

NORTHERN ILLINOIS UNIVERSITY

**“Applying the Sciences of the Natural and
the Artificial for an Effective Design”**

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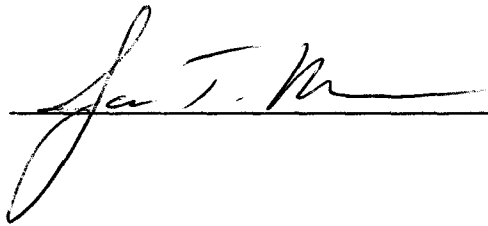
Capstone Approval Page

Capstone Title: "Applying the Sciences of the Natural and the Artificial for an Effective Design"

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This study examines the current use of quantitative and qualitative research methods for Information Systems research. These research methods may have a tendency to limit the evolution of the Information Systems field; it is thus important to consider a new framework for gathering Information Systems research. The new paradigm proposed is a combination of the science of the natural and the science of artificial. The science of the natural focuses on the characteristics and properties objects have in the real world and how they behave and interact with each other. The science of the artificial is related closely to the science of engineering and design and focuses on how objects ought to be in order to attain goals and to function. By combining the sciences of the natural and the artificial, a researcher can more fully understand the system problem and discuss alternative solutions. This project utilizes both research paradigms for developing an effective Website for students. This study provides a real world example of how theoretical practices can be implemented to achieve superior results. In addition to providing practical use of this knowledge, the study also improves the field of Information Systems research by encouraging researchers to look beyond quantitative methods and examine the benefits of a combined paradigm approach.

Traditional Research Methods

In order to more fully understand the techniques and methods used in this research paper it is important to understand why those techniques were selected in the first place. By understanding the various branches of research methods, including qualitative analysis, a researcher appreciates the differences and similarities between the fields of study.

Furthermore, Robert Gephart suggests that a “better understanding of methodological issues may encourage improved research practices by fostering consistency between the underlying assumptions, theories and knowledge production activities of management and organizational researchers” (Gephart 1999). This paper intends to clarify the similarities and differences of research methods and explore ways that two paradigms can be combined to produce a new distinct research approach.

Research methods are often categorized as quantitative or qualitative in nature. The difference between the two methods is based on how research is gathered and analyzed.

Michael Myers distinguishes between the two research methods by saying:

Quantitative research methods were originally developed in the natural sciences to study natural phenomena. Examples of quantitative methods now well accepted in the social sciences include survey methods, laboratory experiments, formal methods and numerical methods such as mathematical modeling. Qualitative research methods were developed in the social sciences to enable researchers to study social and cultural phenomena. Examples of qualitative methods are action research, case study research and ethnography. Qualitative data sources include observation and participant observation (fieldwork), interviews and questionnaires, documents and texts, and researcher’s impressions and reactions (Myers 1997).

Research methods can be further subdivided if one analyzes the underlying assumptions for what constitutes valid research. Three common philosophical paradigms for qualitative research are positivist, interpretive, and critical. According to Myers:

Positivists generally assume that reality is objectively given and can be described by measurable properties which are independent of the observer and his or her instruments...IS research [can be classified] as positivist if there [is] evidence of formal propositions, quantifiable measures of variables, hypothesis testing, and the drawing of inferences about a phenomenon from the sample to a stated population. Interpretive studies generally attempt to understand phenomena through the meanings that people assign to them and interpretive methods of research in IS are “aimed at producing an understanding of the context of the information system, and the process whereby the information system influences and is influenced by the context”. Critical research focuses on the oppositions, conflicts and contradictions in contemporary society, and seeks to be emancipatory i.e. it should help to eliminate the causes of alienation and domination (Myers 1997).

In addition to these underlying philosophical perspectives that may shape research, there are also underlying research methods. Research methods differ based on how data is collected, the research practices used, and the underlying assumptions. Four common research methods used are action research, case study research, ethnography, and grounded theory. The research method of most importance for this paper is action research. Richard Baskerville states:

Action research is an established research method in use in the social and medical sciences since the mid-twentieth century. Toward the end of the 1990s it began growing in popularity for use in scholarly investigations of information systems.

The method produces highly relevant research results, because it is grounded in practical action, aimed at solving an immediate problem situation while carefully informing theory (Baskerville 1999).

Action research best describes the research method applied to this study's goal of improving Website design. Action research works to solve the pressing problem for businesses across the globe of how to effectively design a Website. The research conducted provides great insight into what a group values in a Website and how effectively the Website presents that material. This study provides insight not just for businesses, but also the academic community. This study examined not only the theoretical aspects of a combined paradigm, but implemented the paradigm in a real-world setting.

The Science of the Natural and Artificial

Other paradigms have been suggested in addition to qualitative and quantitative research methods. Two such paradigms are the science of the natural and the science of the artificial. The science of the natural focuses on the characteristics and properties objects have in the real world and how they behave and interact with each other. The science of the artificial is related closely to the science of engineering and design and focuses on how objects ought to be in order to attain goals and to function. Jack Marchewka proposes that "distinction between the science of the natural and science of the artificial can be complementary and provides a basis for IS research. Moreover, strict adherence to one paradigm at the expense of the other may create a hole in our overall body of

knowledge” (Marchewka 1997). The combination of the science of the natural and the science of the artificial are best represented as a continuous cycle (Figure 1).

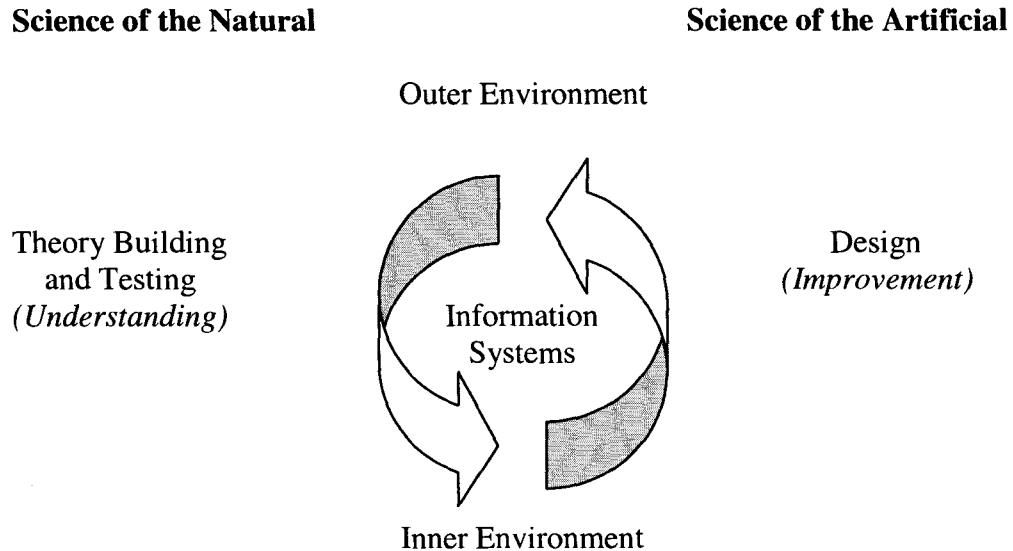


Figure 1 (Marchewka 1997).

The science of the natural uses theory building and testing to best understand the artifact while the science of the artificial seeks to use design as a way to improve the artifact.

Marchewka explains that:

The left side of the model follows the natural science paradigm not only to develop a knowledge base about natural objects and phenomenon, but to understand how the artifact fits into the natural scheme of things. Research of artifacts that focuses on “how things are” creates a cycle for furthering understanding and refinement of the design and development process (Marchewka 1997).

The focus of the science of the artificial is on how things ought to be, which can provide further guidance on the development or improvement of the artifact. The testing provided by the science of the natural is complemented by the continuous improvement seen by the science of the artificial.

Assigning research methods to any one type of paradigm is difficult; many of the currently accepted research methods could be categorized as either qualitative or quantitative in nature. It is even more difficult to classify a research method as belonging to either the paradigm of the science of the natural or of the artificial. Many of the research methods that would fall under the science of the natural are compromised by the application of the science of the artificial. The science of the natural looks to make observations, but not to directly change a situation. However, the definition of the science of the artificial calls for a modification or improvement of the current situation. Below are listed some general classifications of research methods that might fit under each paradigm.

Science of the Natural

Survey Methods

Laboratory Experiments

Mathematical Modeling

Science of the Artificial

Action Research

Case Study Research

Grounded Theory

Application of the Science of the Natural and Science of the Artificial

Empirical-based research has guided much of past Information Systems research, with little emphasis given to qualitative research methods. Orlikowski and Baroudi state:

To date...much information systems research reflects a positivistic orientation, a research tradition that has its roots in the natural sciences. An exclusive view is, in our opinion, always a partial view, and the dominance of positivism, by not acknowledging the legitimacy of other research traditions, has limited what aspects of information systems phenomena we have studied, and how we have studied them. This has implications not only for the development of theory and our understanding of information systems phenomena, but also for the practice of information systems work. The findings of information systems research filter in the practitioner community and are used as prescriptions for action (Orlikowski and Baroudi 1991).

After neglecting the area of qualitative research methods for so long, it is necessary to look at an approach that can include qualitative analysis. Using only a natural science approach is too limiting and examines the organization in isolation. Orlikowski and Baroudi state that “organizations, groups, social systems do not exist apart from humans, and hence cannot be apprehended, characterized, and measured in some objective or universal way” (Orlikowski and Baroudi 1991). The sciences of the natural and the artificial allow a researcher to establish a new paradigm incorporating the benefits of both qualitative and quantitative methods. One might ask what distinguishes the sciences of the artificial and natural from the traditional qualitative and quantitative research

methods. Quantitative research methods deals almost exclusively on traditional numerical data. The science of the natural is not limited to numerical research, but instead seeks to answer a research question through observation. Qualitative research methods seek to interpret various types of research questions using non-numeric methods. The science of the artificial goes beyond qualitative methods and actually makes modifications or improvements to the current research hypothesis.

This project tests Marchewka's hypothesis that the sciences of the natural and artificial can not only provide a basis for Information Systems research, but also be applied to effective Website development. By combining both the sciences of the natural and artificial, a researcher not only answers a research question, but also improves the original theory. The success of the Website development is to be measured by two surveys that are to be distributed to the student population. The first survey records reactions to the original Website. In addition to the original Website, another version of the same Website was created using a format that hoped to be more appealing to the student population. The second survey then measures student reactions to the second Website. These surveys are then to be statistically analyzed and represent how the science of the natural can be utilized in a real-world environment. The collection of the survey results is an application of the science of the natural. The survey is an observation of what the student population values in a Website design.

The effective design of an Internet Website is also heavily dependent upon the opinion of its users, in this situation the student body. To examine the effectiveness of the Website

in isolation is to disregard valuable knowledge that can be gained by simply examining what students' value in a Website and then continue the development process. This process represents how the science of the artificial can be applied to a real-world situation. The science of the artificial provides a means of determining the successfulness of the science of the natural. In this situation, we can use action research to make improvements to the original theory, or in this case, the original Website. Baskerville states, "the fundamental contention of the action researcher is that complex social processes can be studied best by introducing changes into these processes and observing the effects of these changes" (Baskerville 1999). This statement highlights the process the science of the artificial is utilizing in this study. The original Website is modified and improved to create a second Website and the students' reactions are noted. The process continues again with the modification of the Website to create a third Website to correct what students did not like about the second Website. This combined approach of the sciences of the natural and artificial is continued consecutively until an effect Website design is developed.

Survey Methods

Two identical surveys were presented to a student population to determine what students' value most in a Website. Students were randomly assigned to either survey one or survey two. Students were directed to a Website where a consent form was agreed to and survey instructions were presented. The students were then instructed to visit the Website assigned to them and locate specific information contained within that site. Immediately

after visiting the Website, the students took a survey regarding their experience. The survey consisted of twenty questions employing a five point Likert scale ranging from 'strongly disagree' to 'strongly agree' (see Figure 2). The survey also included the following personal information: student identification number, name, phone number, expected graduation date, and gender. Information regarding expected gender was tallied to observe whether gender made a significant difference regarding what a student values in a Website and the expected graduation date information was used to determine if class standing made a difference in student preferences or expectations. The survey measured various components of student user satisfaction such as: accuracy, format, ease of use, timeliness, reliability, completeness, volume of output, and relevancy. The student responses were then submitted electronically to an SQL Server database. At the end of the survey period, the responses were extracted and analyzed in an Excel spreadsheet.

Results

One hundred and eighteen surveys were collected for this study. Twenty-nine of the respondents were from survey one and eighty-nine respondents were from survey two. The results reveal that in many areas the original Website was superior to the newly designed replacement (complete survey results are listed in the Appendix). Students felt that the original Website provided more content, better formatting, greater relevancy, greater reliability, and was easier to use. However, students also felt that the newly designed Website provided information that was accurate, timely, complete, and of a substantial quantity. The improvements that were added to the Website included a flash

introduction movie, more visual graphics, and a continuous formatted layout. The new Website design aimed to improve navigation of the Website, the visual layout of the Website, and completeness. From the survey results it appears that the new Website succeeded in becoming more complete, but did not achieve the goals of better formatting and ease of use.

Gathering the survey results is representative of the science of the natural, but the science of the artificial is used to actually improve the next stage of the Website development. The modifications to the original website that improved completeness will remain intact, but the other modifications will be changed back to the original. The Website designer would now use another formatting and navigation technique to improve the Website's design. The cycle would then continue by measuring student reactions to the new changes followed by more modifications. By following this cycle, an effective Website design can be achieved.

A survey method modification could improve survey results if this study were to be replicated in the future. The current survey method has an individual student view only one of the Websites, unaware of the existing Website. This constraint was used to ensure timely and significant response from the student population. However, if a student were to view the original Website and take a survey followed by viewing the improved Website and taking another survey, the results may be significantly different. A student may rate the newly designed Website as poor, even if the Website is better than the original, simply because the student did not view the original Website. Although the new

survey method would take greater time and effort, the results may be a better indicator of the students' opinion.

APPENDIX

Survey 1(Original Website) Results

content1	content2	content3	for1	for2	acc1	acc2	ease1	ease2	ease3	relevancy1	relevancy2	rel1	rel2	time1	time2	comp1	comp2	vol1	vol2	id	name	phone	grad-date	gender
5	2	4	4	4	4	3	3	4	3	4	3	4	4	4	3	3	3	4	3				May-03	1
4	3	4	4	4	4	3	3	5	2	4	3	2	3	3	2	4	2	2	3				May-02	1
3	3	3	5	5	4	3	1	4	3	5	3	5	3	3	3	4	5	4	3				May-02	1
5	5	5	5	5	5	5	1	4	5	5	5	5	5	5	5	4	5	4	5				Dec-02	1
4	4	4	4	4	4	4	1	4	3	4	4	4	4	4	4	4	4	4	4				May-03	1
4	3	3	3	3	3	3	3	2	2	3	4	4	4	4	3	3	3	3	3				2-Dec	1
5	5	4	5	5	5	5	1	4	4	5	4	5	5	5	4	5	4	5	3				Dec-02	2
1	2	4	1	4	1	4	2	4	5	4	5	4	5	3	5	4	5	4	5				May-03	2
4	4	4	2	4	4	4	2	4	4	4	4	4	4	4	4	4	3	4	2				12/15/2002	2
4	4	4	4	4	4	4	1	3	5	5	5	5	3	4	4	4	4	5	5				Dec-02	2
5	5	4	5	5	4	4	1	5	5	5	4	5	5	5	4	5	4	4	5				May-03	1
2	2	1	2	1	3	2	2	3	1	2	2	3	1	2	1	3	1	3	1				2-Dec	2
5	3	4	5	3	4	4	3	4	4	2	5	4	4	4	4	4	4	5	4				May-02	2
4	2	4	4	3	4	3	2	4	3	3	3	3	3	3	2	4	4	4	3				2-Dec	2
2	2	1	1	1	2	1	2	3	2	2	1	1	1	1	2	2	1	1	1				Dec-02	2
5	4	4	4	4	4	4	2	4	5	5	4	4	4	4	4	4	4	4	5				May-03	1
4	2	3	4	3	3	4	4	3	4	3	4	3	4	3	4	3	3	3	2				Dec-02	1
5	5	4	4	5	5	5	2	3	4	5	5	5	5	5	4	5	4	5	3				Dec-02	1
4	4	4	4	4	4	4	2	3	3	4	4	4	4	4	4	4	4	4	5				May-03	2
5	5	5	5	5	5	5	1	5	5	4	5	5	5	5	5	5	5	5	5				Dec-02	1
4	3	3	4	4	3	4	1	4	4	4	4	4	4	4	4	2	3	3	2				2-May	1
4	4	5	5	5	4	5	4	4	5	5	4	5	5	5	4	5	5	5	4				May-02	2
4	4	4	4	5	4	4	1	3	4	4	4	4	4	5	4	3	4	4	5				Dec-02	1
5	5	5	5	5	5	5	1	3	5	5	5	5	5	5	5	5	5	5	4				May-03	1
1	1	1	3	3	3	3	1	1	3	3	1	3	3	3	3	1	3	3	1				May-02	1
4	4	4	4	4	4	4	1	4	5	4	3	4	4	4	4	4	4	4	4				May-03	1
3	4	4	4	4	4	3	3	5	5	4	4	5	4	4	5	4	5	4	4				Jun-02	1
3	3	4	4	3	4	4	2	1	4	4	3	5	3	4	4	4	4	4	1				May-03	1
5	4	4	5	5	5	5	1	2	4	4	2	5	5	5	5	5	5	5	3				Apr-03	1
3	4	3	4	4	3	2	5	3	1	3	3	3	3	3	1	4	3	2	3				2-Dec	2
3	4	4	4	5	4	4	2	3	4	4	4	5	4	4	5	5	5	4	3				Dec-02	1
3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3				May-03	1
4	5	4	4	3	5	5	1	3	3	4	4	4	5	4	4	5	4	4	3				Dec-02	1
4	2	4	4	5	3	4	1	5	5	4	4	4	3	3	4	4	4	3	3				Dec-02	1
4	3	3	4	3	4	3	3	4	4	3	3	3	4	4	4	3	4	4	3				May-03	2
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3	2	1	2	4	4	1	2	2	2	2	2	4	3	5	4	1	2	1	4				May-03	1
3	3	3	3	4	4	3	1	2	4	4	4	3	4	3	3	3	3	3	4				May-03	2
5	4	5	4	4	4	4	3	4	3	4	3	4	4	4	3	4	4	5	3				Dec-02	2
5	5	4	4	4	5	4	2	4	4	5	3	5	5	5	5	4	4	4	4				May-03	1
4	4	4	4	4	4	3	2	2	3	4	4	3	4	4	4	4	4	4	4				May-03	1
3	3	4	4	4	4	3	3	2	2	4	1	5	3	4	4	3	2	4	4				May-03	1
5	5	4	5	5	5	5	2	5	4	4	5	4	4	5	5	5	4	5	5				May-03	1
5	5	5	5	5	4	4	1	4	5	5	4	5	5	4	3	5	5	5	4				(12/2002)	1
4	4	4	5	4	4	4	2	4	5	5	4	4	3	4	4	5	4	4	4				May-03	1
3	5	3	5	4	3	4	2	1	5	5	2	5	4	5	5	4	4	4	2				12/15/2002	1
4	4	4	4	4	4	4	2	4	4	4	4	4	3	4	4	4	4	4	4				May-03	1
2	3	2	3	3	4	2	4	4	1	1	4	4	3	4	3	4	3	2	3				Dec-02	1
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3	2	4	4	4	4	4	2	2	3	4	3	3	4	4	3	3	3	4	4				2-Dec	1
3	2	2	3	2	2	2	2	2	2	3	2	2	2	2	2	2	3	2	2				May-03	2

	content1	content2	content3	for1	for2	acc1	acc2	ease1	ease2	ease3	relevancy1	relevancy2	rel1	rel2	time1	time2	comp1	comp2	vol1	vol2	ld name	phone	grad-date	gender
	4	5	5	5	5	3	5	1	5	4	5	4	5	3	4	5	5	5	5	5			May-03	2
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	3	5	4	4	4	4	3	2	2	4	4	2	4	4	5	3	4	3	3	4			Dec-02	1
	3	2	2	4	2	4	2	1	1	2	4	3	4	3	3	3	4	3	2	2			Dec-02	1
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	5	4	5	5	5	5	5	1	4	5	5	3	5	5	5	5	4	4	4	5			Dec-02	1
	4	3	2	4	4	3	2	2	4	3	4	3	4	3	2	3	4	2	3	2			Aug-02	1
	5	3	5	4	4	3	4	2	4	3	3	3	3	3	4	3	3	3	4	3			May-03	2
	4	4	4	5	5	3	5	3	5	4	4	4	4	4	4	4	5	4	5	5			Dec-02	2
	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4			May-03	1
	4	4	4	3	2	5	3	3	3	2	4	4	4	5	4	4	5	4	2	5			Dec-02	1
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	4	3	4	4	4	4	4	1	4	5	5	5	4	4	4	4	4	4	4	4			May-03	1
	2	1	2	2	2	2	2	2	3	3	2	2	2	2	2	2	2	3	2	2			52003	1
	3	4	3	4	4	4	3	3	3	5	4	3	4	4	4	5	4	4	3	4			May-03	1
survey1	3.833	3.611	3.711	3.967	3.933	3.800	3.622	2.033	3.422	3.700	3.833	3.478	3.967	3.756	3.856	3.722	3.878	3.744	3.789	3.589				
survey2	3.733	3.533	3.800	3.700	3.600	3.767	3.767	2.300	3.700	3.600	3.667	3.367	3.900	3.733	3.900	3.800	3.833	3.900	3.733	3.867				
	-0.100	-0.078	0.089	-0.267	-0.333	-0.033	0.145	0.267	0.278	-0.100	-0.166	-0.111	-0.067	-0.023	0.044	0.078	-0.045	0.156	-0.056	0.278				

Survey 2 (New Website) Results

content1	content2	content3	for1	for2	acc1	acc2	ease1	ease2	ease3	relevancy1	relevancy2	rel1	rel2	time1	time2	comp1	comp2	vol1	vol2	id	name	phone	grad-date	gender
5	5	4	4	4	4	5	1	4	4	5	4	5	2	5	4	4	4	4	4				Dec-03	1
4	5	5	5	5	5	5	1	5	5	5	5	5	4	4	4	5	5	5	5				5-Apr	1
5	4	5	5	5	5	5	2	4	5	4	5	5	5	5	4	4	5	4	5				Dec-02	1
4	4	4	4	4	5	4	1	4	4	4	4	5	4	5	4	4	4	4	5				May-03	1
5	5	4	5	4	5	4	2	4	5	5	2	5	5	5	5	4	4	4	4				May-02	1
5	3	4	5	4	3	3	1	4	4	4	4	4	4	3	3	4	4	4	5				May-03	2
3	3	3	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3				Dec-02	2
5	4	5	5	5	5	5	1	5	5	5	3	5	5	5	5	5	5	5	5				May-06	2
4	3	4	4	4	3	3	3	4	4	3	4	4	3	3	4	4	4	3	3				2-Dec	1
4	3	4	4	4	4	4	1	4	4	4	4	4	5	5	4	4	4	4	4				Dec-02	2
4	5	5	5	5	5	5	5	5	5	5	4	5	4	5	5	5	5	4	5				May-03	1
3	3	5	5	3	5	5	5	5	3	3	3	4	5	5	5	5	5	5	3				Dec-05	1
4	3	4	2	2	3	4	3	2	4	4	4	3	3	3	4	3	4	4	4				May-02	2
3	3	4	2	2	3	2	4	2	2	3	3	4	3	4	4	2	3	2	2				Aug-02	2
2	2	3	2	2	2	3	2	3	2	2	2	2	3	2	2	3	3	2	4				Dec-03	1
4	4	4	1	4	4	4	1	3	4	5	4	4	4	4	4	4	4	4	5				May-03	1
5	5	5	5	5	5	5	1	4	5	5	5	5	5	5	5	5	5	5	5				May-05	1
3	1	2	1	1	3	3	5	1	1	2	2	3	3	4	4	3	2	4	1				May-03	2
4	3	4	4	5	3	3	2	4	4	3	3	3	3	4	3	3	3	4	5				May-03	1
3	5	4	2	2	3	4	4	1	4	4	3	4	4	5	4	5	4	3	4				Aug-02	2
2	3	2	3	3	2	3	3	3	4	2	2	3	2	3	4	4	3	5	2				2005	1
4	4	4	4	4	5	4	2	3	4	3	4	4	5	2	5	3	4	2	5				May-03	1
4	3	0	3	4	4	3	3	3	3	4	4	4	4	2	3	3	4	4	4				May-03	2
2	3	3	4	3	3	3	2	4	2	3	3	3	3	4	3	3	3	3	1				5-May	1
4	4	4	4	3	4	4	1	5	4	3	4	3	4	4	3	4	4	4	5				Dec-02	2
4	3	4	4	4	4	4	3	5	4	4	2	4	4	4	4	5	4	4	3				June7/2005	2
4	4	5	5	5	5	4	1	5	3	4	3	5	4	5	4	4	5	5	4				May-05	1
2	3	3	3	2	3	2	2	4	2	2	2	3	3	3	2	3	3	2	4				4-May	1
2	2	3	2	2	1	3	3	4	1	3	2	2	2	2	2	3	3	2	3				Dec-02	1
5	4	4	5	5	4	4	1	4	4	4	4	4	4	4	4	4	4	4	4				Dec-03	2
3.733	3.533	3.800	3.700	3.600	3.767	3.767	2.300	3.700	3.600	3.667	3.367	3.900	3.733	3.900	3.800	3.833	3.900	3.733	3.867					

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