. The responses consist of 17 dots spread from very easy to very hard. Each answer is then ranked from 1 to 5 depending on the question. The scores are arranged so that Adaptors get low scores and Innovators get high scores. The score range runs from 32 to 160 with the (empirically derived) mean falling at 96. The majority of people (67%) fall between 80 and 112.

The indicator is composed of three very stable factor traits. These are Sufficiency vs. Proliferation of Originality (SO), Preference for Efficiency (E), and a preference for operating within rules, called Rule Conformity (RC). Each one will be described in detail in the next few pages.

The Sub-Scales

<u>*Sufficiency vs. Proliferation of Originality: The SO factor*</u>

The sufficiency aspect of this trait refers to the Adaptor. Adaptors seemingly prefer to deal with fewer original ideas or possibilities, especially all at once. The ideas they appreciate are those that they view as sound, useful, and relevant to their situation. This, to them, is a manageable and efficient means to institute necessary changes.

Innovators on the other hand enjoy a proliferation of originality. They like to toy with ideas and thus produce many. Not all of their ideas, however, are feasible or to be taken seriously, even by the Innovators themselves. Much of their output is often thrown out, or held over to a later situation, and that doesn't seem to bother them. They like to generate ideas, brainstorm for a considerable period. In the jargon of the creativity literature, they are fluent and divergent. The reference is to Ideational Fluency (Guilfford) and divergent (as opposed to convergent) thinking (Hudson).

It is important to note that this factor just describes the individual's preference for coming up with ideas, not his or her ability to do so relative to other people. An Adaptor is capable of producing more ideas, but prefers not to complicate things unless asked to do more brainstorming for a reason. This also tends to affect the degree to which the ideas are radical. When fewer ideas are produced, they tend to be less radical and less likely to be pattern breaking. A high score on SO, means a higher score on the KAI overall.

The E factor

This factor explores the degree of a person's preference for efficiency. An Adaptor is very concerned with efficiency. Precision and reliability are very important to them. Adaptors also have a tendency to be very thorough. They pay great attention to detail and tend to research things in depth.

Innovation can rarely be described as part of a pattern of efficiency. It causes discontinuity, disrupts things, and reduces immediate productivity in the hopes of a future gain. Something that is found through innovation can be more efficient, but only after development. Development implies that adaptation has taken place, thus credit for the efficiency tends (once again) to go to the Adaptor. The more efficient a person is, the lower their score on the KAI overall.

The RC factor

The RC factor is rule/group conformity. This quality is associated with the individual's being methodical and disciplined. Rules tend to keep ideas within the realm of the accepted logic or group consensus. Group conformity looks critically and skeptically upon methods other than the tried and true.

High quality adaptation (rather than innovation) is encouraged under such conditions. People who are naturally high Innovators are able to resist this move towards conformity. In fact, these people often seem to enjoy going against the group assumptions and norms. Seeing their own ideas developed is much greater in importance to them than making the group happy and supportive by staying within the comfort zone

of the majority with regard to change. The more willing a person is to conform to rules

and groups, the lower the overall score on the KAI.

II. The Other Measures

What is the GCSI: Gordon's Cognitive Style Indicator

Gordon's Cognitive Style Indicator uses two dimensions to classify an individual. The first is differentiation. The other is remote association. The origins for this measure are found in the creativity literature that deals with levels of creativity. This literature also implies that two kinds of creativity exist. These two dimensions are not highly correlated. A person can have a high level of differentiation but a low level of remote association or vice versa. They can also have both, or neither. These variations define the 4 types recognized by the GCSI. With the creation of these "types", Gordon was trying to predict patent receiving among R & D scientists.

Differentiators have the ability to discern subtle differences. This can be very useful in diagnosing a problem and deciding between possible solutions. People who score high on differentiation can seem fussy and cautious about admitting what is obvious to those who don't. They have a discriminating eye, pick up on subtle differences and fixate on them. Things that are obviously the same to others, aren't to them. They have also been described as "nitpicky" and tied up in semantics. This becomes helpful, however, when the underlying nature of a problem is not self-evident and needs to be discovered or uncovered. They are the ferrets of the scientific and technical world, or perhaps its diagnosticians.

Remote association is the ability to see connections, and to see them rapidly and without obvious recourse to logic to solve a problem. Remote Associators are the intuitive "Problem Solvers", with a reputation for ingenuity. For Remote Associators, the

18

solution does not need to be stated or implied in the problem, as they draw in outside information that seems connected or relevant to them with ease. Remote Associators are able to pull together disparate pieces of information to fashion a solution if the necessary elements are known to or available to them. They can access and retrieve information that was encountered in various contexts and any order and put it together rapidly, too quickly for seemingly logical processing. On the other hand, they can't always retrace or defend the steps by which they arrived at a solution.

There are four cognitive types that are produced by crossing these two dimensions. They depend on whether a person scores high or low in each dimension. A high on Mednick's Remote Association measure is determined with respect to larger population norms. The experience base for differentiation is not as extensive, so the scores are typically cut at the median on a study-by-study basis. The four types are described in the next few pages.

The Differentiators

<u>*Integrator*</u>

An Integrator is a person who scores in the high range on both the differentiation and remote association dimensions. Intergrators are good at recognizing small discrepancies in theory or fact. They are also good at pulling seemingly random things together to find a solution, equally comfortable with discrimination or integration tasks. The whole is greater than the sum of the parts in their case, as the interaction of these qualities produces a kind of intuitive problem solving ability whereby many things come easily. In the specific case of a student, this can result easily in lack of discipline due to unusual ease with both the early and later portion of the creative process. Potentially brilliant, these students are often erratic.

<u>*Problem Assessor*</u>

Problem Assessors have differentiation ability, but are Local Associators. The Problem Assessor thrives in task environments where ambiguity, subjective criteria, and conceptual complications are the norm. They do relatively well on ill-structured, open-ended tasks. Problem Assessors are the best able to handle unstructured technical problems where diagnostics and conceptualization are the tough part, and the solution is relatively straightforward or at least not highly complex or interactive.

Inference and logic is the key to their style of problem solving, though trial and error can work if they are determined enough to see it through. Typically, however,

distractions and going off on tangents will intervene before all of the details are worked out. Problem Assessors start much more than they finish unless they compensate with a very disciplined approach to problem solving. In their experience, the second part of the problem solving process takes a lot more effort than the first part.

The Non- Differentiators

<u>The Problem Solver</u>

Problem Solvers are Remote Associators who score in the non- differentiated range. Problem Solvers prefer structured, already defined problems. Theoretically mature fields are the most attractive to Problem Solvers, as they handle abstract concepts well and use prevailing theory to structure problems that are not well defined or broken down into solvable components. They are ingenious and flexible thinkers on the second stage of innovative problem solving, the recombination of elements into new patterns that meet the known specifications or requirements to solve a given problem.

<u>The Implementor</u>

Implementors are Local Associators who also score as non-Differentiators. Persistence, logic, and prior experience are key to their approach to problem solving. They excel when the problem is well structured and the underlying material that would be applied is not too complex or interactive. In justifying a solution, they like to bolster their own logical case with reference to expert authorities. Practical application, working out the details, making a clear exposition of the case, and step by step procedural specification are the tasks at which they are masters. Less likely to be Innovators, but

more likely to carry through step by step and work out the logical possibilities in a new

line of thinking, they are prized in production oriented task environments.

What is the MBTI: The Myers Briggs Type Indicator

The Myers-Briggs Type Indicator is a personaliy instrument that measures preferences. Often likened to that of a personal preference for the use of the right or left hand, the indicator is used to identify peoples' preferences among sets of mental processes. Each question is counted toward one of four scales. Each of the four scales is described briefly below. Each scale has two opposite preferences. A total of sixteen types are formed from the combination of these four scales. A more thorough description of each type can be found in *Descriptions of the Sixteen Types* by Gordon D. Lawrence, Ph.D. This is included at the end of this report.

The E/I Scale

The E/I scale stands for Extraversion vs. Introversion. An Extravert is oriented towards the world outside of them. They are active people, who focus on people and things. They get their energy and stimulation from their environment. Introverts on the other hand are more focused on their inner world of ideas, perceptions, and feelings. They often think for a long time before acting, unlike the Extravert who acts when in doubt, using trial and error more often than deep reflection. The Introvert will often feel drained after long hours of interacting with other people. Although the Introvert is perfectly capable of being a strong leader and people person, this takes an effort and is not his or her natural preference.

The S/N Scale

The S/N scale refers to the type of perception an individual prefers to exercise, though all people, in fact, use both modes. A person with a preference for Sensing perception uses his or her senses first. What is tangible and objective is most real, and to be taken most seriously in making a decision. These individuals work with factual and practical details. Sensing types often focus on the present moment instead of the long term. Intuitive perception, on the other hand, deals with patterns and meanings. People with intuitive perception use their memory and associations to project possibilities not only for right now, but also for the future. Indeed, the possibilities in a situation start to come to them immediately, even before they have looked at all the facts. They are ready to read between the lines and pick up on subtleties. Intuitive types are much more likely to accept possibilities that seem to come to them out of the air as possible and relevant to decision making.

The T/F Scale

T/F stands for Thinking or Feeling when dealing with judgment. Thinking types use logical analysis and impersonal criteria to come to conclusions. They seek justice via dispassionate analysis and they distrust subjectivity. They value logic and order and are often skeptical of things that they can not examine with analytical rigor and thus prove. Thinking types also like to draw attention to cause and effect relationships, which come to them readily. Feeling types, on the other hand, do not make decisions by impersonal analysis. They start with how the various people involved and the group is likely to be

affected by a decision. The goal is harmony not justice, and decisions are made case by case, with empathy rather than with reference to some abstract principle applied consistently without reference to the variable impact on individuals. Human values and motives play a big part in their decisions. A Feeling type is much more likely to value the warmth in a relationship than a value of a person or a "contact". Trust is very important and feeling types are much less likely to be skeptical of the motives of others.

The J/P Dimension

Judgment vs. perception is what this scale is all about. In short, it refers to whether an outsider meeting a person will find out how they take in information (perception) or how they come to decision (judgement) the more salient part of their personality. The practical implications of this difference are far reaching.

A J type prefers to be very organized. Everything is scheduled and goal oriented. J types tend to want closure. They gather only enough data to make a decision and do not like to revisit what is settled. They want to move on. The best way to maintain an orderly and productive environment is to be in control of it. P types on the other hand gather data for its own sake and are constantly changing their minds on the basis of it, so they try to avoid making firm commitments. They are curious and interested people who keep an open mind and try to preserve their options until the last minute. A P type will resist closure until sure that all the relevant data possible is collected or time has run out.

These types behavior is not set in stone, but their preferences tend to be enduring. Each person uses some qualities of each aspect of the individual scales. This indicator only seeks to show which option a person prefers. It does not seek to describe a person's

ability in any way though it does have implications for his or her typical behavior when it is not constrained by environmental factors.

In the behavioral realm there is a lot of room for learning. This is called "mature type development." This means that as one develops, one becomes more competent in the less preferred modes and recognize when they are more appropriate than one's preferred or natural mode. Young people, however, are typically still busy mastering their preferred modes and employ them with regularity.

In our search for literature regarding career choice and cognitive measures, we interviewed Linda Salerno-LaBarge. Linda works in the Career Development Center here on the WPI campus. When asked about the literature and theory surrounding major and ultimately career choice, Linda explained the method that she uses to help students make better decisions. She mostly uses the Strong-Campbell Interest Inventory (SCII). As the name implies, this indicator takes a person's interests into account. The SCII compares a person's interests with the interests of people happily employed in a wide variety of occupations. It is used chiefly as an aid in making career decisions.

Linda is also beginning to get information about the use of the MBTI in selecting a career. Unfortunately, however, she was unable to point us towards any valuable references that would further our research at this time. There is an Atlas of MBTI types in the library, however it does not distinguish between multiple types of engineering. That would severely hamper our efforts considering the nature of the majors at WPI.

A previous study done here at WPI showed the GCSI to have some significance in career choice. This study looked at the majors of electrical engineering, computer science, and mechanical engineering. A disproportionate number of Implementors were found to be electrical engineering majors. A large cluster of Integrators was found to be computer science majors and a large cluster of Problem Assessors was found to be majoring in the mechanical engineering department (Shablin, 1985 and Hohlmaier & Stefanov, 1987).

Table A: 1985 Distribution of Types among the WPI Junior Class (Shablin, 1985)

Major	Integrator	Problem Assessor	Problem Solver	Implementor	N
Electrical Engineering	25%	20%	20%	35%	28
Computer Science	34.5%	24.1%	24.1%	17.2%	31
Chemical Engineering	14.3%	35.7%	14.3%	35.7%	17
Mechanical Engineering	23.0%	42.3%	11.5%	23.0%	25

By 1990, however, these patterns had already started to change (Francis and Pietras, 1990).

Table B: 1990 Distribution of Types

	Integrator	Problem Assessor	Problem Solver	Implementer	N
Electrical Engineering	27.8	22.2	22.2	27.8	18
Computer Science	21.4	21.4	37.5	21.4	14
Chemical Engineering	33.3	25	8.3	33.3	12
Mechanical Engineering	28.6	33.3	19.0	19.0	21

Our own class was to be compared to these two previous studies which were based on limited sample groups.

Chapter 2: Project Theory

One major goal of this project, is to analyze the relationship between the KAI, GCSI, and MBTI. They are different at the level of measurement, but some of the imagery used to describe the types is really quite similar. Of particular interest would be a substantial correlation between the GCSI, especially the Remote Association measure and the KAI. There was a weak correlation found between the KAI and the Remote Associates Test in the Gerhardt and Cashman study conducted in 1980 (as reported in the KAI Manual based on a study of a single class of college students), but given that both are supposed to be measures of creativity, the correlation was surprisingly small. This could be explained by the different aspects or kinds of creativity each is supposed to measure. Based on the KAI manual, a correlation with the KAI should also be found between the sensing and intuitive and judging vs. perceptive dimensions of the MBTI, but that replication would not add much of psychometric interest as that ground has already been covered (A correlation of about 0.62 has been reported in previous studies listed in the manual.) What would be of interest is a correlation between the S-N dimension of the MBTI and Remote Association as that relationship has rarely been examined. If strong, it would create a proxy variable of considerable value for Mednick's Remote Associates Test which is hard to use. It takes the form of a word game (with troublesome culture biases) that must be administered in person. The KAI and MBTI can be self- administered and are used in cross-cultural comparative studies

It is important to note that while the KAI and MBTI are designed to measure preference, the GCSI is supposed to measure a person's facility with cognitive ability (on two complementary dimensions). Kirton's KAI does not construe creativity as a

personality trait, but rather the result of several specific traits. He does, however, call the result a preference indicator and measure of cognitive style. This is the basis for our theory that there will be a correlation between the GCSI and KAI. A person's natural ability at making connections, as measured by the remote association dimension of the GCSI, should have some effect on the preference for originality reflected by the KAI and intuition as measured by the MBTI. Therefore a stronger correlation than was shown through previous study of the KAI and the Remote Associator's measure is expected. There is, however, a potential problem. Remote Associators, especially Problem Solvers, are likely to prefer focused problems and structured task environments. Hence, the stress that Kirton places on Sufficiency of Originality and Efficiency, even Rule Conformity, could have the effect of making this cognitive type seem like Adaptors. Fluency is one aspect of the remote association process, but the conscious process is basically one of convergence after a relatively subconscious process of discarding alternatives rapidly considered until one fits the situation well. Thus the sub-scales of the KAI must be considered separately, since the search for a proxy may involve pulling them together in a manner quite different from that their author envisioned. Remote Associators should score high on efficiency and originality.

The KAI is not expected to produce any correlation with differentiation ability on theoretical grounds, but this possibility will be examined from the standpoint of empirical completeness.

The other major goal of this project was to look at major changing from a cognitive point of view. Change is a part of everyday life. A day does not pass in which no change occurs. Our theory is that the major changing pattern of a specific individual

may be indicative of his or her openness to change. It is not the only thing that can tell us that, however, since some people find a major that they are happy with right from the beginning. How people find a goof "fit" for themselves is not part of the current study's goal. Our concern is the likelihood of change by type, which we think is indicative of the degree of discomfort or stress necessary to provoke official action to make a change. Adaptors we consider likely to endure more before they will act, than Innovators.

The KAI was a large part of our theory on this section. Since the KAI based theory could not be tested using our major-changing sample, some of our theories will not be tested. We will still be comparing this data to the other cognitive style measures in hopes of finding some explanation of what drives people to be more or less comfortable with change.

There was also some hope that a suitable proxy measure would be found. Comparisons were be made using the J/P dimension of the MBTI. However, a 0.6 correlation (36% of variance explained), would not suffice to make J-P results a KAI proxy. Ideally a correlation of 0.8 (64% of variance explained), or higher, would be necessary. This is because currently, this is the dimension with the highest correlation with the MBTI. Another proxy, however, would have allowed us to examine the theory with much more accuracy. Hence, we attempted to create one.

Chapter 3: Project Methods

I.   The Original Sampling Plan

This study was designed to examine perceptions of technical fields and reactions

to them resulting in changes in plan and intended outcome of one's college education. In

its original form, the study focused on individual tolerance of changing one's major based

on perceptions of how stable the working environment of the different intended majors

were and one's cognitive style as measured by the KAI. The study focused on and

centered around the 545 to 600 students in the learning style database of the Class of

2001 at Worcester Polytechnic Institute. Some 150 of these students were to be

administered the KAI and a brief questionaire designed to augment the official records

regarding their pattern of major choice and the rationale behind them.

<u>The Sample</u>

A stratified sample by major, consisting of 300 students, was selected to represent

the class and was contacted by mail. The goal was to have a 50% response rate resulting

in a group of about 150 students who would have taken all three measures including the

KAI and the major choice survey. Transfer students were excluded from the MBTI-GCSI

pool before the students in the KAI sample were chosen. The Class of 2001 data set

included a few transfer students, but they were really joining the Class of 2000. The

transfers into 2001 would have taken part in the New Student Orientation (NSO) of 2002,

and that study did not include any transfer students. This really simplified the study

because the goal was therefore to look at major changing among students who had started

out at WPI and therefore had theoretically gone through the same experiences, so the complication of many starting points was avoided due to data limitations.

The part of the Class of 2001 that went to NSO together was divided by major. A select number of students from each category was then chosen by random selection. The names of students in each major were written on slips of paper and the desired number of slips was pulled out of a hat. The person choosing these slips was not a member of the project team. (This was done in order to prevent any unconscious or accidental biasing of the sample group due to personal knowledge of individuals or their stories by the project team.) The number of students chosen from each major depended on the percentage of students in the Class of 2001 that the specific major represented. It was to be "representative" on that key variable.

Original Plan for Administration of Materials and Data Capture

These 300 selected students were contacted via email and asked to participate in the study. Two specific dates and campus locations were given to the sampled students. Those who agreed to participate were given the KAI, the ILS, and our own survey regarding major change that dealt with how many changes had occurred other than those the Registrar was informed about and what it was currently, as well as a key question about the perceived level of turbulence in one's field or chosen major. The plan was to prepare a data set combining this perception data with the already collected MBTI type and GCSI information on the class. About 620 had completed the GCSI during Orientation and 500 the MBTI. Efforts at follow-up had brought the number of MBTI results closer to 550, though some were incomplete. Our theory was that certain types of

people would be attracted to each major based on its image of turbulence and change or stability and that the KAI would certainly reveal that difference, but so should the MBTI and the GCSI. A correlation was expected between KAI score and the task environment represented by individual majors or at least the individual's perception of the major and the range of occupations to which it might lead.

Sample Yield

As noted earlier, the turn out for this project's data capture meeting was not nearly as high as had been expected. Only about 30 of the 300 members of the Class of 2001 contacted showed up to take part in the study. A 10% yield was not nearly high enough to proceed with the project as it was originally planned. The sample size was too small and the question of how representative it was of the whole was also left in doubt. A look at the distribution of majors in the sample and original population was not reassuring. The respondents were heavily from the majors more likely to be taking classes in the building where the group was holding its data collection sessions.

Breakdown

The project was then divided into two smaller studies in an attempt to preserve most of the original goals for testing the theories involved. These two sections are linked by that common group of 30 students who responded to the original call to participate in the study. The first section encompasses the psychometric aspect of the original study. Results on the KAI are being compared with results on the MBTI and GCSI. The second part of the study is now more completely focused on career choice and the student perspective on major change. Some of the original theories will be studied through the

use of a proxy measure, which if verified, will deal with the same type of variables that the KAI as a whole deals with. The sub-scales would be lost for the career choice aspect of the study, but none of our theories about majors were tied directly to the sub-scales. It is the remote association to KAI theory that stresses the sub-scales.

II. Development of the Survey and Proxy Measure

<u>*The Survey*</u>

The student-produced survey was designed to explore the topic of major change. It was designed to assess and verify the official records on major changing, which were considered incomplete and probably out of date (as well as suspect). They were suspect for reasons having to do with the psychological stress involved in giving up on goals and dreams which would be harder for some students to face up to than others. Through use of the survey, individuals who had changed their major, but not officially submitted the forms notifying the school would be identified and encompassed in the study. The records themselves could also be assessed for accuracy.

The first four questions addressed these issues. The first question deals with the students' intended major upon acceptance to WPI (a matter of record). The second two questions are "yes /no" questions asking if the student has changed their major both officially and unofficially. The fourth question asks for the number of changes the student has really made and the pattern of these changes in terms of the majors he considered himself to have pursued, in order.

The survey was also designed to discover each individual's perception of what his or her major was like as a task environment. This was considered important, because each individual major has several different eventual career paths. In order to be able to compare the KAI to the major, which view the student held of the major and where it would take him or her had to be taken into account. The fifth question asked the student whether he considered his major to be in a turbulent and constantly changing or relatively stable field. An open-ended question was provided to give the student the opportunity to explain further if he or she wished to do so. If one student saw EE as turbulent and dynamic and another saw it as mature and stable, but both students were the same KAI type, one would predict opposite decisions about whether to change majors.

Two questions were added regarding academic progress at WPI. These were added in an attempt to get at the motivations behind major changes from the student's perspective. This would also serve as a verification process for the seemingly prevalent faculty and administrative belief that students are driven to change majors primarily due to academic difficulties related to their current major and course of study rather than in response to the discovery of new possibilities, changing interests, and growing knowledge about the careers to which they once aspired.

A section asking for additional comments was also added to the survey. This was to give the students the opportunity to express their own ideas. Basically it was hoped that students would express ideas or feelings about the WPI experience in general, the study specifically, the topic of career or major choice, or anything else they felt to be a pressing issue that they wished to express. A copy of the original survey can be found as an appendix to this report.

The Proxy Measure

The proxy measure was designed to look at the same concepts covered by the KAI. It was developed using Adaptation-Innovation theory. Descriptive paragraphs describing each extreme position were written. The group of WPI students who had already taken the KAI was asked to choose which paragraph they felt was more descriptive of them. The goal was to see if their responses to this polarized set of answers on a semantic differential were highly predictable using the KAI. We needed a 0.8 or 0.9 correlation to adopt the one item as a true proxy for the whole scale.

Arbitrary names were chosen to represent each extreme. The decision was made to make them of the same gender to avoid unconscious bias toward one extreme due to the gender of the representative name. The names Rich and John were chosen because they are relatively generic and thought not to provoke the image of any specific "type" of person. These names did not seem to us to be indicative of any specific race or religion likely to be a minority group at WPI. This was also done to prevent unconscious human bias.

Students were asked to answer on a scale of one to ten where the extreme score of one was indicative of an extreme Innovator. Likewise, the extreme score of ten was indicative of an extreme Adaptor. A scale of one to ten was chosen so that there was no exact middle choice. The scale did, however, allow for people who felt they were in the moderate range to express this.

The decision to have the Adaptor as a high score and the Innovator as a low score was not accidental. These people had taken the KAI. This was to offset the possibility

that any individual could have remembered a brief explanation of the theory behind the KAI given to them. Although the exact language of the KAI, and the terms *innovative* and *adaptive* were not used in the proxy measure, this change in order was used to effectively nullify any bias in results due to past exposure to the KAI.

These results are to be compared to the continuous KAI total scores. Another category of KAI results was also created both for analysis of data and verification of this proxy measure. KAI total scores were split into two categories where the score of 96 was designated as adaptive. The score of 97 therefore became the lowest in the innovative category.

If the proxy survey worked out in a validation analysis of this data, the original theory of KAI correlation with major choice would still be able to be tested in the career part of this study. If it could not be verified, however, this would demonstrate the importance of personal administration of the measure. The inability to administer the measures in person would then be considered to have undercut this aspect of the study. A copy of the proxy measure administered to the students is an appendix to this report.

III. The New Study: Comparative Psychometric Analysis of the KAI and other Cognitive Style Measures

The psychometric section of the original study was converted into this new project. There are some slight differences, however, in the measures being studied. The first major change is that the Index of Learning Styles has been dropped from the study, as it was not possible to gather enough data to study this measure. The MBTI, GCSI, and KAI are still under study.

<u>*Sample and Final Yield*</u>

The original KAI sample was supplemented with several different groups of people. This served to expand the social diversity of the final sample and make the findings more generally applicable. However, at first we just wanted more WPI students. The first addition was a group of about 60 students enrolled in three social science courses at WPI. They were added to the study regardless of class year. Ten to fifteen more people were added by including graduate students enrolled in a summer course at WPI. At this point the sample included people from many different stages of study at WPI, not just juniors.

The next group to be added to the sample was a group of professional Chemists and Biologists from the Gillette Corporation. This addition served to expand the social diversity of the sample group even more. The age range of the sample became much more diverse. The expanded sample now included approximately 45 people who were not undergraduate college students. About 15 more were Graduate students.

The last significant group added to the study was a group of about 25 mechanical engineering majors in their senior year at Boston University. While this was yet another group of college students, they added to the study because of their institution of learning, and the obvious opportunity to compare them to WPI ME's. These students have had a decidedly different educational experience from the students at WPI. The study now contained 178 participants, a reasonable sample. All who took the Remote Associate's Test were native American speakers of English. Had it not been for this restriction, the sample would have included about 250 respondents.

Administration of Measures and Data Collection

The administration of the KAI was different for each group of participants. There were, however, some general similarities. In some cases, the KAI was administered with the GCSI, the MBTI, or both. In all the other cases, the KAI was administered to someone likely to already have taken one or both of the other measures. Some of the WPI students (seniors, transfers, and others) added to the study were given two or three of the measures as part of their respective classes. Others in these classes already had their NSO (freshman) data scored and on file. For the juniors in the original study, the MBTI data was over two years old and for others it was months, or almost a year, old. The same was true for the Boston University group.

Methods of Analysis

The KAI scores were compared with the results of the other measures. This is explained in much greater detail in the analysis section to follow. This section is simply a brief description of the different comparisons studied.

The KAI forms provided to us by The Creative Problem Solving Group were scored and used in multiple ways. Scoring was done Kenneth Lauer of The Creative Problem Solving Group in Buffalo at a reduced price reserved for research partners. Corporate clients are charged $16.00 each, so the value of this partnership was great. Without it, the study would not have been possible. The first value of concern to us in testing our theories was the KAI total score. The second involves splitting the total score into two categories with a total score of 96 or less being considered adaptive and a score of 97 or higher being considered innovative. This allowed for a more general comparison of scores. Last, but not least, the individual sub-scales of the KAI (SO,E and RC) will be used to look for correlations with the other cognitive indicators.

The MBTI was studied both as an entire personality type (such as an ESTJ or an INFP) and as four separate dichotomous variables. The E/I, S/N, T/F, and J/P preference factors were studied in combination with the KAI scores as explained above in an attempt to replicate the reported levels of correlation. If the correlations prove to be higher when dichotomized than they were when treated as continuous measures this will simply be reported, unless the correlation approaches 0.8, the level at which it can be considered an acceptable proxy for the KAI. In that case the theory based on KAI differences can be tested after all. The GCSI was studied in much the same manner, looking both at the total cognitive style typology and the individual remote association and differentiation dimensions in connection with the KAI data.

IV. The Class of 2001 Major Changing Study

This section of the study deals entirely with the WPI Class of 2001. This is the group of people who came in as freshmen in the fall of 1997. This section looks mainly at major choice, and more specifically, changing of majors among the members of the class. Our goal was to find out if there were any specific cognitive types that tended to change more or less often and in more or less extreme ways each time they make a change than the others. The pattern of cognitive types within each specific major was also to be examined to look for similarities or patterns.

Sample and Final Yield

The sample that this part of the project was working with was the WPI class of 2001. These are the people who entered WPI with New Student Orientation (NSO) in the fall of 1997. Those who were transfer students and those who did not take the measures during orientation were removed from the data set. Major data for the first four semesters of study at WPI were then entered into the data set.

The original sample of students was contacted once again and asked to take part in our study. This time, however, they were sent only our survey. The rest of our data would have to be taken from records or already made data sets. One hundred eight people responded to our repeated requests to fill out the survey.

Method of Analysis

Several different things were examined in this part of the project. A person's major changing history was looked at in several ways from simply whether they had ever

changed their major or not, to the degree of difference between the majors, to the total numbers of changes. These data were compared against each dimension of the MBTI and the GCSI as well as against the complete cognitive types formed by the GCSI. There were, however, no specific correlations expected until it is evident whether the majors have attracted clusters of a given type. A small sample study of 120 WPI students in their Junior year, done in 1985 (Shablin), revealed an Integrator cluster in CS, an Assessor cluster in ME and an Implementor cluster in EE. A later study of the incoming freshman class of BBT majors revealed a Problem Solver cluster in that major. The location of Shablin's clusters of disproportionate representation of given GCSI types was replicated in 1987 by a study done with Brown University engineering and CS students(Stephanova and Hohlmeier).

There are also several other things that were examined. Most of these came from the survey involving major choice. Examples of these are whether the survey respondents found their majors to be stable or turbulent. Another was their satisfaction with WPI and their academic progress here. The sample for this is much smaller, 110 WPI undergraduate cases out of 488 for whom we had MBTI and major change data from the registrar and 528 for which we have GCSI data. By the end of the sophomore year, the point at which major changing counts were made, about 75 people for whom we had MBTI or GCSI data hat left WPI. They were dropped from the analysis of the Class of 2001.

The response rate for the survey was not high enough to claim that the data can be applied to our entire class. The distribution of majors was sufficiently diverse, however that it gave a general idea of the validity of the records. If the records were

found to be valid, it would further support our use of the entire Class of 2001 data set in our sample.

Unfortunately much of our theorizing about major change had to do with factors measured by the KAI. When the KAI had to be dropped from this part of the project, it seriously reduced the number of hypotheses we were set up to test. Unfortunately, unless a suitable proxy could be found, our original theories about major changing would have to give way to a strictly descriptive analysis.

Chapter 4: Project Findings

Comparing Discrete and Continuous Scores

In order to be able to effectively compare the KAI results to those of the MBTI and the GCSI, a decision had to be reached as to how to group the scores for analysis. It was decided that the KAI scores would be split into two groups and made a dichotomous variable. This was considered to be the most appropriate method of comparing the variables since the MBTI dimensions are definitely intended to be dichotomous measures based on Jungian theory. The GCSI dimensions are also treated as dichotomous, this seems to be a matter of tradition on usage for the differentiation dimension, but remote association is considered dichotomous on empirical grounds (Charanion, 1961)

All significance levels reported in this paper are Chi-square. The Gamma correlations reported are the absolute value of the actual correlation calculated using SPSS software. This is because of the nature of the data set used to generate them. If the numbering was entered into the computer backward (i.e., so that if the high value was called a 1, the next lower a 2, etc.), it generated a negative gamma correlation. The absolute value of the correlation is what is important, however, since if the numbers were just reversed, that is what would have been generated.

The Measures

The GCSI

Remote Association and Differentiation as Separate Dimensions

The possibility of a correlation between the Remote Association dimension of the GCSI and the KAI was the major psychometric question driving this project. The GCSI and KAI both derive from the creativity literature. Their authors claim that both are measures of creativity. They differ in conception, but should still show some correlation. This was especially expected to be true of the Sufficiency vs. Proliferation of Originality sub-scale of the KAI. Both the Remote Association Dimension of the KAI and this sub-scale mention fluency in description of what they measure. The KAI Manual confirmed that a modest correlation had been found between the Remote Associator's test and the KAI in a previous study of a small sample. We were looking to replicate that finding and hopefully increase the relationship by dichotomizing the remote association scores.

One specific difference between this study and the previous one, was that the GCSI includes a differentiation dimension as well as remote association. There was no theoretical correlation expected between the differentiation dimension and the KAI, but for the sake of empirical thoroughness, that dimension was also examined. The results have been compiled into the following chart.

Table 1 : Remote Association and Differentiation vs. KAI Scores (dichotomous)

GCSI	ADAPTOR # (%)	INNOVATOR # (%)	TOTAL #	AVERAGE KAI SCORE	SIGNIFICANCE AND GAMMA CORRELATION
Remote Association					
High	16 (42%)	22 (58%)	38	93.6	Not Significant
Low	33 (49%)	34 (51%)	67	100.2	Gamma = 0.143
Differentiation					
High	26 (47%)	29 (53%)	55	98.2	Not Significant
Low	23 (47%)	26 (53%)	49	97.2	Gamma = 0.007

It is clear from this data that no correlation was found between the overall KAI scores and the Remote Association and Differentiation results. In order to make our investigation more thorough, each dimension was also compared to the sub-scales of the KAI. Those results can be found in the following table.

Table 2 : Remote Association and Differentiation vs. KAI Sub-Scales

		Sufficiency vs.	Proliferation of Originality	Efficiency		Rule	Conformity	
		Fewer Original Ideas	More Original Ideas	More Efficient	Less Efficient	Prefers Rule Conformity	Dislikes Rule Conformity	Total
Remote	High	5 (13%)	33 (87%)	25 (66%)	13 (34%)	17 (45%)	21 (55%)	38
Association	Low	10 (15%)	57 (85%)	48 (72%)	19 (28%)	34 (51%)	33 (49%)	67
		Not Significant	Gamma = 0.073	Not Significant	Gamma = 0.136	Not Significant	Gamma = 0.120	
Differentiation	High	10 (18%)	45 (82%)	38 (69%)	17 (31%)	29 (53%)	26 (47%)	55
	Low	5 (10%)	44 (90%)	34 (69%	15 (31%)	22 (45%)	27 (55%)	49
		Not Significant	Gamma = -0.323	Not Significant	Gamma = 0.007	Not Significant	Gamma = 0.156	

These findings also indicate that there are no significant correlations between the two variables making up the GCSI and the sub-scales of the KAI.

The Cognitive Types vs. the KAI

The next step was to compare the complete Gordon's Cognitive Typology with the KAI. This was to ensure that there was no correlation when the two dimensions were looked at simultaneously. The results of this inquiry, including the KAI total score presented in dichotomous form, the average score for each GCSI type and each of the sub-scales are presented in the following chart. The "types" were ordered in a way that was theoretically significant. The Integrator was thought most likely to be an Innovator. The Implementor was thought most likely to be an Adaptor.

Table 3: Cognitive Types (GCSI) vs. the KAI and its Subscales

		Integrator	Problem Assessor	Problem Solver	Implementor	Total	Significance and Gamma Correlation
	Adaptor	8 (16%)	17 (35%)	9 (18%)	15 (31%)	49	Not Significant
	Innovator	9 (16%)	21 (38%)	11 (21%)	14 (25%)	55	Gamma = 0.061
	Average KAI Score	98.6	98.0	88.8	103.1		
Sub-scales							
Sufficiency vs.	Fewer Original Ideas	3 (20%)	7 (47%)	2 (13%)	3 (20%)	15	Not Significant
Proliferation of Originality	More Original Ideas	14 (16%)	31 (35%)	18 (20%)	26 (29%)	89	Gamma = 0.216
Efficiency	More Efficient	11 (15%)	27 (38%)	13 (18%)	21 (29%)	72	Not Significant
	Less Efficient	6 (19%)	11 (34%)	7 (22%)	8 (25%)	32	Gamma = 0.055
Rule Conformity	Prefer Rule Conformity	9 (18%)	20 (39%)	8 (16%)	14 (27%)	51	Not Significant
	Dislikes Rule Conformity	8 (15%)	18 (34%)	12 (23%)	15 (28%)	53	Gamma = 0.084

It is obvious from these results that there are no significant findings. It is clear that in this particular sample, the Implementors are markedly higher in average KAI score than the Problem Solvers though the actual performance of Problem Solvers in getting patents and contracts in industrial R&D settings is more impressive than that of the Implementors. The other two types are relatively close in score. With such a high level of possibility of error, however, this can not be explained as anything more than simple coincidence. It was actually surprising in the fact that Implementors are stereotypically thought of to be those people who get things in order and put plans into action when given directions. These are the attributes typically described to be adaptive. From the results of this study, the Implementors are made out to be much more innovative than the other cognitive styles.

In conclusion, our theory about a correlation between the KAI and the GCSI was incorrect. There was no correlation found between the KAI and either the Remote Association dimension of the GCSI or the entire GCSI. These findings suggest that the KAI and the GCSI are indicative of entirely different aspects of creativity.

Both measures claim to be measures of creativity. The GCSI measures a person's creative ability. It looks for how well a person is able to see subtle differences and tie together abstract concepts. The KAI on the other hand, does not look at ability. The KAI searches for the method a person uses when being creative. It is obvious from both theory and empirical evidence that the creators of these measures were not referring to the same meaning of the word *creativity*. That the categories associated with "adaptation" and

"implementation" do not overlap and produce a small correlation is unexpected, but not a theoretical anomaly.

The MBTI

Each dimension of the MBTI was compared separately with the KAI results. The total number of each "type" and its percentage of the whole were found and calculated. These results were then compiled into the following table.

Table 4: The Four Dimensions of the MBTI vs. the KAI (dichotomous)

MBTI	ADAPTOR # (%)	INNOVATOR # (%)	TOTAL #	AVERAGE KAI SCORE	SIGNIFICANCE AND GAMMA CORRELATION
E	15 (34%)	29 (66%)	44	105.9	Significance = 0.04
I	35 (55%)	29 (45%)	64	95.4	Gamma =0.40
S	24 (77%)	7 (23%)	31	87.5	Significance = 0.000
N	26 (34%)	51 (66%)	77	105.5	Gamma = 0.74
T	35 (50%)	35 (50%)	70	99.8	Not significant
F	15 (40%)	23 (60%)	38	101.9	Gamma = 0.211
J	37 (69%)	17 (31%)	54	90.5	Significance = 0.000
P	13 (24%)	41 (76%)	54	102.2	Gamma = 0.75

Three of the dimensions of the MBTI were significantly correlated with the KAI, with two of the relationships being quite strong. The Thinking/Feeling dimension was the exception with no significant correlation. The Extravert/Introvert dimension showed a moderate but significant correlation with the MBTI. The Extraverts were more likely to be innovative (66%) than adaptive (34%). Among the Introverts, however, the opposite was true with 55% of Introverts scoring in the adaptive range and only 45% scoring in the innovative range.

The Sensing/Intuitive and Judging/Perceiving dimensions, however, showed larger significant correlations of 0.74 and 0.75 respectively. When the Sensing/Intuitive dimension is studied more closely, one can see that in this sample, 77% of all Sensors were Adapters and only 23% fell into the Innovative category. Much the same was found when the Intuitives were examined. Among the Intuitives, 66% were Innovators whereas only 34% were Adaptors. The Judging/Perceiving dimension showed 69% of all Judging types to be Adaptive with only 31% falling into the Innovative range. Among Perceivers, the difference was even more marked with 76% scoring as Innovators and only 24% scoring as Adaptors.

In order to help explain some of these findings, we next turned to the sub-scales to look for possible explanation. It was hypothesized that perhaps one of the individual sub-scales would be responsible for the different levels of correlation described in the previous section. These results are presented in Table 5.

Table 5: The Four Dimensions of the MBTI vs. the KAI Sub-Scales

	Sufficiency vs.	Proliferation of Originality	Efficiency		Rule	Conformity
MBTI	Fewer Original Ideas	More Original Ideas	More Efficient	Less Efficient	Prefers Rule Conformity	Dislikes Rule Conformity
E	3 (7)	41 (93%)	28 (64%)	16 (36%)	20 (46%)	24 (54%)
I	16 (25%)	49 (75%)	44 (68%)	21 (32%)	36 (55%)	29 (45%)
	Not significant	Gamma = 0.09	Not significant	Gamma = 0.20	Significance = 0.02	Gamma = 0.63
S	10 (33%)	21 (67%)	28 (90%)	3 (10%)	24 (77%)	7 (23%)
N	9 (11%)	69 (89%)	44 (56%)	34 (44%)	32 (41%)	46 (59%)
	Significance =0.01	Gamma = 0.57	Significance = 0.001	Gamma = 0.76	Significance= 0.001	Gamma = 0.66
T	13 (18%)	58 (82%)	51 (72%)	20 (28%)	35 (49%)	36 (51%)
F	6 (16 %)	32 (84%)	21 (55%)	17 (45%)	21 (55%)	17 (45%)
	Not Significant	Gamma = 0.09	Not significant	Gamma = 0.35	Not significant	Gamma = 0.12
J	13 (24%)	42 (76%)	47 (86%)	8 (14%)	32 (58%)	23 (42%)
P	6 (11%)	48 (84%)	25 (46%)	29 (54%)	24 (44%)	30 (56%)
	Not Significant	Gamma = 0.43	Significance = 0.000	Gamma = 0.75	Not significant	Gamma = 0.27

The slight correlation found between the Extravert/Introvert dimension and the KAI was due for the most part to the Rule Conformity sub-scale of the KAI. Although the numbers were very close, the Extraverts were more likely to dislike rule conformity than the Introverts. This difference resulted in a correlation of 0.63.

The Sensing/Intuition dimension of the MBTI, was correlated with all three KAI sub-scales. The Efficiency sub-scale was by far the strongest of these correlations (0.76). This was due to 90% of all sensors scoring in the more efficient range. Among the Intuitives, 60% scored in the more efficient range. The next highest correlation was with the Rule Conformity sub-scale. Sensors tended to prefer Rule Conformity with 77%

scoring in this range. Intuitives on the other hand tended to resist Rule Conformity with 59% scoring in this range. The total correlation on this sub-scale was a 0.66. The last sub-scale was Sufficiency vs. Proliferation of Originality. This correlated respectably at a level of about 0.57.

Unlike the Sensing/Intuition dimension, the Judging/Perceiving dimension of the MBTI's relationship to the KAI was based on only one significant correlation with the sub-scales. This was with the Efficiency sub-scale. Those who preferred Judging, rather than Perceiving, were more likely to prefer to be efficient too, with 86% scoring in that range. Perceivers, on the other hand were more likely to be less efficient with 54% scoring in that range. The total correlation on this sub-scale was 0.75. So, the overall KAI correlation is based on S/N relating to Sufficiency vs. Proliferation of Originality, S?N and J/P relating to Efficiency, and E/I and R/N relating to Rule Conformity.

Due to the high levels of correlation found between the S/N and J/P dimensions of the MBTI and the KAI, it was decided that the combination of these two dimensions should also be examined for correlation. These numbers were tabulated and there was indeed a significant correlation found.

Table 6: Combination of S/N and J/P Dimensions vs. the KAI (dichotomous)

MBTI	ADAPTOR # (%)	INNOVATOR # (%)	TOTAL #	AVERAGE KAI SCORE	SIGNIFICANCE AND GAMMA CORRELATION
SJ	21 (91%)	2 (9%)	23	83.4	
					Significance = 0.000
NJ	16 (52%)	15 (48%)	31	98.6	
					Gamma = 0.73
SP	3 (38%)	5 (62%)	8	99.1	
NP	10 (22%)	36 (78%)	46	102.7	

If these numbers are examined, there is a clear trend established. These "types" were ordered in a fashion with those most likely to be Adaptors towards the top and the more innovative towards the bottom. This tendency is especially strong if one disregards the middle two categories and only focuses on the SJ and NP combinations. Those who were SJ were much more likely to be Adaptors (91%) than Innovators (9%). On the other hand, those who were NPs were more likely to be Innovators (78%) than Adaptors (22%). The difficulty of predicting how NJ and SP types will come out on the KAI, however, results in the combined factor correlation being no higher than those of the separate dimensions with the KAI

These combinations were then compared against the individual sub-scales.

Table 7: The Combination of the S/N Dimension of the MBTI and the KAI Sub-Scales

Sub-scale		SJ	NJ	SP	NP	Total #	Significance and Gamma Correlation
SO	Fewer original ideas	8 (42%)	5 (26%)	2 (11%)	4(21%)	19	Significance = 0.05
	More original ideas	15 (17%	27 (30%)	6 (7%)	42 (46%)	90	Gamma = 0.44
E	More Efficient	23 (32%)	24 (33%)	5 (7%)	20 (28%)	72	Significance = 0.000
	Less Efficient	0 (0%)	8 (22%)	3 (8%)	26 (70%)	37	Gamma = 0.73
RC	Prefers Rule Conformity	19 (34%)	13 (23%)	5 (9%)	19 (34%)	56	Significance = 0.005
	Dislikes Rule Conformity	4 (8%)	19 (36%)	3 (5%)	27 (51%)	53	Gamma = 0.376

Each KAI sub-scale showed some correlation with these MBTI combinations. The highest by far was the Efficiency sub-scale. In this sub scale, 100% of all those classified as a SJ scored in the more efficient category. Those who were classified as NP, however, were much more likely to be less efficient. In fact, 70% of all NPs scored in the Less Efficient category. The middle two categories were much more split with the NJs being slightly more inclined to efficiency and the SPs being slightly less inclined to efficiency.

The other sub-scales were much less correlated. The Sufficiency vs. Proliferation of Originality sub-scale correlated at a level of 0.44. The Rule Conformity sub-scale correlated at a level of 0.376. These are all significant correlations which are revealing

though they do not have the effect of boosting the correlation solidly into the range necessary to allow the MBTI to proxy for the KAI. These correlations are due to the S/N dimension with the typical Sensor preferring Rule Conformity and having fewer original ideas, whereas the typical Intuitive disliked Rule Conformity and had more original ideas.

In conclusion, the expectation that the KAI would correlate with the S/N and J/P sub-scales of the MBTI was accurate. In fact, the correlation we found was considerably higher than that found in previous studies. We also found a small but significant correlation between the E/I dimension, which was unexpected and is most definitely a matter for further research. The prior reports of a 0.62 correlation (explaining 36% of the variance) were understated probably due to the inappropriate use of the MBTI preference weightings to turn the four MBTI dimensions into continuous measures like the KAI. The dichotomized indicators correlated 0.76, (representing 58% of the variance explained). The boost of 22% of variance explained is very substantial bringing dimensions of the MBTI nearly to the point of being a proxy for the KAI. That would involve finding an additional variable that would sore the NJ's and SP's enough to add 6% to the total variance explained.

The significant correlations found between the individual sub-scales and the MBTI dimensions were not predicted based on theory, however, in retrospect, it does make perfect sense that these dimensions are correlated. The very essence of the descriptions of Sensor vs. Intuitive, is that a Sensor would prefer to be more efficient, whereas this would not be top priority for an Intuitive. Thus, although there were some Intuitives found in the more efficient range, the difference was much less marked than among the Sensors. This is much the same for the J/P dimension. A Judge would be

much more likely to prefer to be efficient than would a Perceiver. The theoretical basis of this is once again found in the very essence of the difference between Judging and Perception.

The Rule-Conformity sub-scale was the other sub-scale with multiple correlations. Among the Sensors and Intuitives, the Sensor was much more likely to prefer Rule Conformity than the Intuitive. This idea is theoretically consistent given that Sensors like to work within the realm of the known and tangible. Intuitives prefer to work a bit "off the wall", a preference which rules and groups sometimes stifle.

The Proxy Measure

About 50 WPI students had previously been administered the KAI when we broke

off efforts to contact people by inviting them to meetings for measure administration.

They were once again contacted vie e-mail and asked to take the proxy measure we had

designed to go out over e-mail. The proxy measure was worded like the following.

 Please indicate the extent to which you can identify with the two people described
below. For example if I am more strongly like Rich than John, I'd indicate a 9. If a bit
more like John, I'd indicate a 5

John   Rich

1   2   3   4   5   6   7   8   9   10

Rich is a person that is described by many people to be practical. Extremely
efficient, Rich tends to focus on the here and now. He loves to work with things that need
find tuning, and is very good at coming up with ways to do things better and better the
more he works with them. He thrives in relatively stable situations and when procedures
are well established and of proven worth. Rich prefers changes to be incremental and
small as he finds it difficult to break with tradition

John is a person that co workers describe as a radical. He prefers unstructured
work environments and is always coming up with new ideas. Some of there ideas are
seen by other people as being "Out in left field", but when a new or different ideas is
needed, John is your man. People often view John as impractical and unstructured. He is
a powerhouse of new ideas, but tends not to work out the details to put them into effect.
When things don't work out, he just moves on to another idea and doesn't look back. John
tends to focus on the long term effect of something rather than the here and now

Thirty-six people responded to the request. The results were compiled into the

following table.

Table 8: Proxy Results vs. the KAI

Proxy Designation	Adaptor # (%)	Innovator # (%)	Total
Rich	11 (73%)	4 (27%)	15
John	9 (43%)	12 (57%)	21

Significance = 0.07 Gamma = 0.57

As can be seen by this pattern of response, those people who responded saying they were like Rich, were much more likely to be Adaptors than Innovators. Those who responded saying they were like John, were more likely to be Innovators. This was the way that the proxy measure was designed. The numbers correlated at a level of 0.57. This was a strong correlation, but not strong enough to be a true proxy. The level of significance at a 0.07 was also not quite low enough to be considered reliable. As a result, the proxy measure was not sent out to the rest of the Class of 2001. Any results that would have been generated would have been suspect and unreliable.

A Possible Solution

Through the study of the results of this project, two things were found to have a correlation with the KAI. The first was the MBTI, with the focus falling mainly on the J/P dimension. The second was our proxy measure, although the level of significance and correlation was not nearly so high. The J/P dimension of the MBTI, although having a very strong correlation with the KAI, was not quite at a level at which it could be considered a true proxy. In order to be considered a true proxy, a significant correlation of 0.8 or 0.9 has to be reached.

In an attempt to find a combination of things that could be considered a proxy to the KAI, the proxy measure was once again investigated, but this time in combination with the J/P dimension of the MBTI. The results can be found below.

Table 9 : Combination of Proxy Results and J/P Dimension vs. the KAI

Combination	Adaptor # (%)	Innovator # (%)	Total
Rich-J	6 (86%)	1 (14%)	7
Rich-P	3 (75%)	1 (25%)	4
John- J	5 (71%)	2 (29%)	7
John –P	1 (10%)	9 (90%)	10

Significance = 0.007 Gamma = 0.796

As is easily seen even in cursory inspection of these numbers, a much more significant finding was found when the J/P dimension was added to the proxy. In fact, the level of significance was now well within the desired range. It is striking to have such a significant finding despite the small sample size. A much higher level of correlation was

also found. At a 0.796, this number is just barely high enough to be considered a true proxy.

The combination of the one item proposed proxy measure and the J/P dimension of the MBTI is a combined proxy indicator that is showing some promise. With further testing it could be turned into a true proxy for the KAI. All of the respondents in our small sample were students. Further testing on professionals would also be needed to make this claim.

Unfortunately, the proposed proxy measure was dropped from the Class of 2001 survey study before its value in combination with J-P was discovered. If further work is done using the proxy measure, and it is verified, it could very well be an interesting addition to future KAI and WPI Class studies alike.

The psychometric study has influenced the major changing study in several ways. The first is in theory. It was through the development of the KAI theory for the original psychometric section of the project, that much of the career change theory was developed. The lack of a KAI proxy jeopardized our ability to test those theories.

Through the results of the psychometric study, however, the MBTI findings approaching proxy level relationships with the overall KAI became more significant in our mind. The decision was made that with a 0.76 correlation, our KAI based theories could be partially tested using the MBTI (J/P) data as a proxy.

The first analysis performed was a validation of the Registrar's records. This was done by comparing the Registrar's records to the data provided by the respondents to our survey. The number correct, the number slightly wrong and the number with major mistakes were counted and tabulated. These data can be found in Table 10.

Table 10 : Verification of Major Data

Original major	Correct # (%)	Almost correct # (%)	Wrong # (%)	Total
Biochemistry	6 (74)	1 (13)	1 (13)	8
Biology	9 (90)	1 (10)	0 (0)	10
Biomedical Engineering	4 (100)	0 (0)	0 (0)	4
Biotechnology	11 (65)	5 (29)	1 (6)	17
Chemical Engineering	9 (100)	0 (0)	0 (0)	9
Chemistry	4 (100)	0 (0)	0 (0)	4
Civil Engineering	2 (67)	0 (0)	1 (33)	3
Computer Science	10 (77)	0 (0)	3 (23)	13
Electrical Engineering	7 (78)	2 (22)	0 (0)	9
Engineering Undecided	2 (50)	0 (0)	2 (50)	4
Humanities and Arts	1 (100)	0 (0)	0 (0)	1
Industrial Engineering	3 (100)	0 (0)	0 (0)	3
Manufacturing Engineering	0 (0)	0 (0)	1 (100)	1
Mathematical Science	1 (100)	0 (0)	0 (0)	1
Actuarial Science	0 (0)	1 (100)	0 (0)	1
Mechanical Engineering	13 (100)	0 (0)	0 (0)	13
Physics	4 (67)	0 (0)	2 (33)	6
Not Decided	0 (0)	0 (0)	1 (100)	1
Total	86 (80)	10 (9)	12 (11)	108

Out of the 108 respondents, 22 were incorrect. Of these 22 that were incorrect, ten were only slight mistakes. This would be, for example, a Biotechnology major being registered as a Biology major. Only twelve were major mistakes. This means that the data set is about 89% accurate, and good enough for our purposes.

The next group of things slated for analysis dealt specifically with changing majors. The first analysis was simply whether an individual had changed his or her major or not by D term of sophomore year. This was compared with each of the four dimensions of the MBTI, the two dimensions of the GCSI, and the composite results of the GCSI. This data can be found in Table 11.

Table 11: At Least One Major Change vs. the Cognitive Measures

Type	Registered major change # (%)	No registered major change # (%)	Total #	Significance (Chi Square) and Gamma correlation
Extraverts	60 (31)	134 (69)	194	Significance = 0.023
Introverts	64 (22)	230 (78)	294	Gamma = 0.23
Sensing	54 (24)	170 (76)	224	Not significant
Intuitive	70 (26)	194 (74)	264	Gamma = 0.06
Thinking	84 (26)	242 (74)	326	Not significant
Feeling	40 (25)	122 (75)	162	Gamma = 0.03
Judging	59 (26)	170 (74)	229	Not significant
Perceiving	65 (25)	194 (75)	259	Gamma = 0.02
Remote	24 (19)	104 (81)	128	Significance = 0.037
Local	112 (28)	288 (72)	400	Gamma = 0.26
Differentiated	69 (23)	236 (77)	305	Not significant
Non-Differentiated	74 (28)	194 (72)	268	Gamma = 0.13
Integrators	8 (11)	66 (89)	74	
Assessors	59 (28)	154 (72)	213	Significance = 0.019
Problem Solver	16 (30)	38 (70)	54	Gamma = 0.16
Implementors	51 (28)	133 (72)	184	

A small but significant correlation of 0.23 was noted between the Extravert/Introvert dimension of the MBTI and whether or not a person changed his or her major . Another small but significant correlation of 0.26 was found between the Remote Association dimension of the GCSI and whether the student changed his or her

major. Although the correlation between the cognitive types and major changing was very low, it was noticed that Integrators were significantly less likely to change their major than the other three types.

The next question raised was whether these results varied by the number of times a person changed majors. The class was once again examined with each individual being classified as one of three types. The first type was those who had not changed their major at all. The second was those who had changed, but only once. The last was those who have changed multiple times ranging from two to eight, but typically two or three times.

Table 12: Number of Major Changes vs. the Cognitive Measures

Type	Never changed major # (%)	Changed major once # (%)	Changed major more than once # (%)	Total #	Significance (Chi Square) and Gamma correlation
Extraverts	134 (69)	49 (25)	11 (6)	194	Significance =0.02
Introverts	230 (78)	59 (20)	5 (2)	294	Gamma = 0.24
Sensing	170 (76)	43 (19)	11 (5)	224	Significance =0.08
Intuitive	194 (73)	65 (25)	5 (2)	264	Gamma = 0.04
Thinking	242 (74)	75 (23)	9 (3)	326	Not significant
Feeling	122 (75)	33 (21)	7 (4)	162	Gamma = 0.02
Judging	170 (74)	51 (22)	8 (4)	229	Not significant
Perceiving	194 (75)	57 (22)	8 (3)	259	Gamma = 0.02
Remote	104 (81)	16 (13)	8 (6)	128	Significance =0.005
Local	288 (72)	100 (25)	12 (3)	400	Gamma = 0.21
Differentiated	236 (77)	60 (20)	9 (3)	305	Not significant
Non-Differentiated	194 (72)	63 (24)	11 (4)	268	Gamma = 0.13
Integrators	66 (89)	5 (7)	3 (4)	74	
Assessors	154 (72)	53 (25)	6 (3)	213	Significance =0.010
Problem Solvers	38 (70)	11 (20)	5 (10)	54	Gamma = 0.15
Implementors	133 (72)	45 (25)	6 (3)	184	

Correlations were found with the same dimensions as in the previous analysis. The level of correlation, however, was slightly lower. The most remarkable observation from this analysis once again involved the Integrators. Again, the Integrators were much more likely to stay in their original majors. This difference was especially marked when looking at the group that only changed their major once. Only 7% of Integrators had changed their major once, whereas the other three types had percentages above 20 in that group.

We theorized that the degree of the change that a person was willing to make would differ by cognitive type. These hypotheses were based primarily on the KAI. Our logic focused on the fact that Adaptors prefer much smaller, incremental changes and Innovators are more comfortable with large changes. When the KAI was dropped from this sample, this question became much less crucial to the study. Based on the data thus far, the J/P or S/N finding needed to make that case has not appeared. Still, it was thought to be worthwhile to compare the degree of major changing that a person has made to the other cognitive style results that were available. This data can be found in Table 13.

For this analysis the degree of change between any two majors were synthesized into a table in which the degree of change could vary from 1-5 depending on whether one made a modest shift from Chemistry to Chemical Engineering or a moderate change from Chemical Engineering to Mechanical Engineering or a major jump right out of the engineering profession to be a Manager or Social Scientist.

Despite the empirical attractiveness of having committed the codes to a statement of the relative size of any possible major change in advance of examining the data, the

coder rebelled at the use of the table. In theory a jump from Biomedical Engineering to

Mechanical Engineering seemed large. However, linkages between the departments

existed in the form of specializations that actually overlapped quite a bit. Some large

jumps became specialization within a large field, or a logical outgrowth of a double

major. In the end, ad hoc case by case judgements were made in assigning numbers to the

degree of change in aspiration represented b each major change by a member of the Class

of 2001.

Table 13: Degree of Major Change vs. the Measures

Type	None # (%)	Decided # (%)	Slight # (%)	Major # (%)	Total #	Significance (Chi Square) and Gamma correlation
Extraverts	134 (69)	7 (4)	40 (20)	13 (7)	194	Significance =0.08
Introverts	230 (78)	10 (4)	45 (15)	9 (3)	294	Gamma = 0.23
Sensing	170 (76)	8 (4)	39 (17)	7 (3)	224	Not significant
Intuitive	194 (74)	9 (3)	46 (17)	15 (6)	264	Gamma = 0.07
Thinking	242 (74)	12 (4)	58 (18)	14 (4)	326	Not significant
Feeling	122 (75)	5 (3)	27 (17)	8 (5)	162	Gamma = 0.020
Judging	170 (74)	6 (3)	41 (18)	12 (5)	229	Not significant
Perceiving	194 (75)	11 (4)	44 (17)	10 (4)	259	Gamma = 0.03
Remote Associators	104 (81)	1 (1)	15 (12)	8 (6)	128	Significance =0.06
Local Associator	288 (72)	15 (4)	77 (19)	20 (5)	400	Gamma = 0.21
Differentiated	236 (77)	9 (3)	47 (16)	13 (4)	305	Not significant
Non-Differentiated	194 (72)	8 (3)	51 (19)	15 (6)	268	Gamma = 0.13
Integrators	66 (89)	0 (0)	5 (7)	3 (4)	74	
Assessors	154 (72)	9 (4)	40 (19)	10 (5)	213	Not significant
Problem Solver	38 (70)	1 (2)	10 (19)	5 (9)	54	Gamma = 0.15
Implementors	133 (72)	6 (3)	35 (19)	10 (6)	184	

There were no correlations that were found to be significant at the 0.05 level.

There were two that were relatively close with a significance of 0.06 and a 0.08

respectively. These were the Remote Association dimension of the GCSI and the E/I

dimension of the MBTI. Again it is not the J/P or S/N dimensions, our proxy measure, that are showing promise as predictors. When the cognitive types as measured by the GCSI were examined, although not statistically significant, none of the Integrators were undecided upon entering WPI. Some had changed their major, but those who had were much more likely to make slight rather than major changes. At all points, however, they were decided as to a major and unlikely to change their minds. Other analysts of their experience report that they are unusually likely to drop out, but not to change their minds in terms of major first, even as a means of saving themselves from academic difficulty.

There were two other things that were examined using the survey. One was whether people perceived their individual majors to be in stable or turbulent fields. This analysis had to be performed on the smaller data set of 110 respondents for which we had survey information. However, not all had completed all the cognitive measures.

Table 14: Student Assessed Stability vs. the Cognitive Measures

Type	Stable # (%)	Turbulent #(%)	Total #	Significance (Chi Square) & Gamma correlation
Remote Associator	15 (58)	11 (42)	26	Not Significant
Local Associator	27 (44)	35 (56)	62	Gamma = 0.28
Differentiated	25 (50)	25 (50)	50	Not Significant
Non-Differentiated	16 (39)	25 (61)	41	Gamma = 0.22
Integrators	9 (56)	7 (44)	16	
Problem Assessors	16 (49)	17 (51)	33	Not significant
Problem Solvers	6 (60)	4 (40)	10	Gamma = 0.2
Implementors	10 (36)	18 (64)	28	
Extraverts	17 (53)	15 (47)	32	Not significant
Introverts	21 (43)	28 (57)	49	Gamma = 0.2
Sensing	19 (56)	15 (44)	34	Not significant
Intuitive	19 (40)	28 (60)	47	Gamma = 0.30
Thinking	26 (51)	25 (49)	51	Not significant
Feeling	12 (40)	18 (60)	30	Gamma = 0.22
Judging	19 (59)	13 (41)	32	Significance= 0.07
Perceiving	19 (39)	30 (61)	49	Gamma = 0.40

There were no significant correlations found between this question and the MBTI or GCSI dimensions. There was one finding that was very close to being statistically significant and since this question was raised based on KAI theory and nearly correlated with the KAI proxy it is worth noting. This failure to achieve significance may have been simply due to small sample size. The J/P dimension of the MBTI was associated with 60%/40% differences and found to have a correlation of 0.40 with the students' responses regarding the stability of their major. Those who were Judging types were much more likely to be in majors that they viewed as stable. Perceiving types were much

more likely to be in majors that they viewed as turbulent. This finding was consistent with our Adaptor /Innovator prediction.

Let's review the logic of why this finding is very interesting. When you look at the results of the psychometric study, the J/P dimension was found to have a correlation of 0.75 with the KAI. This means that we can use it to roughly examine our original KAI theories, but it is not a high enough correlation to be a true proxy. It had been expected that Adaptors would migrate towards relatively stable fields. The Innovators on the other hand, were more likely to prefer turbulence. Our findings fell along those lines. The Judging types had correlated previously with the Adaptors. Perceivers were found previously to be more likely to be Innovators. As was predicted, the Judging types were indeed more likely to prefer stable majors, whereas the perceivers migrated towards those majors they considered to be turbulent.

The question of stability vs. turbulence was also compared with the respondent's major. This served as an attempt determine if there was consensus among people of the same major regarding its level stability. These results can be found in Table 15.

At one point an attempt to rank order the fields in theoretical terms to try to predict which ones would be considered most turbulent by those majoring in them was made. There seemed, however, to be no defensible way to do so. Hence, significance testing, rather than correlation was to determine, as a first step, whether the fields were perceived differently by those majoring in them. The resulting Chi-square of .01 demonstrated this to be true. However, only a dew wit enough agreement among the coders fields could be ranked based on reputation to see if the participant would concur.

Even then, there was a great surprise in EE, which the students majoring in it saw as more turbulent than we, as outsiders, did. Giving this up as a lost cause, the analysts noted that it would probably result in a moderate correlation if the fields were ranked by "insider" perception of stability, but that this would not prove anything about the accuracy of their perceptions given the difference in the kinds of students attracted to each field.

We would have to have had everyone rank all the major fields to achieve a consensus against which to see whether some perceived to be relatively stable attracted Adaptors whether or not they perceived the field to be stable from their vantage poing. This matter will have to be left to future study. For now, it is enough to say that the fields differ significantly in the degree to which those majoring in them report them to be stable and the fields would differ sharply is rank ordered in these terms

Table 15: Student Assessed Stability of Career Choice

Final major	Stable # (%)	Turbulent # (%)	Total #	Significance (Chi Square) and Gamma correlation
Biochemistry	2 (40)	3 (60)	5	
Biology	3 (33)	6 (67)	9	
Biomedical Engineering	0 (0)	2 (100)	2	
Biotechnology	3 (23)	10 (77)	13	
Chemical Engineering	7 (78)	2 (22)	9	
Chemistry	2 (50)	2 (50)	4	
Civil Engineering	3 (75)	1 (25)	4	
Computer Science	2 (18)	9 (82)	11	
Electrical Engineering	1 (12)	7 (88)	8	
Environmental Science	1 (100)	0 (0)	1	Significance = 0.01
Humanities and Arts	0 (0)	2 (100)	2	
Industrial Engineering	0 (0)	1 (100)	1	
Management Engineering	2 (100)	0 (0)	2	
Management Information Systems	1 (50)	1 (50)	2	
Mathematical Science	1 (100)	0 (0)	1	
Actuarial Science	2 (100)	0 (0)	2	
Mechanical Engineering	10 (77)	3 (23)	13	
Physics	3 (75)	1 (25)	4	

The other issue examined with the survey was whether the students were satisfied with their academic progress here at WPI and with the amount of help that WPI offers. In general, the 110 people responding to our survey were satisfied with the amount of help that WPI provides for its students. There were always extremes. For instance, those students who thought they were doing horribly (some with pretty good averages) were more likely to think WPI should provide more help for them.

Many respondents thought that they could be doing better at WPI. There was a general consensus that one's grades could be higher if more effort were expended, so WPI was not to blame. The average respondent seemed to take responsibility for his or her grades rather than looking to WPI for greater assistance. It is important to note that this is self-image data instead of an actual grade analysis. There are several people who have very good grades who think they can and should be doing better. On the other hand, there are those with average grades who think they are doing very well.

In order to compare our class data to that of previous junior classes, and thus to replicate or refute previous findings(Shablin, Stephanov et.al.), we isolated from the complete Class of 2001 data set those members of our class who were majoring in electrical engineering, mechanical engineering, or computer science. We then ran the cross-tabulation of their major, MBTI, and cognitive style results. The following table contains those data, though the prior studies included only GCSI data.

Table 16: Three Majors vs. the Cognitive Measures

	Computer Science	Electrical Engineering	Mechanical Engineering
E	29 (28)	31(40)	37(43)
I	74 (72)	47 (60)	50 (57)
S	31 (30)	44(56)	46(53)
N	72(69)	34(44)	41(47)
T	65(63)	61(78)	60(69)
F	38 (37)	17 (22)	27 (31)
J	38 (37)	43(55)	42(48)
P	65 (63)	35 (45)	45 (52)
Remote Associator	28 (26)	23(26)	20 (22)
Local Associator	78 (74)	66(74)	71 (78)
Differentiator	54(49)	65(61)	56 (55)
Non- Differentiator	57 (51)	41 (39)	45 (45)
Integrator	26 (25)	24 (27)	25 (27)
Problem Assessor	27 (26)	34 (39)	26 (29)
Problem Solver	28 (26)	10 (11)	12 (13)
Implementor	25 (23)	20 (23)	28 (31)

Shablin's 1985 study performed at WPI on the basis of a sample of 120 Juniors, a cluster of Integrators was found in the computer science major. A cluster of Problem Assessors was found in the mechanical engineering major and a cluster of Implementors was found in the electrical engineering major. (See Table A in the literature review). Stephanov and Hohlmeier replicated her finding with a sample of 30 students from Brown University. In 1990, however, Francis and Pietras failed to replicate it with a sample of 106 WPI respondents (See Table B in the literature review).

In 1989, Bais and Rahyet had refuted the idea that Junior year student clusters were reflections of faculty clusters with a sample of 30 faculty in the same fields. Their

study revealed that the faculty cluster in CS and EE were of Problem Assessors and in ME Problem Solvers were the dominant group. Of course, when the faculty had entered these fields of specialization, they were in a different stage of development than that which their students were responding to.

In this study, early Junior year major data in those fields revealed no real clusters among the computer science majors and mechanical engineering also strikingly over-represented types. In electrical engineering, Problem Assessors accounted for almost 40% of the sample and this would be considered a cluster. That type of student, however, was concentrated in ME in the 1985-1987 period if prior data are to be believed. Clearly there are no stable student clusters by type over time. As the image of the fields change, they will attract different types of students.

Chapter 5: Conclusions and Future Studies.

In conclusion, this study truly was a study of change. Not only did we study change, but our project itself had to undergo much change when the original plan to gather data had to be abandoned. There is much more to be studied within these topic areas. This study has just barely scratched the surface on major changing, but some psychometric issues were settled. The KAI was compared to both the GCSI and the MBTI. No correlation was found between the GCSI dimension and the KAI as had been hoped. There are pressing practical reasons why a proxy for remote association must be devised.

There were correlations found between the S/N and J/P dimensions of the MBTI and the KAI. These had been expected, however our correlations were considerably stronger than had been previously reported. The explanation is probably that we were more careful to honor the fact that MBTI variables should be construed as dichotomous.

The combination of the J/P dimension of the MBTI and our proxy measure is one of our most promising findings. With a correlation of 0.8 it shows promise as a possible future proxy for the KAI. Both of these components alone were not quite able to reach the point of correlation necessary of a true proxy. Together, however, they reach that point and even with a small sample remain significant.

In the major choice study, many things were explored, but not many substantial explanations were found. The major observation was that Integrators were much less likely to change their major than any of the other types. In fact, Integrators were more likely to leave WPI than change their major in an attempt to "save" their academic career.

It was also found that Introverts were also less likely to change their major than Extraverts.

In terms of future studies, it would be much easier to look at the relationships between the measures and a person's career choice if all of the data came from the same sample of people. This would have the effect of controlling out many random factors, which could influence the results. Our use of the J/P dimension of the MBTI as a weak proxy, however, did not provide much encouragement as to there being a correlation between the number or degree of major changes and the KAI.

Looking at the perception of the different fields as the students experience them and consider alternatives is one of the most promising future research ideas that came out of the major choice study. A full study of the "insider" perception of each major compared to those perceptions that other people have of that field would be very interesting. Even from our modest sample, there was evidence that what we as "outsiders" had expected, was in actuality very different from what the students experienced.

Another possible avenue of study would be to look at the connection between the E/I dimension of the MBTI and Integrators. Both of these were much less likely than anyone else to change their majors. An exploration of the similarities between these two groups of people would be interesting. Especially of interest would be the characteristics of those people who happen to be both Intergrators and Introverts.

Some pages are incorrectly numbered

IQP/MQP SCANNING PROJECT

Appendix 1: Original Proposal

Introduction

This IQP is focused on perceptions of and reactions to change. Change is something that happens in our every day life. A day does not pass in which change does not occur in at least some small way. There are some people who are frightened by the idea of change and yet others who welcome it. Today's careers are also always changing. Some change in big jumps and others change in small increments. The goal of this IQP is to find out what types of people welcome change, and which do not. It is also to find out what types of people are comfortable with large changes and which prefer a relatively small amount of change.

This project will be a psychometric study of the MBTI, GCT, KAI, and ILS. A study of this design including these four indicators has never been done before. The MBTI and the GCT both have areas that possibly indicate a person's creativity level. The KAI, however, is believed to be the best available indicator of creativity. In order to use the KAI on any future classes, it would be required that someone be trained to administer and score the test. This project proposes to test the KAI on a sample of students. This will help indicate whether the KAI is truly worth the additional cost, or if the other two measures will suffice. It is also believed that the ILS would be a worthy addition to this project. The ILS is free over the Internet. It would cost nothing more than copying costs for use. There is a section of the ILS not covered in the other indicators. This could add insight into students' preferred style of lecturing.

One of the major goals of this project is to gain an understanding about people's reactions to turbulence. A person's career choice is most likely closely tied to the amount of turbulence in that field. The KAI results would also provide an insight into this area. This turbulence will also be studied through the Class of 2001 part of this project. The project group proposes to find out what people's perceptions of their majors are. This could have a large impact on the results of the KAI indicator. Changing majors could also be an indicator of how acceptable large changes are to the student. Through the attrition data of the Class of 2001, the project group will attempt to determine if those students who have left WPI left solely because of academic difficulty, or if in effect it was just an extreme of changing ones major.

Explanation and Procedure

The first part of this IQP will focus on how to describe people in ways affecting career choice. The project group will examine a database of MBTI and GCT scores as well as the scores from two additional indicators to see if there are any correlations to be found. WPI has a database of the MBTI and GCT scores for both the class of 2001 and the class of 2002. A test group of approximately 150- 200 students would be chosen from this database. This group would be comprised of approximately 50 students from 3 different groups of majors. The first group would be comprised of Engineering Majors. The second group would contain the sciences of Physics, Biology, Chemistry, Humanities and Math. This group is interesting for two reasons. The first is that this group is comprised of majors that are traditionally stable fields. The second, however, is that at WPI, these majors are not the tradition. The people undertaking these majors are

actually going against the norm. This could effect their KAI results. The last group would be comprised of management majors in general.

Each participant would then be given the KAI, the ILS (Index of Learning Styles), and a questionnaire made up by the project group. The results of these indicators would then be added to the database. The project group would then examine the entire database to see if there were correlations between the KAI results and the two indicators previously administered.

The MBTI is the Myers- Briggs Type Indicator. It has already been administered to the classes of 2001 and 2002. This indicator uses four factors to classify people. People are classified either as introverts or extroverts, sensors or intuitives, thinkers or feelers, and judges or perceivers. The GCT is the Gordon's Cognitive Typology. This uses the concepts of Differentiation and Remote association to determine whether people are Remote or local associators and whether they have a high level of differentiation or not. This typology classifies people into four groups. They are the integrator, problem assessor, problem solver, and implementer.

The KAI is a measure of creativity. It looks at what working conditions a person is most comfortable in and also how they best operate. The KAI classifies people as either Adaptors or Innovators. This project is going to use the KAI as an indicator of a person's openness to change. This will also provide new feedback to the school as to what kind of person does the best here. We, the authors, are looking to see if students from similar majors or similar learning styles score similarly on the KAI.

The ILS is the Index of Learning Styles. It is available free on the Internet. There is another dimension to the ILS than the Myers Briggs has. The ILS also determines whether a person is a global or a sequential thinker. We are using this indicator to see if certain majors contain more of one thinking type than the other. We also want to see if there is a correlation between memory, as measured by the ILS through the sequential and global learning section, and openness to change as measured by the KAI.

The second part of this IQP deals specifically with the class of 2001. The authors, both being of the class of 2001, have seen many of their friends either change majors or leave the school permanently. This is where the surveys will come into play. With them, it is hoped that we can determine if people with similar learning styles and results on the KAI, change majors at a similar rate or more often than students with significantly different cognitive styles. Our theory is that there is a correlation between major choice, a person's perception of their major, the number of times a person has changed their major, and the KAI results.

The attrition data for the class would also be an interesting addition to this project. If possible, we propose to contact those people who have left WPI, as fellow classmates and find out what has happened since they left WPI. Some possible questions to ask would be whether they had changed majors to something not offered at WPI or if they are in the same major. A large number of people leave WPI having academic difficulty. For these students, it would be interesting to find out if the student started getting bad grades

because they were not happy with their major. If so, finding out whether they started getting poor grades before or after they realized that their major was not for them would be a definite goal. For those people who respond, we propose to look into the database and find out what learning type they are. It would then be possible to look at the KAI results from a person with the same or similar learning styles and see if there is any significant correlation there.

Timeline

This project begins with C term 1999 and continues through B term 1999. Both sections of this project will be worked on concurrently. The findings will also be compiled into one report at the end of the project.

The first term is one of planning. During this term, the survey will be developed, the details worked out on usage and cost of the KAI, and test dates and the such will also be worked out. The class of 2001 data will also have to be requested. We will have to obtain permission slips from the people we wish to include in this study.

D term 1999 will consist mainly of data collection. The KAI and ILS will have to be administered. We will then have to score the ILS and arrange for the KAI to be scored. These numbers will then have to be added into a database of existing scores. The answers to the survey will also have to be added. If approved, surveys to former students who have returned the permission slips will be mailed. During this term, we also wish to look at the records, with the names changed to protect people's privacy, to look for any trends in the attrition data.

A and B terms 1999 will be the data analysis stage of this project. It is during this time that the main part of the project will be written as well. Our projected completion date is the end of B term 1999.

Budget

A budget of approximately $550 is expected for this project. The project group will be responsible for generating the first $150 of this. We also have a donation of approximately 50 KAI from the Gillette Corporation. This means that we have to acquire approximately 100 – 150 more KAI. The Gillette Corporation was given a price of $8 for each KAI. We are attempting to negotiate a price in the $4 range. If this is not possible, we will acquire as many KAI indicators as possible for the money allotted us. The ILS is free of charge. A score sheet and directions for scoring the ILS are available free of charge on the Internet. There will be some copying costs, but those will be minimal. These would be for permission slips, both surveys, and the ILS. At this point there are no other foreseen costs.

Conclusions

In conclusion, this project has a large possible impact on society. There are many things that go into what type of a person a specific student is. These findings could also be extended beyond education into career choice and what kind of environment a person is most comfortable in. The goal of this IQP is to find out if

there are certain qualities that show up often together in a person's preferred learning style and work environment.

We, the project group, also want to look at our class, the class of 2001. These are people we are familiar with. This familiarity places us in a position to understand where they are coming from and perhaps give new insight into previous results based on this understanding. The goal is to find out what kind of people left WPI and what types of people remain. Of those who have stayed, have many changed their major, or for the most part is our class steadily working towards their original goal?

All of this has a major impact on what kind of future is ahead of us. Significant findings in the realm of career choice and openness to change could largely impact society's reaction to certain careers and education in general. It could also change the work environment that society traditionally places them in thereby increasing productivity and making society a more efficient place to work.

Appendix 3: The Survey

1. What was your intended major when you entered WPI?

2. Have you officially changed it at any point during your time here? __YES __NO

3. Have you unofficially shifted career plans and not told the school? __YES __NO

4. IF so, how many times have you changed your mind, and from to what? What was the list or pattern of majors you considered? (for example ME to CS to ME to EE to ME to BE to ME to CM to ME)

5. Do you feel the field of your choice is relatively settled (mature +stable technology)? Or is it constantly changing (a turbulent field in terms of technology)?

6. Are you satisfied with your Academic progress here at WPI?

7. If not, Is there more you feel WPI could be doing to help you with succeed academically given your situation? How much more? Please rate it on a scale of 1-6

Not much   somewhat   Alot

1   2   3   4   5   6

8. Any additional comments?

Appendix 4: Proxy Measure

Please indicate the extent to which you can identify with the two people described below. For example if I am more strongly like Rich than John, I'd indicate a 9. If a bit more like John, I'd indicate a 5

John   Rich

1   2   3   4   5   6   7   8   9   10

Rich is a person that is described by many people to be practical. Extremely efficient, Rich tends to focus on the here and now. He loves to work with things that need find tuning, and is very good at coming up with ways to do things better and better the more he works with them. He thrives in relatively stable situations and when procedures are well established and of proven worth. Rich prefers changes to be incremental and small as he finds it difficult to break with tradition

John is a person that co workers describe as a radical. He prefers unstructured work environments and is always coming up with new ideas. Some of there ideas are seen by other people as being "Out in left field", but when a new or different ideas is needed, John is your man. People often view John as impractical and unstructured. He is a powerhouse of new ideas, but tends not to work out the details to put them into effect. When things don't work out, he just moves on to another idea and doesn't look back. John tends to focus on the long term effect of something rather than the here and now

Appendix 5:

In order to obtain the data set used in this project, please contact Professor John Wilkes preferably via email (jmwilkes@wpi.edu) and ask for KAI2000.sav. This is in SPSS 9.0 format and includes cases for the Psychometric Study. Likewise major2000.sav includes cases for the major choice study.

These files are available in two versions. One containing names to make future addition of data possible. The other is without names to do further analysis with existing variables. Permission for use will normally require a signed consent form by the affected members of the WPI Class of 2001. The exception would be a study of SAT scores and the college experience.

Bibliography

- Bais, Badariah and Rahmut, Zareena. "Cognitive Styles, Teaching Styles and Learning Styles" Interactive Qualifying Project, WPI, 1989

- Beasley, D., Huey, C.,Wilkes, John M. and, McCormick, Keith, "Cognitive Styles and Implications for the Engineering Curriculum" http://iies.ecn.purdue.edu/c1/asee/fie95/4d3/4d32/4d32.htm

- Charanian, T. (1964). "Creativity and the research and development proposal". Unpublished master's thesis, University of Chicago, Chicago, IL.

- Felder, Richard M. "Index of Learning Styles (ILS)" http://www2.ncsu.edu/unity/lockers/users/f/felder/public/ILSpage.html

- Francis, Peter and Pietras, Mark, "Cognitive Style and Imagery of Women Engineers," Interactive Qualifying Project, WPI, 1990

- Guildord, J. (1959). Traits of creativity. In H. Anderson (Ed.), *Creativity and its Cultivation* (pp.142-161). New York: Harper &Row

- Hohlmaier, Susan and Stefanov, Laurie, "Women as Pioneers in Engineering," Interactive Qualifying Project, WPI, 1988.

- Hudson, L. (1966). Contrary imaginations. Edinburgh, Great Britain: Methuen.

- Isaksen, S. and Kirton, MJ, "The Progress and Potential of the Crativity Level-Style Distinction: Implications for Research and Practice" drawn from a paper prepared by the senior author for the British Psychological Society's Occupational Psychology Conference . Warwick, UK January 3-5, 1995

- Kirton, M.J. (1976). "Adaptors and innovators: A description and measure." *Journal of Applied Psychology*, 61, 622-629

- Kirton, M.J. (1987) *Kirton adaptation-innovation inventory manual –second edition*. Hatfield, UK: Occupational Research Center

- Lawrence, Gordon "Descriptions of the Sixteen Types" Center for Applications of Psychological Type, Inc. 1993

- Shablin, Lisabeth "Sex Discrimination in Scientific Imagery," Interactive Qualifying Project, WPI, 1985

- Wilkes, John M. (1994) Characterizing Niches and Strata in Science by Tracing Differences in Cognitive Styles Distribution. In Shadish, W. and Fuller, s. (Ed.) *The Social Psychology of Science* (pp. 300- 315) New York: The Guilford Press