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Proceedings of the Academy of Information and Management Sciences

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TEACHING ADVANCED BUSINESS STATISTICS: STUDENTS' PERCEPTION OF EFFECTIVENESS

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ABSTRACT

The primary focus of this research was to investigate the student's perceptions of the effectiveness of various methodologies of teaching advanced business statistics. A questionnaire was administered to students enrolled in advanced statistics in the fall semester, 1998. An analysis of the results indicates that students exhibited a strong opinion regarding the use of the manual (hand-held calculator) method of learning instead of the use of a computer software package (MINITAB).

INTRODUCTION

Most universities and colleges require students to take one or more statistics courses in many different majors, e.g., education, psychology, business, etc., for the non-specialist. This paper focuses on methods utilized in teaching statistics to those non-specialists who are majoring in a field within business. The traditional method currently used in teaching statistics is widely viewed as being ineffective (Cobb 1993, Mosteller 1988). One of the reasons generally given for this lack of success is that current statistical teaching methodology neglects to establish a definitive linkage between statistics in the classroom and its use in "real world" applications (Yilmaz, 1996). The non-specialist does not aspire to be a mathematical theorist, but needs only to use statistics as a tool in analyzing or solving a problem. This paper does not intend to imply that mathematical theory is unimportant, but takes the position that the use of statistics as a tool is equally important to those people involved in the ongoing everyday activities of business and life. We, therefore, will approach the teaching of applied statistics as a skill. The teaching of any skill involves repetition and the actual performance of an activity, i.e., "hands-on" training. In short, you cannot acquire statistical competencies via the passive role of listening to lectures or observing the professor solve a statistical problem - you can only acquire these skills by being an active participant, i.e. by performing the activities yourself. Smith (1998) states that students should design the study, collect the data, analyze the results, prepare written reports, and give oral presentations.

The successful use of statistics involves many components, for example, basic mathematical skills, problem selection, model building, data gathering (possibly from global databases or data warehouses), interpretation, computer literacy, software selection and utilization, and clearly communicating the statistical results to those interested parties. It is incumbent upon the authors to acknowledge that ethics and legal issues also play a major role in the use and interpretation of statistics; however, these important issues are outside the scope of the current paper. It has been documented ad nauseam that when students enter universities they lack the basic foundation mathematical skills required to immediately enroll in mainstream mathematical courses. Perhaps this is because individuals tend to avoid what they are not successful in doing, which in this case, can lead to math anxiety or math phobia. Hogg (1991) found that “students frequently view statistics as the worst course taken in college.”

In the fall of 1998, there was a total of 2,583 first time freshmen at Middle Tennessee State University which 1,106 freshmen had to take at least one developmental mathematics course (Bader, 1999). Many students hope that if they can just get past this course that everything will be all right, which is of course, is a non sequitur because they will have to utilize these statistical skills in many courses. Ideally, the statistical courses should view the entire scope of an individual’s life (1) statistics is an important part of each student’s professional development: and (2) statistics is an important part of each student’s everyday life (Iversen 1985, Moore and Roberts 1989, Moore and Witmer 1991). Rumsey (1998) believes that selecting a textbook which contains relevant, real-world examples and exercises, real-world data sets of varying sizes, and text written in the general education themes is vital to satisfying these two goals.

Many students who enroll in the statistics courses do so without sufficient computer literacy skills, and, therefore, spend their time attempting to master those requisite computer skills, ultimately neglecting the in-depth understanding of the statistics which was the objective of the course. Additionally, students appear to be more interested in acquiring computer skills than mathematical skills, probably because it is much more fashionable to talk about computers than statistics, and, very importantly, students are aware that computer skills are advertised as a prerequisite for most jobs whereas they seldom find mathematical competencies advertised as a prerequisite for jobs.

The recommendations of the American Statistical Association and the Mathematical Association of America (ASA/MAA, 1998) Committee on Undergraduate Statistics should be integrated into the methodology utilized for teaching statistical courses. These recommendations are to teach statistical thinking; to emphasize more data and concepts, less theory and fewer recipes; and, to foster active learning. There are several approaches for teaching statistics to the non-specialist: (1) the use of manual calculations by using a hand-held calculator, (2) the use of a computer package, and (3) a combination using both the manual and computer software package. A computer package, such as MINITAB, could be selected which would enhance the student's ability to visualize and explore basic statistical concepts. MINITAB provides the means to generate the output and then allows the student to become statistical thinkers.

Considerable discussions among MTSU statistics faculty have occurred, ranging from statements like "you don't have to know how to build a car to be able to drive it" to "if you don't know how it works you can't fix it". However, if you are going to be a professional race car driver, then you should know how to build or rebuild a car, know how to fix it, and be an expert driver. In an attempt to satisfy those people at both ends of the continuum, many statistics faculty members introduce new topics to students with manual methods (hand-held calculators) then reinforce the topic with the use of a computer statistical package (MINITAB).

The College of Business at MTSU is AACSB accredited and has a state-of-art new building with computer labs and networked telecommunication facilities. Each classroom has multimedia, a projector, and is networked so that computer software is immediately available to the instructor and students alike. MINITAB for Windows is used in the classrooms and in the computer laboratory, making MINITAB available both in class and for out-of-class assignments. In addition to the computer lab, there is a separate business statistics lab in the same locale as the offices of the faculty members who teach the statistical courses. The business statistics lab staff is composed of graduate assistants whose assignment is to assist students who require additional information, as well as help then in utilizing statistical packages.

All students majoring in any field offered within the College of Business must take an introductory level course in statistics (Statistical Methods I) which covers topics in measures of central tendency, variation, probability theory, point and interval estimation, and hypothesis testing. This survey did not include students in this introductory statistic course.

MTSU schedules over 10 sections of the junior level course in advanced business statistics (Statistical Methods II) each semester. While each faculty member teaching this course must cover specific core topics, the method of presentation is an individual decision. Topics covered include hypothesis testing and regression analysis. Techniques range from those faculty members who make minimal use of a statistical software package (MINITAB) to those who make minimal use of manual calculations (hand-held calculators).

RESEARCH METHODOLOGY

A questionnaire was created and administered to seven sections of the advanced statistics course (Statistical Methods II) during the last scheduled class day in the fall semester of 1998. The students were asked to relate their views on the efficacy of the dual method of presentation, i.e., utilizing both the manual (hand-held calculator) and a computer package, as well as their evaluation of the effectiveness of more or less presentation with either of the methods (See Appendix for Questionnaire). A Likert-type scale from 1 (strongly disagree) to 7 (strongly agree) was utilized to determine the student's perceptions of the benefits of one teaching methodology over the others.

DATA ANALYSIS

We wanted to identify any statements, with which the students either strongly agreed or strongly disagreed. The Likert-type scale used to measure the degree of agreement (disagreement) had a midpoint of 4, so we tested a null hypothesis that the midpoint of responses = 4 for each of the twenty-five statements.

What statistical procedure should be utilized? If we used a t-test, there would be people that would argue that we did not meet the normality assumption, and the Wilcoxon Signed-Rank test should have been used. We tested the responses to each statement using an Anderson-Darling test for normality and all 25 statements were found to have responses that were not normally distributed at the 0.000 level of significance. If we used the Wilcoxon Signed-Rank test, some people would argue that we had ordinal level data and should have used the Sign test. To try to satisfy as many objections as possible, we tested all 25 statements using the Wilcoxon Signed-Rank test and the Sign test. See tables 1 and 2.

We wanted to check those statements that had the strongest effects to see if there was a difference that could be attributed to the influence of a particular instructor. For each of these statements we wanted to test the null hypothesis that the student responses for a particular statement for all three instructors were essentially the same. To do this we first needed to determine which statements had the strongest effects.

From table 1 (the Wilcoxon Signed Rank test) the statements with the strongest effects (P=0.000) are:
1, 2, 3, 5, 7, 9, 10, 11, 16, 18, 19, 20, 21 and 23.

From table 2 (the Sign test) the statements with the strongest effects (P=0.000) are:
1, 2, 3, 5, 7, 9, 11, 16, 18, 19, 20, 21 and 23.

According to the Sign test, statement 10 is only significant at the 0.001 level of significance, so it was not included in the common set of thirteen statements showing the strongest effects.

These thirteen statements may be further broken down as follows:

Statements showing the highest levels of agreement:
{1, 3, 5, 9 and 11}.

Statements showing the highest levels of disagreement:
{2, 7, 16, 18, 19, 20, 21, and 23}.

Now that we have isolated those statements with the strongest levels of agreement, how do we rank them? Which statement shows the highest level of agreement, the second highest, and so on? When you have a t-test, this ranking may be done easily by ranking the computed value of the t-test statistic. However, this approach would not be appropriate for the Wilcoxon Signed-Rank test (ranking by the computed values of the Wilcoxon statistic) or for the Sign test (ranking by the number of values above the median), because in both of these procedures the number of values equal to the median are not used. What we decided to do was to calculate the appropriate Z-value for each computed value of the test statistic and then rank the Z-values.

For the Wilcoxon Signed-Rank test, the normal approximation formula is:

Z = [W - (n')(n' + 1)/4]/sqrt[(n')(n' + 1)(2n' + 1)/24]
where n' is the number of responses that differ.
These Z-values and their ranks and are shown in Table 1.

For the Sign test, the normal approximation formula is:

Z = [Above - (n')/2]/sqrt[(n')/4].
These Z-values and their ranks and are shown in Table 2.

Both the Wilcoxon Signed-Rank test and the Sign test have the same rank order for the five statements for which the students showed the largest amount of agreement. This order was:

Highest agreement to lower (but still very significant) agreement
5, 3, 1, 11, 9.

However, the Wilcoxon Signed-Rank test and the Sign test have a slightly different rank order for the eight statements that the students showed the largest amount of disagreement. These orders were:

Wilcoxon Signed-Rank test

Highest disagreement to lower (but still very significant) disagreement
7, 2, 18, 16, 20, 21, 19, 23.

Sign test

Highest disagreement to lower (but still very significant) disagreement
2, 7, 18, 21, 19, 16, 20, 23.

We mark the statements: H for manual (hands on) and M for MINITAB.

Positive	H	M	H	HM	H	M			H	M	H	M	M
Statement:	1	2	3	4	5	6	7	8	9	10	11	12	13
Negative	M	H					H	M					

positive	M	M	M	M	M	M	M	M	M	M	M	M
Statement:	14	15	16	17	18	19	20	21	22	23	24	25
Negative				H								

Now examine where the most agreed with statements are. They will be designated **A1**, **A2**, **A3**, **A4** and **A5**.

Most Agreed with Statements

	A3		**A2**		**A1**				**A5**		**A4**		
Positive	H	M	H	HM	H	M			H	M	H	M	M
Statement:	1	2	3	4	5	6	7	8	9	10	11	12	13
Negative	M	H					H	M					

positive	M	M	M	M	M	M	M	M	M	M	M	M
Statement:	14	15	16	17	18	19	20	21	22	23	24	25
Negative				H								

Note that in every statement where manual calculation is placed in a positive connotation (H above the statement number), it is in the set of statements with which the students' agreement was at the highest level.

Now examine where the most disagreed with statements are. They will be designated **D1**, **D2**, **D3**, **D4**, **D5**, **D6**, **D7** and **D8** and will be rank ordered determined by the Sign test.

Most Disagreed with Statements

		D1					**D2**						
Positive	H	M	H	HM	H	M			H	M	H	M	M
Statement:	1	2	3	4	5	6	7	8	9	10	11	12	13
Negative	M	H					H	M					

			D6		**D3**	**D5**	**D7**	**D4**		**D8**		
positive	M	M	M	M	M	M	M	M	M	M	M	M
Statement:	14	15	16	17	18	19	20	21	22	23	24	25
Negative				H								

Note that in two of the three statements where manual calculation is placed in a negative connotation (H below the statement number), it is in the set of statements with which the students' disagreement was at the highest level. In fact, these two were the two statements with the highest level of disagreement. The other statement (17) where manual calculation is placed in a negative connotation (H below the statement number), that it is easier to learn to perform a hypothesis test with MINITAB than to learn to perform it manually was generally disagreed with by the students surveyed but not significantly so (Wilcoxon p = 0.262 and Sign p = 0.5940).

For each of these statements we wanted to test the null hypothesis that the student responses for a particular statement for all three instructors were essentially the same. Since the Anderson-Darling test would not let us assume a normal population for the responses for any statement, we decided against using a one-way ANOVA. We decided to do a Kruskal-Wallis and a Mood's Median test for each of these statements to see if we could find a difference based on instructor. No significant differences were found at the 0.05 level of significance. Statement 10 came the closest with a p-value of 0.062 using a Kruskal-Wallis test adjusted for ties.

Table 1
Wilcoxon Signed Rank Test
Test of median = 4.000 versus median not = 4.000

Boldface for P-value = 0.000

	N	N Missing	N for Test	Wilcoxon Statistic	P	Estimated Median	Z for W	Rank
C1	**104**	**0**	**91**	**3767.5**	**0.000**	**5.500**	**6.62751**	**23**
C2	**104**	**0**	**88**	**476.5**	**0.000**	**2.500**	**-6.16431**	**2**
C3	**104**	**0**	**88**	**3628.0**	**0.000**	**5.500**	**6.94863**	**24**
C4	104	0	86	2042.0	0.462	4.000	0.73848	19
C5	**104**	**0**	**95**	**4308.0**	**0.000**	**6.000**	**7.52765**	**25**
C6	104	0	84	1080.0	0.002	3.500	-3.14414	10
C7	**103**	**1**	**93**	**496.0**	**0.000**	**2.000**	**-6.47348**	**1**
C8	104	0	82	1606.0	0.661	4.000	-0.44149	17
C9	**104**	**0**	**82**	**2832.5**	**0.000**	**5.000**	**5.22854**	**21**
C10	**104**	**0**	**83**	**901.5**	**0.000**	**3.000**	**-3.82052**	**9**
C11	**104**	**0**	**90**	**3359.0**	**0.000**	**5.000**	**5.27707**	**22**
C12	104	0	87	1798.0	0.625	4.000	-0.49096	16
C13	103	1	72	776.0	0.003	3.500	-3.01909	11
C14	103	1	72	1140.0	0.330	4.000	-0.97643	15
C15	103	1	84	1168.5	0.006	3.500	-2.74945	12
C16	**104**	**0**	**84**	**747.5**	**0.000**	**3.000**	**-4.62702**	**4**
C17	103	1	88	1688.0	0.262	4.000	-1.12343	14
C18	**104**	**0**	**71**	**358.0**	**0.000**	**3.000**	**-5.27145**	**3**
C19	**104**	**0**	**72**	**556.0**	**0.000**	**3.000**	**-4.25366**	**7**
C20	**104**	**0**	**70**	**481.5**	**0.000**	**3.000**	**-4.45351**	**5**
C21	**104**	**0**	**68**	**454.5**	**0.000**	**3.000**	**-4.39029**	**6**
C22	103	1	69	818.0	0.020	3.500	-2.32880	13
C23	**104**	**0**	**63**	**448.0**	**0.000**	**3.500**	**-3.83382**	**8**
C24	104	0	76	1431.5	0.872	4.000	-0.16309	18
C25	104	0	78	1842.0	0.134	4.500	1.50170	20

Table 2
Sign Test
Test of median = 4.000 versus not = 4.000

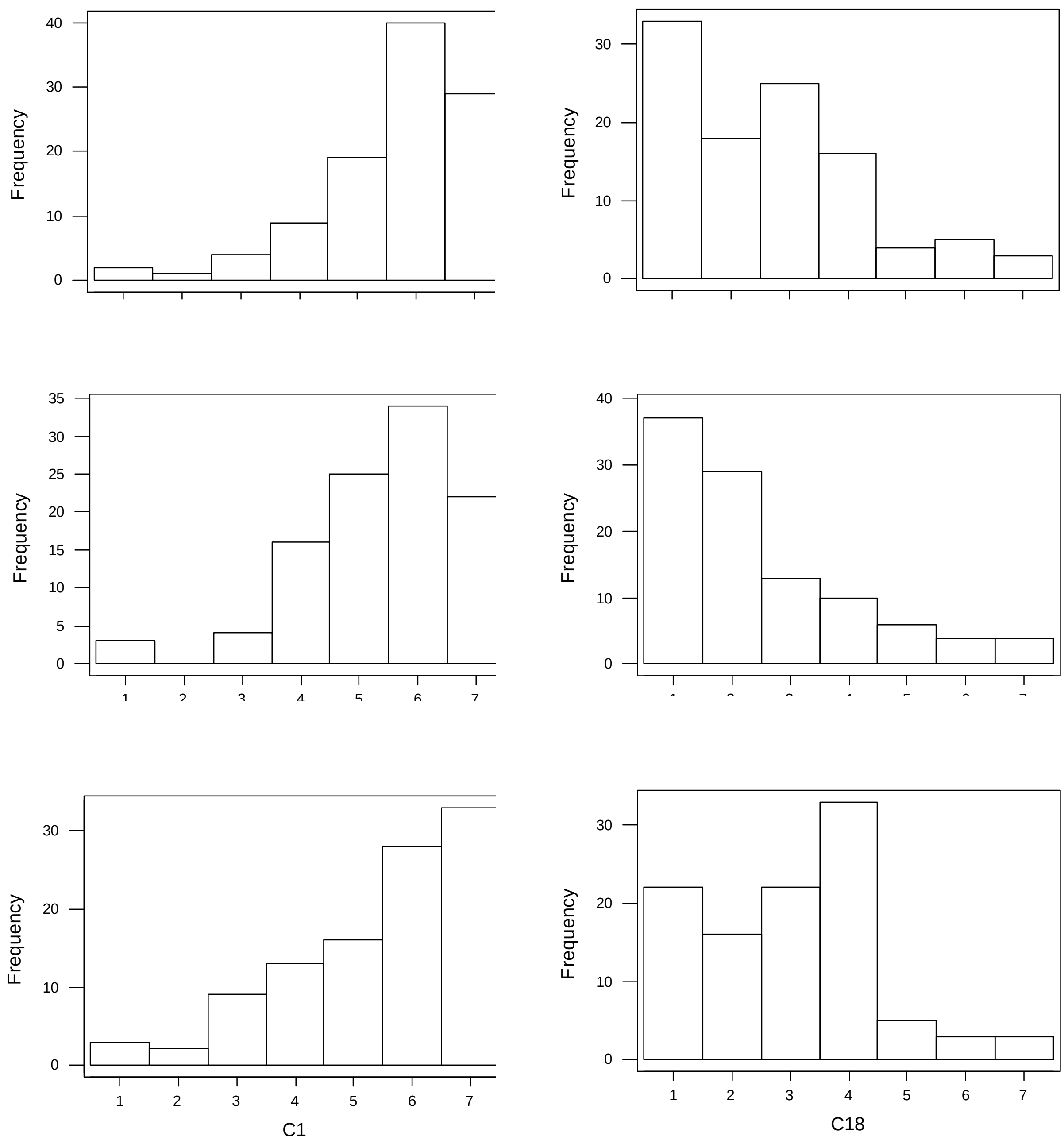
Boldface for P-value ≤ 0.000

	N	N*	Below	Equal	Above	P	Median	Z for Above	Rank
C1	**104**	**0**	**14**	**13**	**77**	**0.0000**	**6.000**	**6.60419**	**23**
C2	**104**	**0**	**76**	**16**	**12**	**0.0000**	**3.000**	**-6.82242**	**1**
C3	**104**	**0**	**7**	**16**	**81**	**0.0000**	**6.000**	**7.88843**	**24**
C4	104	0	34	18	52	0.0668	4.500	1.94099	19
C5	**104**	**0**	**7**	**9**	**88**	**0.0000**	**6.000**	**8.31042**	**25**
C6	104	0	54	20	30	0.0121	3.000	-2.61861	10
C7	**103**	**1**	**79**	**10**	**14**	**0.0000**	**2.000**	**-6.74019**	**2**
C8	104	0	42	22	40	0.9121	4.000	-0.22086	16
C9	**104**	**0**	**17**	**22**	**65**	**0.0000**	**5.000**	**5.30071**	**21**
C10	104	0	57	21	26	0.0010	3.000	-3.40269	9
C11	**104**	**0**	**18**	**14**	**72**	**0.0000**	**5.000**	**5.69210**	**22**
C12	104	0	44	17	43	1.0000	4.000	-0.10721	17
C13	103	1	44	31	28	0.0771	4.000	-1.88562	13
C14	103	1	38	31	34	0.7237	4.000	-0.47140	15
C15	103	1	53	19	31	0.0219	3.000	-2.40040	12
C16	**104**	**0**	**61**	**20**	**23**	**0.0001**	**3.000**	**-4.14614**	**6**
C17	103	1	47	15	41	0.5940	4.000	-0.63960	14
C18	**104**	**0**	**60**	**33**	**11**	**0.0000**	**3.000**	**-5.81523**	**3**
C19	**104**	**0**	**54**	**32**	**18**	**0.0000**	**3.000**	**-4.24264**	**5**
C20	**104**	**0**	**52**	**34**	**18**	**0.0001**	**3.500**	**-4.06378**	**7**
C21	**104**	**0**	**53**	**36**	**15**	**0.0000**	**3.000**	**-4.60818**	**4**
C22	103	1	45	34	24	0.0161	4.000	-2.52810	11
C23	**104**	**0**	**46**	**41**	**17**	**0.0004**	**4.000**	**-3.65366**	**8**
C24	104	0	36	28	40	0.7308	4.000	0.45883	18
C25	104	0	29	26	49	0.0315	4.000	2.26455	20

Statements with the strongest:

Agreement

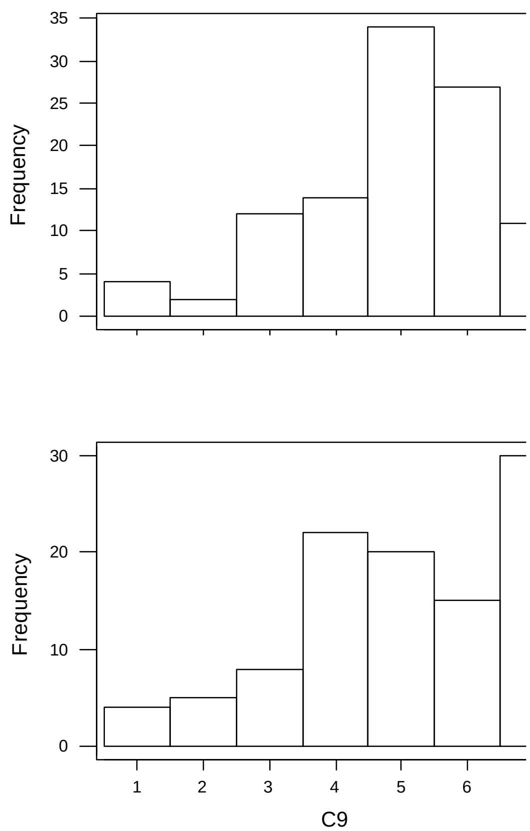
Disagreement
(Sign test rank order)

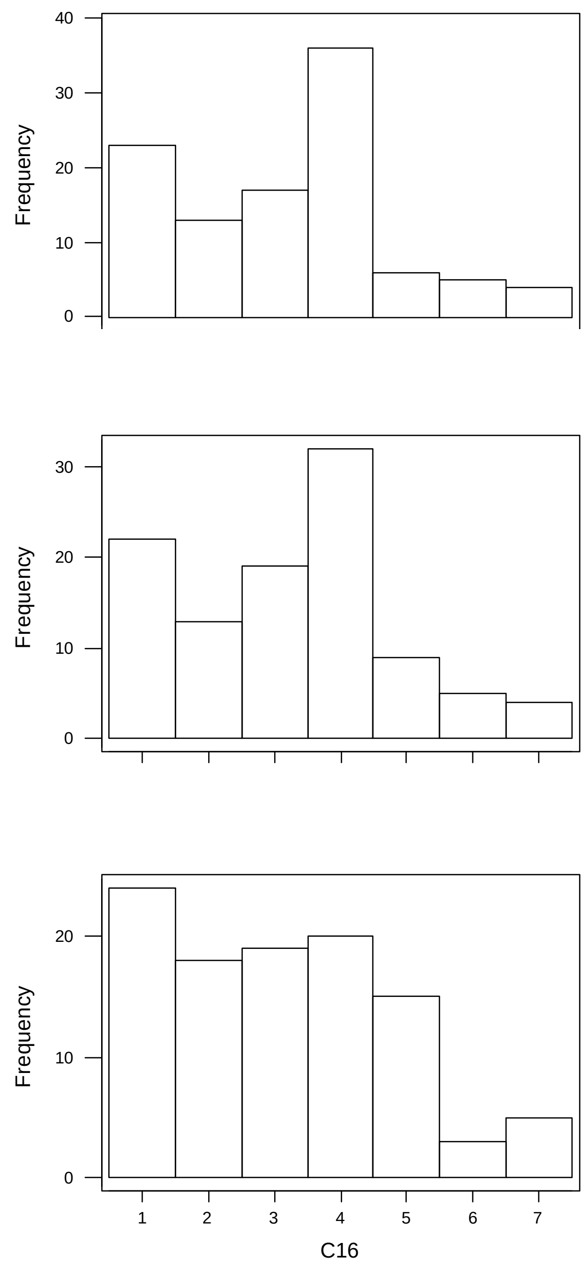


Statements with the strongest:

Agreement

Disagreement
(Sign test rank order)

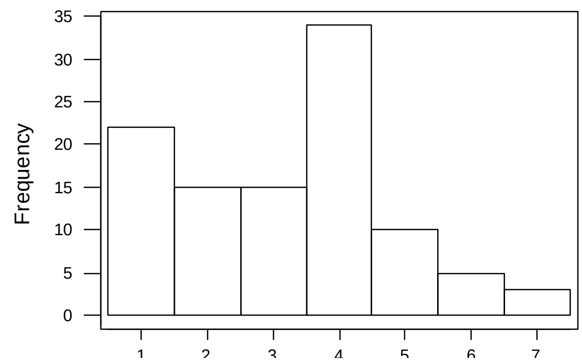


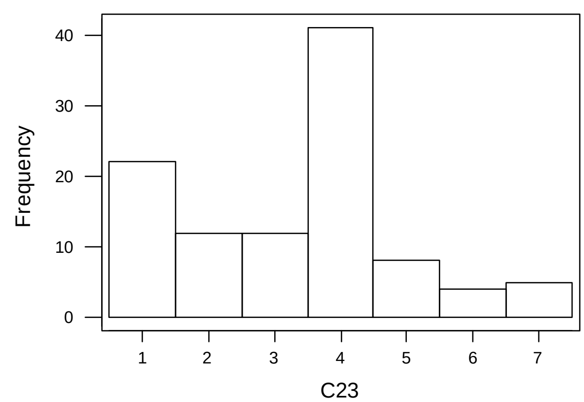


Statements with the strongest:

Agreement

Disagreement
(Sign test rank order)





DISCUSSION OF RESULTS

An analysis of the results indicates that students in advanced business statistics at MTSU exhibited a strong opinion and preference regarding the use of the manual (hand-held calculator) method of learning instead of the use of a computer software package. However, as the level of computational complexity increases the level of disagreement with MINITAB usage decreases.

SUMMARY AND CONCLUSION

A questionnaire was administered to students at MTSU who were enrolled in advanced statistics in the fall of 1998 in an effort to investigate their perceptions of the effectiveness of various methodologies of teaching, i.e., manual (hand-held calculator) or utilizing a computer software package. The students clearly preferred utilizing the manual method.

Further research is suggested to investigate possible difference in preferences in teaching methodologies between gender, instructor, age, and instructor, as well as ease of use between the different methodologies. Additionally, outcome assessment studies could be undertaken in order to analyze the relationship between students perception and performance.

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APPENDIX

Q.M. 362 CLASSES

Student Perception of Learning: Comparing Manual Procedures with MINITAB

In many Q.M. 362 classes a statistical topic is introduced using manual techniques with hand-held calculators. Once the basic principles and procedures of the technique are presented MINITAB is then used to work the same or similar problems. In an effort to ascertain the benefits students obtain from the two approaches the following questionnaire has been devised.

Please circle your response to each of the following questions on a scale from 1 (strongly disagree) to 7 (strongly agree)

	Strongly Disagree	Strongly Agree
1. I learn more from manual calculations than from problems solved with MINITAB	1 2 3 4 5 6 7	
2. I retain more knowledge of statistical techniques from problems worked with MINITAB than problems worked manually	1 2 3 4 5 6 7	
3. Introduction of statistical topics using manual procedures provide a good understanding of the rationale and techniques of the topics	1 2 3 4 5 6 7	
4. Reinforcement of statistical topics using MINITAB after manual techniques have been covered strengthens and enhances my understanding of the topics	1 2 3 4 5 6 7	
5. Manual exercises increased my knowledge of each statistical procedure	1 2 3 4 5 6 7	
6. MINITAB exercises increased my knowledge of each statistical procedure	1 2 3 4 5 6 7	
7. Manual computations distracted me in understanding and mastering concepts of statistical methodology	1 2 3 4 5 6 7	
8. MINITAB procedures distracted me in understanding and mastering concepts of statistical methodology	1 2 3 4 5 6 7	
9. I would prefer greater emphasis on manual calculations in the course	1 2 3 4 5 6 7	
10. MINITAB procedures were clear and understandable	1 2 3 4 5 6 7	
11. Manual procedures were clear and understandable	1 2 3 4 5 6 7	

12. MINITAB procedures challenge and encourage independent thought 1 2 3 4 5 6 7

13. In the classroom MINITAB allows for better structure of content 1 2 3 4 5 6 7

14. In the classroom MINITAB allows for standardized delivery of content 1 2 3 4 5 6 7

15. In the classroom MINITAB allows for more interesting instruction 1 2 3 4 5 6 7

16. In the classroom MINITAB allows for longer retention of course material 1 2 3 4 5 6 7

17. It is easier to learn how to use MINITAB to perform a hypothesis than it is to learn how to perform the hypothesis test manually 1 2 3 4 5 6 7

18. MINITAB was particularly helpful in understanding one-sample parametric tests such as the t-test 1 2 3 4 5 6 7

19. MINITAB was particularly helpful in understanding one-sample non-parametric tests such as the Wilcoxon Signed Ranks test 1 2 3 4 5 6 7

20. MINITAB was particularly helpful in understanding two-sample parametric tests such as two-sample t test with pooled variance 1 2 3 4 5 6 7

21. MINITAB was particularly helpful in understanding two-sample non-parametric tests such as the Mann-Whitney test 1 2 3 4 5 6 7

22. MINITAB was particularly helpful in understanding multiple-sample parametric tests such as ANOVA 1 2 3 4 5 6 7

23. MINITAB was particularly helpful in understanding multiple-sample non-parametric tests such as the Kruskal-Wallis test 1 2 3 4 5 6 7

24. MINITAB was particularly helpful in understanding simple linear correlation and regression 1 2 3 4 5 6 7

25. MINITAB was particularly helpful in understanding multiple regression analysis 1 2 3 4 5 6 7

HAS INFORMATION SYSTEMS BECOME TO BROAD FOR ONE CURRICULUM MODEL?

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ABSTRACT

Just a few years ago when a student asked the question, "What kind of job can I expect to get with a degree in Information Systems?," the answer was usually easy: maintenance programmer or junior programmer. Today, the answer is much more difficult. Along with the tremendous growth in the use of information technology, has come tremendous growth in both the number and type of jobs available. While it is true that many of the entry level jobs in Information Systems (IS) are still of the traditional programer type, many new IS graduates begin in jobs that previously were the province of experienced programmers and analyst, or in jobs that didn't even exist just a few years ago. New graduates may start in jobs such as developing and supporting Internet applications, user support in functional areas, designing and building user interfaces, multimedia applications, and the list goes on.

New IS graduates are being educated via curricula that are typically based on a single model that has little room for diversity. Instead of embracing diversity with several different curriculum models, the discipline has migrated to a single model, IS'97 (see table 1). The IS'97 curriculum model is a joint effort of the Association for Computing Machinery (ACM), Association for Information Systems (AIS), and the Association of Information Technology Professionals (AITP), (formerly DPMA). IS'97 is a significant accomplishment developed and supported by some of the best minds in the IS academic community and this paper in no way attempts to diminish their achievements. Instead, it is a call to examine the possibility that the IS discipline has grown to the point that alternatives to a single curriculum model should be considered.

One could argue the IS'97 model represents a common body of knowledge that provides a foundation for lifelong learning. This foundation can then be used as a launching pad to branch into more specialized areas on the job. However, with compressed time frames for decision-making and higher expectations of IS graduates, it may be time to examine a different approach to IS curriculum design.

Recent research has shown significant diversity in the course offerings of different colleges and universities. Table 1 shows courses typically associated with the IS'97 courses and the percentage of schools offering those courses. Only three courses (Programming, Systems Analysis and Design 1, and DBMS concepts) were offered 100% of the time and one course (Data Communications) was offered 88% of the time. The remaining seven courses in the model were offered from 26 to 59% of the time. This would seem to indicate that most colleges and universities do not follow the IS'97 curriculum model. Alternative approaches to the IS'97 model are offered in the full paper.

Table 1

IS'97 Courses	Typical Course Names
IS'97.0 - Knowledge Work Software Tool Kit	56% Microcomputer Applications
IS'97.1 - Fundamentals of Information Systems	53% Computer Concepts IS Concepts
IS'97.2 - Personal Productivity With IS Technology	26% End User Computing
IS'97.3 - Information Systems Theory and Practice	59% Management of IS
IS'97.4 - Information Technology Hardware and Software	53% Computer Concepts
IS'97.5 - Programing, Data, File and Object Structure	100% COBOL I & II, C**, or Visual Basic
IS'97.6 - Telecommunications	88% Data Communications
IS'97.7 - Analysis and Logical Design	100% Systems Analysis & Design I
IS'97.8 - Physical Design and Implementation with DBMS	100% DBMS Concepts
IS'97.9 - Physical Design and Implementation with Programming Envnts	35% Systems Analysis & Design II
IS'97.10 - Project Management and Practice	53% IS Projects

A SURVEY OF PROJECT MANAGEMENT METHODS UTILIZED BY MEMBERS OF THE PROJECT MANAGEMENT INSTITUTE

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INTRODUCTION

Project management, functional management, and general management are now considered to comprise the horizontal differentiation of management responsibility [1]. Typically project managers coordinate the work of individuals from several different units in the organization. Consequently, individuals assigned to a project management team vary from project to project as needed. The project management staff permanently assigned to a project manager often are facilitators and schedulers. Since projects usually entail many interrelated activities necessary to compete the task successfully, project planning and control of scheduled times are key facets of utmost importance to the project manager. Consequently, many methods ranging from the Gantt Chart to a myriad of sophisticated proprietary products are available to assist the project manger in job performance.

In a southern MSA of approximately 280,000 population, the membership of the regional Project Management Institute (PMI) were surveyed to ascertain the scheduling, planning, and control method(s) used in their work and the perceived effectiveness of these methods. Respondent employment included construction engineering, military and civilian service, banking and finance, credit card processing services, and insurance services. Many proprietary methods to assist the project manager are readily available. Respondents were asked to rank from (rarely) 1 to 5 (almost always) the frequency of usage and to rank the effectiveness of the method from 1 (not at all) to 5 (very). Additional information ascertained included sex, age, education, and experience.

The questionnaire specified twelve tools or methods available for use by the project manager with an added category labeled “my own method.” Interestingly, more (63%) of the responding project managers specified “my own method” as a choice than for the Gantt Chart (60%), Microsoft Project (57%), Multi-Trak and Lotus Notes (53%), PERT/CPM (50%) and Prima Vera (43%). The company with the most PMI members provides training for employees in Multi Trak/Lotus Notes usage. We suspected that the Gantt Chart would be used the most often as it is the oldest and perhaps easiest technique to use. Ascertaining the specifics of “my own method” to search for commonality was not attempted.

Table 1 presents the survey results specifying percentage of respondents using each method, mean frequency of use on the 1-5 scale and mean usage effectiveness.

TABLE 1
Project Management Tools Usage Percentage of Respondents,
Mean Usage Frequency and Effectiveness - by Surveyed PMI Members
January 1999

Method	Usage Percentage	Mean Usage Frequency	Mean Effectiveness[2]
My Own Method[3]	63%	3.47	3.37
Gantt Chart	60%	3.59	3.06
Microsoft Project	57%	3.41	3.35
Multi Trak/Lotus Notes	53%	4.56	3.56
PERT/CPM	50%	3.00	3.53
Prima Vera	43%	3.54	3.31
Project Scheduler	17%	2.60	1.60
Linear Programming	7%	2.50	2.50
Scere Trak	7%	2.50	2.00
Artemis	7%	1.50	2.00
6 Per Plan	7%	2.50	2.00
Project/2	3%	2.00	2.00
CA-Super Project	3%	2.00	3.00

Footnotes: (Since respondents use multiple methods, percentages do not total to 100%)
1. Usage Scale: 1 (Rarely), 2 (Seldom), 3 (Sometimes), 4 (Usually), 5 (Almost Always)
2. Effectiveness Scale: 1 (Not at All), 2 (Not Very), 3 (Somewhat), 4 (Fairly), 5 (Very Effective)
3. Specifics unavailable for this survey

Using the 1 to 5 scaling technique and assuming 3 to be the mean of a uniform distribution, the top six techniques exhibited usage and effectiveness levels that were slightly above the assumed mean. Multi Trak/Lotus Notes training was available within the company that had the most respondents to the survey; thus the mean usage frequency of 4.56 reflects the tool commonality within this single organization. Excepting PERT/CPM, the mean effectiveness of the six most used techniques was universally below the mean usage frequency. This may reflect the inherent uncertainly in scheduling and time extrapolation. However, none of these difference was greater than 1 unit (20% of the scale).

Linear programming, a widely used aggregate planning technique, that assumes known and certain variable relationships and values was used by only 7% of the responding project managers. Again this supports the problem of uncertainty and its pervasiveness in project management. The need for a simple, easy to use, and effective tool is both a function of tool usage experience and project manager skill. This survey does not find that any specific technique is universally used or effective for this group. If a panacea tool is available, its presence and usage was not discovered in this survey.

Respondents demographics are (2):

Sex: 53% male, 47% female
Age: 3% below 25, 10% were 26 - 30, 27% were 31 - 35, 23% were 36 - 40, 27% were 41 - 50, and 10% were 51 - 60. Mean age: 37
Education: No college - 17%, Associate degree - 13%, Baccalaureate degree - 43%, Masters degree - 27%
Years Experience: below 5 - 23%, 6 to 10 - 17% 11 to 15 - 30%, 16 to 20 - 10% 21 to 25 - 10%, over 25 - 10%
Years in Current Position: below 5 - 83%, 6 to 10 - 13%, 11 to 15 - 4%

FOOTNOTES

1. Management, Bartol and Martin (2nd Ed., McGraw-Hill Publishing, New York), p. 26.

2. Survey of Membership of Columbus, Georgia Project Management Institute Membership.

EFFICACIES OF A COLLABORATIVE DISCIPLINE WEBSITE: FACULTY, STUDENT, AND ADMINISTRATIVE BENEFITS

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ABSTRACT

In this age of evolving technologies that can impact pedagogical endeavors so strongly, instructors in higher education often find themselves charting new territories in teaching and learning. The pace of technological advances often has outstripped the capacity to master the skills necessary to use the technology effectively in the classroom. One of the advances impacting the learning approaches in college classrooms is the availability of the Internet. While administrators scramble to find the dollars to fund the computers and projectors needed in the classroom, instructors scramble to learn the best utilization of the technological tools available.

This paper describes a collaborative effort of a small marketing faculty in a college of business to construct a discipline-wide website: a website that could be utilized by instructors and students in all the marketing courses. In this effort, each faculty member contributed his/her most useful links to online material that served to enhance the learning experiences of students enrolled in the marketing courses. By utilizing a collaborative effort, the instructors were able to share their online research and to get a more comprehensive idea of what their colleagues were covering in their respective courses. Some of the professors had personal class websites already; some did not. The project helped to involve those who had not gone online and strengthened the information base of those already online. All marketing students had access to the online material and college administrators praised the effort as both an enhancement of learning and teaching and a cost-efficient usage of the college webmaster's time.

INTRODUCTION

Traditional college classrooms are at various stages in the process of being technologically transformed. In this process, teaching and learning is being transformed as well. Noble (1997) argues that "recent events . . .signal dramatically that we have entered a new era in higher education, one which is rapidly drawing the halls of academe into the age of automation." Wilcox and Osterlaus

(1998) add that "today, with . . . a screen and projector, a laptop computer, and a positive attitude, a traditional classroom can be immediately transformed."

In no place is this technological transformation more evident that the classrooms of applied disciplines such as marketing. As little as five years ago, the professor was considered current and innovative when she brought to class the latest issues of the discipline's newsletters and shared "current events." Or perhaps this professor engaged the students with articles copied from the latest issued of a journal in the field. Today's classroom is likely to be enhanced by at least one computer connected to the rest of the world. Students can discuss current issues while browsing databases in class or while perusing the Internet. When studying issues beyond domestic borders, internationalizing the curriculum is accomplished "in no better way . . . than the World Wide Web." (Rao, 1998) Technology of all types is having a major impact on the educational system. Just a few years ago Stout (1993) predicted that "the impact will come in the creation of effective learning environments where people become active and/or the material becomes richer." Today, "the virtual classroom is the concept that the world is our classroom . . ., and students may find sources of information as close as their computer." (Hawes, 1998) New technology has tremendous potential if students and faculty use if to engage in real instructional work. Another side benefit is "the potential to break down the arbitrary walls that exist between the disciplines. Computers do not understand academic boundaries." (Stout, 1993)

FACING REALITY

With the strong emphasis on advanced technology in college classrooms today, students (and faculty) can suffer from information overload. In particular, some faculty may not be sufficiently prepared to incorporate new technology (e.g. the Web) into their courses. Assistance is available to faculty through such services as NODE/REDO, a network operated by a Canadian consortium of educational institutions. It links post-secondary course and program developers, faculty, administrators, and learners interested in technologically-mediated teaching and learning (http://noed.on.ca/tfl). FIRST MONDAY is a peer-reviewed journal on the Internet that publishes original articles about the Internet and the global information infrastructure. (http://www.firstmonday.dk/) *The Technology Source for Higher Education* features articles on integrating informational technology in higher education (http://www.microsoft.com/education/hed/news/). Jensen (1998) has a collection of working papers on the Web that cover instructional technology topics applicable to any discipline (http://www.trinity.edu/~rjensen/). (IAT INFOBITS, 1997).

Faculty looking for a beginning point may want to consider working in partnership with colleagues. While postsecondary colleagues have conducted research together for decades, most faculty have yet to collaborate in teaching endeavors. "Participation in any activity has its price, and participation in collaborative teaching is expensive for teachers. Involving technology increases the price for many teachers." (Oberg, 1990) Often it is easier not to collaborate, as each effective collaborative team must proceed through three basic stages (Austin, A. And Baldwin, R., 1991):

1. Choosing team members
2. Dividing the labor
3. Establishing work guidelines

In advocating collaborative approaches, teachers often are challenging the norms of teacher privacy and self-reliance so deeply ingrained in their backgrounds. Administrators can foster collaboration by developing supportive policies to reward collaborative efforts. A multitude of case studies to support faculty peer collaboration can be found in Hutching's (1996) review conducted for the American Association of Higher Education.

The potential for high payoffs in student learning and in instructor effectiveness suggest that instructors work together and become oriented toward their entire body of majors. Shared goals and commitment to the field of study are mutually reinforcing. Collaboration allows professors to learn from one another. These professors are of critical importance in this learning change environment and their cooperation can facilitate continuous improvement.

BUILDING THE PRODUCT

Realizing the importance of utilizing the latest technological advances in their teaching efforts, the faculty of a small marketing program in a college of business constructed a discipline-wide website. This website was designed to be utilized by professors and students in all the courses in the entire marketing program. The "home page" of the site was designed to introduce the faculty members, to welcome students to the marketing program, and to set forth the mission and desired outcomes of the curriculum (see Figure 1). Additionally, the page offers to students a fast and efficient gateway to literally hundreds of links to marketing journals, magazines, libraries, newspapers, online surveys, and governmental , research, and consumer sites. Finally, the page links to individual sites of each professor and the college site (which links back to the university site).

Figure 1

BUILDING THE TEAM

The realization of the pioneer website design necessitated teamwork from the program faculty. This was initiated by the discipline coordinator bringing the seed idea to the rest of the faculty and enlisting their opinions relating to the concept. All of the faculty were quick to realize the benefits to the marketing majors of such a collaborative website. Through brainstorming the concept, each faculty member became a stakeholder of the concept. It was important that every faculty member be involved and willing to contribute to the continuous evolution of the site.

SHARING THE LOAD

The marketing professors found themselves at different levels of Internet integration in their respective courses. All had a minimum of a standardized webpage mandated by their college of business. These webpages listed degrees earned, years of experience, fields of specialty, and dissertation titles. The pages were extremely restrictive but at least were an attempt to introduce the faculty to students visiting the pages. Beyond these pages, some marketing faculty had no educational materials online while others had made pioneering efforts to put course materials online for their current students.

Work began on the discipline-wide website by faculty sharing their design ideas. In one face-to-face meeting and one electronic meeting, a design was adopted. Subsequently, the faculty were asked to share favorite links to be placed on the homepage for the use of all students in the discipline (these links related to the courses in the program, including Marketing Principle, Consumer Behavior, Promotional Strategy, Personal Selling, Retailing, Marketing Research, and Marketing Management).

To place the material on the university's server, aid was enlisted from the college of business webmaster and a group of students enrolled in a Computer Information Systems web design course. Within two weeks after the design was completed, the site was uploaded to the Net and available for use.

PROMOTING THE WEBSITE

The marketing faculty immediately began to utilize the new website for class assignments. Students were most appreciative of the ease of finding relevant marketing online information and were encouraged to share the URL with fellow students in the discipline. Additionally, the website was announced in a college-wide faculty meeting and praised by the department chair. Other disciplines were encouraged to begin collaboration on their own sites with the full endorsement of the dean of the college.

The college webmaster favored the collaborative approach of the marketing faculty in putting their materials online. Such efforts by groups of faculty members help avoid the duplication of effort of faculty within the same discipline putting the same types of materials online for their students. Avoidance of this duplication saves time, effort, and dollars of the already stretched budgets allocated to technology.

College administrators realize the enhancement of teaching and learning that the connectivity of the collaborative effort brings. They realize, too, that much promise exists for cross-disciplinary collaboration that eventually could help bring all faculty in the college into closer working relationships, perhaps extending into partnerships among faculty housed in different colleges.

THE FUTURE OF THE PROJECT

Plans exist to expand and improve the contents of the website continuously. Admittedly, it is a primitive first effort to enhance the learning experiences of students and faculty alike. Perhaps the most important benefic to such continuous improvement is the ongoing collaboration of the faculty regarding the goals and content of their respective courses. Dialogue about useful web material leads to dialogue about course topics and pedagogical approaches. Faculty without previous collaborative teaching experience are drawn into an ongoing team approach to improving the quality of all the courses in the program via enrichment of research sources. All faculty are an integral part of this team approach to total quality management of the major coursework. All members of the discipline should not only teach better, they should learn more about their field from one another. In these times of conflicting schedules and a tendency toward faculty isolation within a discipline, the website collaborative project is proving to be a key to inclusion and connectivity of all faculty within a particular field, with hopes of working as a cross-disciplinary tool as well. The future for such collaborative work both within and among disciplines is bright indeed.

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TELELOGISTICS: AN EFFECTIVE COST EFFICIENT UTILITY FORECASTING TOOL

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ABSTRACT

The birth and expansion of computers together with the growth of the Internet permitted government agencies and companies to work more efficiently and effectively. In a context of technology turmoil, logistics had an opportunity to redefine its boundaries. Innovative tools that change the concept of time and space have been implemented. Using these tools together with the Internet permitted faster response to customer demand. Until the emergence of the Internet, logistics was consuming a great deal of resources because there was no other way to transfer goods and information from the point of origin to the point of consumption. Nevertheless, with the technological "big bang" came the potential for businesses and government agencies to outsource some of their work.

If logistics can be handled by distant services, then it becomes cost-effective; workload and profit are increased. The technology is available and the market is ready, therefore the concept of a logistics service through the Internet must be accepted, understood, and desired. In this context, telelogistics can be defined as the choice of implementing, controlling, and updating the effective, cost-efficient flow and storage of logistics data from a local or distant Telelogistics database to remote users for the purpose of conforming to the remote users' requirements. All materials are accessible using Internet or Intranets technologies. According to AIL Systems demo web page, "An introduction to the field of Telelogistics," a typical telelogistics system is structured as an Intranet application that supports secure remote access. Accessing the information can be performed through a Local Area Network or through the Internet. Telelogistics data can be accessed using a standard Internet browser. No other software is required for the user unless the user is going to make revisions to documents. Not only is telelogistics more effective and efficient, but it permits a decentralization of the logistics system and it enhances the value of the product; above all positive aspects of this system is the capability to forecast with better accuracy the actual customer needs.

TRADITIONAL LOGISTICS VERSUS TELELOGISTICS

Traditional logistics is a centralized process. The structure is organized around a single logistics organ that manages the flow and storage of goods and related information. If any problem occurs at this central point, then the entire structure is affected.

On another hand, telelogistics is a decentralized system. There are several possible ways to go from point A to point B due to the nature of the Internet. Information can be accessed at any time even if a server containing the desired information is not working or is over-utilized. Telelogistics systems use mirror technology. Mirror technology provides at least one copy of the telelogistics database called "mirror server" at any given point in time. This solves two major problems: First, if there is a server failure, the information can still be accessed using a mirror server; Second, if the flow of information is very slow due to the number of users utilizing the same server, an alternative path can be found. Server failure and bottlenecks are anticipated and possible alternatives are created with this system.

Telelogistics is an effective, cost-efficient way to provide customers with logistics support. Telelogistics is designed with the latest computer technology to satisfy the customer needs in terms of getting the desired information at the right place, time, and condition.

THE UTILITY CONCEPT

A product or service possesses some value or utility because customers expect to find it or use it at the right place and time. Therefore, the two basic types of utility are place utility and time utility.

Stock and Lambert (1987), in their textbook, Strategic Logistics Management, define Place utility as the value added to a product by making it available at the right place. Value added by a telelogistics system is significant in this domain. Information is stored at the right place and can be accessed and modified from any location. This means that a telelogistics system provides its customers with a distant control on the place where information is delivered. Such a system can be really valuable to health centers or hospitals. Prior to an operation, a surgeon can access a telelogistics database and use its powerful search engines to find the desired information. A list of required equipment and photographs from previous operations are made available. Thus, prior to the surgical procedure, the surgeon is aware of his needs in terms of staff and equipment.

Stock and Lambert (1987), define Time utility as the value added to a product by making it available at the right time. Telelogistics users have fast and easy access to a large amount of logistics information. A request is sent to the telelogistics database and an answer is received in seconds. During the Gulf War, for example, U.S. military had ground and air supremacy because it had continuous information about movement of enemy troops. The military leaders were able to determine needs in terms of where and when they should strike because they were gathering and comparing information collected from various sources. Time was very valuable since the situation was continuously changing. Satellites, AWACS, and the Secret Service collected information that was simultaneously stored in several distant places and available at any time for fighter pilots and ground units. This military telelogistics system permitted minimum loss of human lives and material resources.

The value of a traditional logistics system can therefore be defined by a function of two variables, place utility and time utility. Nevertheless, having the right product at the right place and time is not enough. Since so many products and services are similar, confusion arises when a choice must be made. If all similar products are provided at the right time and at the right place, what really makes one the best of all? If there is no difference in the product itself, then the company should focus on the service or the condition in which the information is provided to customers. The development of the Internet is most helpful in this matter. It not only gives businesses an opportunity to expand their marketing campaign at a minimum cost, but it also adds value to the product or service by making it available in a customized manner. This additional new value is called "proprietary utility" and adds a third dimension to the traditional place and time utility concepts.

Proprietary utility adds value to the product or information by personalizing the system to the customer. A virtual bookstore, for example, can keep track of the category of books one is interested in so that it can better satisfy the customer (i.e. amazon.com). This gives personality to the system and helps the customer in his choice among all competitors. This new utility is called proprietary utility. Place and time utilities are still very important, but proprietary is the driver that makes the big difference between logistics and telelogistics because customization is too expensive locally. Customers are first attracted by a business because it can provide great place utility and time utility on its products but when competition gets tougher, proprietary utility is the variable that drives customers to their final choice.

Telelogistics adds proprietary utility to a business because quality management and customer support is a strategic choice which cannot be easily duplicated. As there are many ways to design a telelogistics system, some designers focus on providing a simple user interface with a good search engine; other systems are less user-friendly and more complex, but more efficient. Designing a telelogistics system that matches one customer's needs gives a business a unique, personalized, and competitive advantage. Telelogistics is so flexible that it permits the development of several different interfaces. People searching for logistics information can access the data the easy way with a friendly but limited interface or the hard way with powerful tools and search engines. Therefore, telelogistics is a personalized, intangible financial asset used to improve customers satisfaction with a forecast of their needs.

As computer price and dial-up connection cost are made affordable, accessing information through the Internet becomes a daily process. The Internet provides businesses with an opportunity to design and implement a customizable telelogistics system which has a value defined by a function of three variables, place utility, time utility, and proprietary utility.

GETTING A BETTER FORECAST

As the "world of bits" expands (Negroponte, 1995), the probability of making a strategic mistake decreases. One reason for this is the availability of information on the Internet, which permits a better forecast of what a business should do next. Managers must decide which strategy leads to the best outcome in terms of cost, satisfaction level, and profit. They must decide how to allocate a budget in order to enhance every aspect of their businesses. Telelogistics provides companies with ways of continuously tracking the customers' needs. This is done not only in terms of when, where, and how the product is expected to be, but also in terms of the "competitors' utility strategy." By keeping track of customers' needs and competitors' strategy, a company defines its own strategy based on the competitors' trend. Telelogistics provides a company with a continuous flow of data used to determine an average trend. If the time interval between successive data is small enough, a good extrapolation of the trend function is calculated and a "utility forecast vector" is computed. Companies implementing a telelogistics system appear behind their competitors, but as the continuous flow of data permits a better forecast, they will quickly move ahead. The more a business is enhancing the features of a product by improving place, time, and proprietary utility, the better the attraction for customers. The better the forecast, the less expensive it is to implement a new strategy.

DISCUSSION

Another major difference between logistics and telelogistics is the cost of increasing the value of a product / service. According to Larry Downes and Chunka Mui in Killer App, "the usefulness, or utility, of a network equals the square of the number of users". This statement, known as Metcalfe's Law, has been proven statistically accurate, this means that there is a high probability to have a second-degree polynomial relation between utility and the number of users.

For classical logistics, we can assume that the usefulness or utility of a product is a linear function of the number of customers.

With Telelogistics, if the number of users increases, the utility of the network increases exponentially. New tools are developed to satisfy users' needs and more information is available on the network. New equipment is not necessarily required. With logistics, if the number of customers increase, the utility of a particular product increases linearly. If more people are expected to buy a particular car if it has specific features and if it is available at a given time and place, then the utility of this car must be increased through enormous infrastructure investment. Staff and equipment requirements cost money and reduce the profit margin.

With Telelogistics, when the number of customers or users increases, the cost of adding value to a product / service decreases faster, and the value added to a system increases faster than with Logistics.

Managers must decide how to invest the money. They must choose and implement a strategy that leads to the best possible outcome. Metcalfe's Law does not give indication about what proportion, Place, Time, and Proprietary represent in the overall utility of a product. Therefore, the next step of this analysis is to expand Metcalfe's Law so that it includes the three basic utilities: Place, Time, and Proprietary utility. The objective is to determine how a company allocates its "Utility budget" and what is the impact on the value added to the product or service. The portion of the budget allocated to the product / service enhancement is split into three slices. The first slice represents how much money is given to implement a change in place utility in a given time frame. The second one represents how much money is given to implement a change in time utility in a given time frame. And the last one represents how much money is given to implement a change in proprietary utility in a given time frame. This could be seen as an investment "trade-off" between the three basics utility component.

Example: If management decide to allocate 60% of the "Utility budget" to increase place utility, then 40% is left for time utility. Note that allocating a fixed percentage of the "utility budget" to a particular utility (place or time in that case) does not mean that this utility will increase by the same percentage.

$$^{\%}Budget_{t_1 \to t_2}^{place} + {}^{\%}Budget_{t_1 \to t_2}^{time} = 100\% \text{ of initial Utility budget}$$

Meaning: The percentage of "Utility budget" allocated to improve place utility between time t1 and t2 plus the percentage of "Utility budget" allocated to improve time utility between time t1 and t2 is equal to the initial "Utility budget".

Including Proprietary utility, we get:

$$\%Budget_{t_1 \rightarrow t_2}^{place} + \%Budget_{t_1 \rightarrow t_2}^{time} + \%Budget_{t_1 \rightarrow t_2}^{proprietary} = 100\% \text{ of initial Utility budget}$$

Meaning: The percentage of "Utility budget" allocated to improve place utility between time t1 and t2 plus the percentage of "Utility budget" allocated to improve time utility between time t1 and t2 plus the percentage of "Utility budget" allocated to improve proprietary utility between time t1 and t2 is equal to the initial "Utility budget".

Example:

If management decides to allocate 70% of the "utility budget" to increase proprietary utility, then 30% is left for time and place utility. Therefore, a set of possible solutions must be constructed (i.e. segment [AB] on the following graph). Management must decide how to allocate the remaining 30%. They might decide to allocate 10% to place utility and 20% to time utility or any other combination of numbers as long as the sum of the two remaining percentages is 30%. Remember that allocating a fixed percentage of the "Utility budget" to a particular utility does not mean that this utility will increase by the same percentage.

The next question managers must answer is what percentage of the budget must be allocated to a utility in order to increase or decrease that utility by a given amount. The answer is given by the derivative of a function.

The slope of each line tells by how much a utility increases when additional budget is allocated to this utility function. The slope of a function is determined by its derivative. The following example is based on the previous graph.

Example based on the graph above:

If 50% of the budget is allocated to proprietary utility, then this utility is increased by 40%, meaning that the slope or rate of change of proprietary utility with respect to budget is 40/50. Therefore, a 1% investment on proprietary utility leads to a (40/50)% increase in proprietary utility.

Note that each "utility function" has a different slope. Obviously there is no reason why they should be identical.

Then,

Now that we have three rates of change, the next step is to calculate the actual increase in dollar amount of each utility.

Money invested is transformed into value added (increase in utility). Using the previous example, if the rate of change of proprietary utility with respect to budget is 40/50, then, a $100 investment leads to a $80 added to proprietary utility. Note that $80=$(100*40/50).

Then,

Here, we still don't know how fast the change in utility occurred. The next step of our analysis is to differentiate the change in utility with respect to time. We need to develop this equation in order to determine the maximum rate of change of one utility with respect to time.

$$\frac{\partial}{\partial t}\left(Budget_{t_1 \to t_2}^{place} * \frac{\partial Place^{u}}{\partial Budget_{t_1 \to t_2}^{place}}\right) = \frac{\partial}{\partial t}\left(\Delta Place_{t_1 \to t_2}^{u}\right)$$

$$\frac{\partial}{\partial t}\left(Budget_{t_1 \to t_2}^{time} * \frac{\partial Time^{u}}{\partial Budget_{t_1 \to t_2}^{time}}\right) = \frac{\partial}{\partial t}\left(\Delta Time_{t_1 \to t_2}^{u}\right)$$

$$\frac{\partial}{\partial t}\left(Budget_{t_1 \to t_2}^{proprietary} * \frac{\partial \Pr oprietary^{u}}{\partial Budget_{t_1 \to t_2}^{proprietary}}\right) = \frac{\partial}{\partial t}\left(\Delta \Pr oprietary_{t_1 \to t_2}^{u}\right)$$

These equations permit to determine when the money should be invested in order to obtain the largest increase in Utility (maximum slope at a given time t*). From the previous equations, we know that a change in utility is more expensive for Logistics than for Telelogistics under some special conditions. Point A and B must be passed on the utility-users and cost-users curves. Passed a given number of users, Telelogistics is more valuable than logistics.

How do we get this information?

Companies are using incentives such as discount rate when they receive early payment from customers. The data required to build our model is at least as much valuable as collecting money earlier. Keeping the same idea in mind, a discount should be given to customers and users for answering a few questions such as:

- Out of 100 points, how many points would you allocate for having more of this product in a store close from where you live? [0-10], [10-20], ...

- Out of 100 points, how many points would you allocate for improving the accessibility of a particular web service? [0-10], [10-20], ...
- Do you consider this service, a waste of time?
- Would you like being able to further customize this interface (e-commerce)?

Customers and users of traditional logistics system do not have an incentive for providing this kind of information. On another hand, customers and users of telelogistics system are given an opportunity to get a small discount and a better service by supplying this information. Often, companies are sending survey forms by mail to their customers. A more efficient way to survey people is to use a web page. First, information is directly collected in a database. Second, customers are given an opportunity to personalize their product. This is very valuable because it permits to evaluate how customers perceive the three utilities: Place, Time, and Proprietary.

What does the company do with this information?

The company can plot a 3D surface representing the money they spent during a given period of time for improving their overall utility by an amount specified by their customers or users. Remember that the cost of enhancing a utility with a Telelogistics system is less expensive than with a logistics system under the condition that the number of users/customers is large. Previous equations support this statement.

What about the company Performance Level?

The overall utility of a business can be represented as a set of parallel surfaces for each "performance level"

Consider the following equation:

$$\text{Utility} = f(\text{Place, Time, Proprietary}) + L$$

Where "L" is the performance level of your company.

Each value of "L" defines a different surface shifted downward or upward. The better the performance level L, the higher the surface. Each point on the surface represents a different Telelogistics strategy and "L" tells if your strategy was good or not. If your Telelogistics system operate at 50% (L=.5), that means that some of your competitors did much better than you with a different Utility strategy. Therefore, the strategy of your business must be changed to push the surface upward. The competitor who generates the highest profit should serve as a benchmark. Its performance level is L=1 or 100% and yours is a ratio between 0% and 100%.

What could be done if the surveys from all your competitors were available?

This question is answered by introducing the regression analysis concept.

From the previous equations and surveys, a company can determine how much was spent to increase a utility by a given amount for performing at a defined level of performance using a specific strategy. If you know how much your competitors spend on utilities and how well they performed, then the following method can be used.

1. We will assume that an answer is qualified as good if its probability of occurrence is equal to or greater than 95%. Meaning that the value is found by a "t distribution" curve or two tails curve. 95% of the area under the curve correspond to the probability to find the information in within a ± 2 interval.

2. It is most likely that among your competitors, some will have a comparable performance level. So, we can plot an area of 95% probability that contains your competitors' strategy information (utility percentage) at a particular performance level L.

This implies that if several businesses decide to implement a similar "Utility strategy" (similar allocation of the "Utility budget"), then the probability that their level of performance "L" will be similar is high.

The information needed to perform such a regression could be in the following format:

Note that the same data are needed for Time and Proprietary utility as well. The final result is a triple regression analysis (one on each axis).

Because of the following assumption,

$$\%Budget_{t_1 \to t_2}^{place} + \%Budget_{t_1 \to t_2}^{time} + \%Budget_{t_1 \to t_2}^{proprietary} = 100\% \text{ of initial Utility budget}$$

We need only two regression analysis to plot a most probable "strategy point" at a given performance level "L".

3. Then, a "utility trend curve" is defined by interpolation of each "strategy point" at each performance level. Using this curve as a base line, we can determine the direction of a "utility forecast vector". This vector provides a powerful information. It tells you how you should allocate your resources (utility budget) in order to get the best possible outcome (customer satisfaction, maximum utility, and maximum profit).

CONCLUSION

Telelogistics systems provide businesses with tools to achieve their first economic objective; lower cost and higher profit margin. Customer satisfaction is the second long term objective. Customers are satisfied when they can find a low cost, high value, and customized product where and when they need it. Businesses that use this system can segment the market needs in terms of the three major utility variables. Place, time, and proprietary utility needs are based on surveys conducted by a business as well as on competitors' strategy analysis. Telelogistics is more valuable than logistics when data can be collected on a continuous basis, and when the number of users is large. Also, the smaller the time interval between information collection period, the better the extrapolation and the forecast of utility needs. The expansion of the Internet and the decreasing price of computers created a favorable environment for the birth of this "Killer App". Telelogistics is the strategic choice of satisfying customers needs by maximizing the value of a product or service at the lowest possible cost. Telelogistics permits a better forecast of utility needs.

Editor’s Note: Figures and tables available from author

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A WEB-BASED DECISION SUPPORT SYSTEMS FOR LOGISTICS DECISION MAKING: A SUPPLY CHAIN MANAGEMENT PERSPECTIVE

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ABSTRACT

This paper proposes a web-based decision support systems for a supply chain management decision making. In supply chain management, there is always a likelihood of having disagreements among parties for a certain decision making process. This phenomenon gets worse when the business environment becomes more competitive and turbulent. Much research has been done on the topic of DSS. There have been only a few literatures on a web-based DSS. However, no research has been done on a web-based DSS for a supply chain management decision making. A lack of study on the particular DSS drives this study. It is expected that this research provides additional insights to the supply chain management and information systems literatures. An aggregate production and inventory control model is used for the proposed systems' application example.

INTRODUCTION

In Supply Chain Management, there is always a likelihood of having disagreements among parties for a certain decision making process. This phenomenon gets worse when the business environment becomes more competitive and turbulent. In literature, a lot of algorithmic approaches as well as behavioral approaches have been proposed to coordinating a conflict of decisions. Recently, decision support systems (DSS) approaches are receiving more attention from researchers and practitioners as information technology advances rapidly. Especially, as the Internet-based telecommunication environment is prevailing in the modern firm, integration of DSS and Internet emerges as one of promising alternatives for coordinating a decision making process which often operates in a separate and remote area. Accordingly, a web-based DSS is considered capable of coordinating such a business case.

Much research has been done on the topic of DSS. DSS has been integrated into many different parts of the business industry, such as logistics, inventory management, supply chain, and the World Wide Web. In the area of logistics, Min (1998) found that computer assisted DSS aids logistics managers in numerous ways. Robinson (1997) states that DSS help logistics managers make facility network design decisions. In the area of inventory management, Harrison (1998) found that many companies are using DSS tools to analyze sales figures and track business strategies. On the World Wide Web, O'Keefe and McEachern (1998) explain how a customer DSS connects a company to its customers and provides support for some of the decision-making process. Wilson (1997) tells about the relationship of a data warehouse and a web server. He also discusses three approaches that are used. There have been only a few literatures on a web-based DSS. However, no research has been done on a web-based DSS for a supply chain management decision making. A lack of study on the particular DSS drives this study. The purpose of this paper is to explore a possibility to develop a web-based decision support systems for a supply chain management decision making. It is expected that this research provides additional insights with the supply chain management and information systems literatures.

This paper is composed of five sections. Section 2 reviews literatures on related topics. Section 3 attempts to build a web based DSS model and an illustrative example uses the web-based DSS for an aggregate production and inventory control model. This paper ends with some concluding remarks.

LITERATURE REVIEW

Logistics Management

Min (1998) reports that a personal computer assisted decision support system aims at aiding logistics managers in selecting the most appropriate transportation choice between private and common carriers. In contrast with a traditional stand-alone system, this decision support system is designed for integration with the company's internal data base systems, the analytic hierarchy process model base and user controlled dialog systems for what-if scenarios. Robinson (1997) states that logistics managers frequently utilize decision support systems (DSS) to make facility network design decisions. Many DSS do not provide optimization capabilities, but instead rely on scenario evaluation as a means for developing solutions. Decision makers generate relatively high-quality solutions using the DSS variants. The type of design problem solved does not significantly impact problem-solving performance. However, performance degraded and variability in solution quality escalated as problem size was increased. The availability of incremental solution cost improvement cues in the DSS significantly improves solution quality and reduces performance variability. Kogan, Sudit, and Vasarhelyi (1997) explain that recent developments in Internet technology and electronic commerce will have a profound effect on the role of management accounting systems in decision support, internal auditing, and control. Internet technology will likely become increasingly more hospitable to electronic commerce. Companies increasingly are experimenting with EDI (Electronic Data Interchange)-type systems over the Internet. A number of the so-called enterprise-wide information systems are available commercially. Internet-based enterprise-wide information systems provide management accountants with a working set of comprehensive inter-organizational, intra-organizational, and global decision-support systems. Internet technology also stimulates electronic commerce significantly. It increases analytical power, relevancy, and reach of management accounting. Hickey (1999) reports that Concept Information Systems and MicroStrategy jointly announced Q-Manufacturing, which is a data warehousing and decision support software solution that is integratable with enterprise resource planning software. Baan Co. NV, an enterprise resource planning (ERP) software company, recently announced the beta release of a new software product, Baan Enterprise Decision Manager. Kewill ERP, a division of Kewill Systems PLC, introduced new modules for its ERP solutions for small to midsize manufacturing companies. TranSolutions, a distribution and transportation management software company, has developed EZ-Overcharge, an application to recover excess costs when a company has been overcharged by a carrier.

Inventory Management

Verity (1997) states that in the fall of 1996, such major retailers as Wal-Mart Stores Inc., Sears, Roebuck and Co., Sara Lee Corp., Warner-Lambert Inc. and a few other major players in the consumer packaged goods and retailing industries rallied around a promising new Web-based scheme called CFAR (collaborative forecasting and replenishment). CFAR promised a formalized way for manufacturers and retailers to collaborate on future demand for products. By posting selected internal data on a shared Web server, supply chain partners could share and jointly develop forecasts that are more accurate. However, getting CFAR to work as promised and be adopted widely as an industry standard is taking longer than it seemed it would in 1996. Wal-Mart and other potential users have deemed its original scope too limited, and they are now scrambling to expand it into CPFR (collaborative planning forecasting and replenishment). Hammering out the definitions of CFR now are technologies from nearly 50 different retailing and manufacturing companies. Harrison (1998) explains that a growing number of companies are turning to decision support tools to analyze sales figures and keep track of business strategies. Managers at Service Merchandise Company Inc. decided that the firm's economic survival hinged on a transition to a more traditional retail operation. Service Merchandise had sales data sitting on an IBM mainframe, but managers had no way of looking at sales figures by store, market, or region to determine which catalog items were the fastest sellers in which parts of the US. To solve the problem, they pulled its legacy data from the mainframe into an Informix data warehouse where it could capture sales and product information by market of region. Then, they selected the DecisionMaster DSS tool, which allowed the company to identify less profitable products and eliminate the slower-moving merchandise. With this DSS tool, managers can compare a specific market, region, district, or individual store to data from the entire chain, as well as compare store inventory levels and forecast projected sales.

Supply Chain

Foster (1998) describes how GAF Materials Corp., the largest manufacturer of asphalt-based roofing materials in the US, is about to take the plunge into supply chain optimization. But the company has decided to first test the waters, trying optimization on a smaller scale. Its first venture into this area has been a freight-management decision-support system that the company developed on its own. The purpose of this freight-optimization model is to find the least-cost dispatching option for each day's shipments. However, freight optimization is just a small part of the proposed enterprise-wide supply chain optimization plan.

Web-Based Systems

Curtis (1998) tells about how getting ahead in e-business means having good information on which to base decisions. The first step in defining an approach to e-business site design and metrics gathering is understanding and articulating the questions that need to be answered. A good place to start is to develop an understanding of how each of the pages of the e-business site is performing. There are various tools on the internet today that will measure Web sites hits and can report various types of information, yet their usefulness to business line managers is questionable. The conclusion is that Web sites need to be designed with metrics for measuring business success in mind. O'Keefe and McEachern (1998) reports that a customer decision support system (CDSS) is a system that connects a company to its existing or potential customers, providing support for some part of the customer decision-making process. CDSS is one way of conceptualizing second-generation Web-based marketing systems. It is a well-planned framework for those developing substantial systems particularly in the business-to-business environment. The parts of the customer decision process can be supported. A CDSS must be placed within the context of the other Web and Internet facilities available to a customer. This is done through a simple framework based on consumer behavior. Fielden (1998) tells about Information Builders Inc.'s WebFocus 3.3.1. It is a very good solution aimed at helping both developers and Web designers build powerful executive information system (EIS) and decision-support applications. Because WebFocus is built on IBI's Enterprise Data Access (EDA) middleware, applications will be able to pull data from multiple sources regardless of hardware platform, database structure, or physical location. WebFocus is made up of just 3 components beyond the basic Web browser: the Web server, WebFocus CGI, and the WebFocus server. Nevertheless, the product is not flawless, but it does offer powerful reporting and decision-support capabilities. King (1998) states that Chrysler Corp. is giving 2,000 business users point-and-click access to large amounts of real-time manufacturing and production data. In doing so, the $61 billion car-maker is extending decision-making to business analysts, line personnel and almost anyone with an Internet browser. The enormous effort integrates 21 mainframe transaction systems and users throughout the world. The World Wide Web-based Do All system lets users view everything from vehicle ID numbers and parts lists to quality and warranty data. Wilson (1997) explains that to access decision-support information with a browser, software is needed that sits between the Web server and the data warehouse. The software's sole mission is to translate the HTML (hypertext mark-up language) of the Web into the structured query language of relational databases. If the data warehouse sits on top of a database that uses a different type or proprietary form of query language, translation software will have to work with that, too. Web-enabled OLAP products use one of 3 basic approaches. The first approach lets developers transform data from a warehouse into static HTML reports. The second approach gives users more options about what data they view and how they view it. It uses Java applets to provide a richer GUI and maintains the overall framework of an HTML page at the same time. The third approach is a Java-only environment. This provides a rich graphic environment and the flexibility to do ad hoc queries because it does not limit users to the restrictive structure of HTML pages.

In summary, much research has been done on the topic of DSS. DSS has been integrated into many different parts of the business industry, such as logistics, inventory management, supply chain, and the World Wide Web. In the area of logistics, Min (1998) found that computer assisted DSS aids logistics managers in numerous ways. Robinson (1997) states that DSS help logistics managers make facility network design decisions. In the area of inventory management, Harrison (1998) found that many companies are using DSS tools to analyze sales figures and track business strategies. On the World Wide Web, O'Keefe and McEachern (1998) explain how a customer DSS connects a company to its customers and provides support for some of the decision-making process. Wilson (1997) tells about the relationship of a data warehouse and a web server. He also discusses three approaches that are used. However, no research has been done on web-based DSS for Logistics decision-making from the SCM (supply chain management) perspective.

In summary, the literature review reveals there has been only a few literatures on a web-based DSS. However, no research has been done on a web-based DSS for a supply chain management decision making.

A WEB-BASED DECISION SUPPORT SYSTEMS

A web-based DSS is characterized by the following properties: (1) It can run on the Internet that has open connectivity (2) Multiple web-based DSSs can be easily interconnected to each other (3) a web-based DSS consists of several intelligent agents that perform problem-solving tasks.

The web-based DSS is composed of three layers such as (1) network communication layer, (2) problem-solving layer, and (3) user interface layer. Descriptions about both network communication layer and user interface layer are straightforward. The network communication layer is to support various protocols such as TCP/IP, http, ftp, gopher, and X.25, etc., and the user interface layer is to generate an effective user interface form. The problem–solving layer is composed of three agents such as knowledge management agent, model management agent, and data management agent. However, in this paper we focus to investigating not the role of each agent but the Web-based SCM coordination process through the coordinating interactions between a supplier and a manufacturing plant. Figure 1 depicts the architecture of the proposed web-based DSS for coordinating SCM decisions.

AGGREGATE PRODUCTION AND INVENTORY PLANNING: A SCM EXAMPLE

An illustrative example for SCM decision making is shown in Figure 2, in which several parameters are supposed to be determined by decision makers. They are production cost, inventory cost, demand estimate, etc. Since the total production and inventory cost should be minimized, an optimization model like a linear programming can be used for such a case.

[Insert Figure 2 about here]

The linear programming model is formulated as following:

$$\text{Min } Z = C_1 X_1 + C_2 X_2 + \ldots + C_t X_t + H_1 I_1 + H_2 I_2 + \ldots + H_{t-1} I_{t-1}$$

Subject to

$$X_1 = I_1 + D_1 - I_0$$
$$X_2 + I_1 = D_2 + I_2$$
$$X_3 + I_2 = D_3 + I_3$$

.

.

.

$X_t + I_{t-1} = D_t$

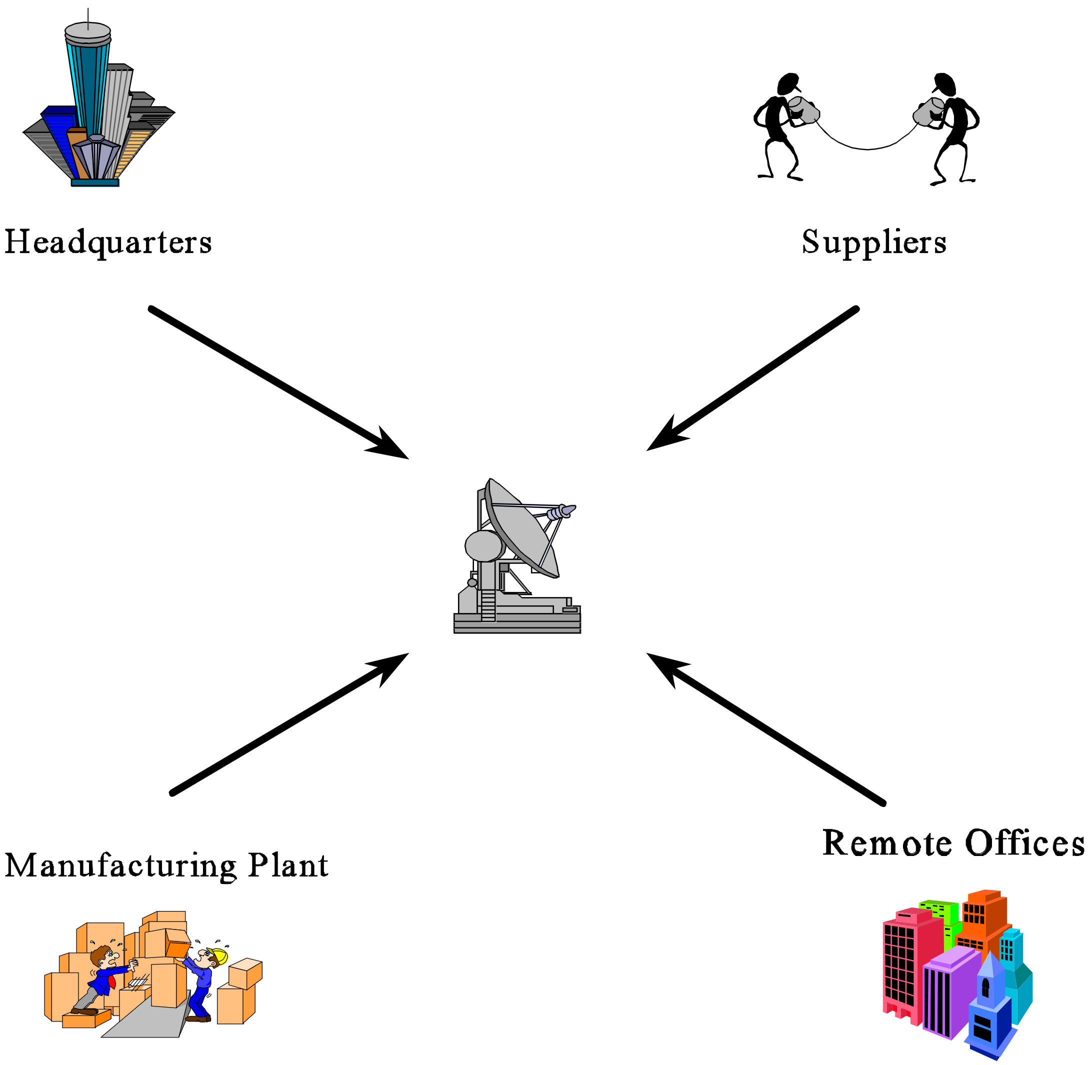
And $X_{j,}\ H_j \quad (j = 1, 2, 3, \ldots\ldots. n) \geq 0$

Where:

X_t	Production scheduled for period *t*
D_t	expected demand in period *t*
I_t	Net Inventory at the end of period *t*
I_0	Initial inventory
C_t	Unit variable cost of production during periods *t*
H_t	Inventory carrying cost per unit (from period *t* to period *t*+1)

A WEB-BASED DSS FOR SCM DECISION MAKING

In Figure 3, a web-based DSS for SCM decision making is illustrated. Decision makers at remote sites access the web and input their information for such parameters as C_t, H_t, D_t, etc. listed in the previous section. Then the proposed system is supposed to optimize the decision making process and provide the solution.



JavaScript is a convenient tool for programming such a DSS on the web. Table 1 shows a JavaScript example for a DSS.

Table 1. A JavaScript Example for a Web-Based DSS

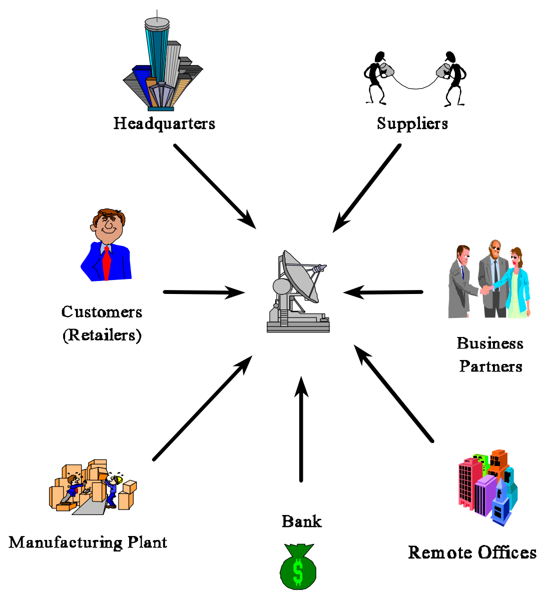
```
<html>
<head>
<title> Web-Based DSS for SCM decision making </title>
</head>

<body>
<Script Language="JavaScript">
var num1;     // used for equation one
var num2;     // used for equation one
var num3;     // used for equation two
var num4;     // used for equation two
var num5;     // used for equation three
var num6;     // used for equation three
var a= prompt("What is the first slope?")        // slope for equation one
var b= prompt("What is your first y intercept?")  // y int for equation one
var c= prompt("What is the second slope?")       // slope for equation two
var d= prompt("What is your second y intercept?") // y int for equation two
var e= prompt("what is the third slope?")        // slope for equation three
var f= prompt("What is your third y intercept?")  // y int for equation three
alert ("Thank you, please wait as I work")    // just for kicks
var n=0
do
{
var z = (a*n)          // slope multiplied by value of n  which is a counter
num1 = parseInt(b);     // sets num1 an int and to the value of y
num2 = parseInt(z);     // sets num2 an int to the value of c
var result = num1 + num2              //adds the two ints
document.write("X = ")
document.write(+ n)
document.write("  Y = ")
document.write(""+ result +"")
document.write("<br>")         // value of y
n++
}
while(result >=0);
</script>
</body>
</html>
```

SUMMARY AND CONCLUSION

To solve the SCM coordination problem, this study extended conventional DSS concepts into the web-based DSS using an intelligent agent approach. On the other hand, there are several concerns about the proposed systems. A security issue on the Internet has been widely discussed lately. The proposed DSS is not immune to such a discussion, either. Hardware, training, maintenance, etc. can be problems.

Further studies may investigate more possibilities for the web-based DSS concept. One example can be an expanded model adding customers (retailers), financial institutions like bank, business partners, and so on, to the model this paper proposed. Figure 4 illustrates this new concept. In addition, we are now extending this proposed model by investigating the role of each intelligent agent.

Figure 4. Future of Web-based DSS



In conclusion, this research attempted to build a web-based DSS for a SCM decision making. It will enhance the productivity as well as the firm's effectiveness, if it is properly designed and implemented.

Editor's Note: Figures available from author

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CUSTOMER ORDER ACCEPTANCE DECISION MODELS FOR A PROCESS-FOCUSED PRODUCTION SYSTEM

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ABSTRACT

This paper attempts to improve and evaluate a model for the customer order acceptance decision in a process-focused production environment. The MANOVA was used as the primary statistical procedure for analyzing the results from the factorial experimental design of the research because more than one performance criterion is employed in this research. The experimental factors include the customer order acceptance decision model and the utilization level. Tukey's test was used to isolate the performance of the specific customer order decision models. The statistical analysis indicates that the integer linear programming model described in this paper is in the superior performance category under all utilization levels tested compared to other order acceptance models.

COLLEGE STUDENTS' PERCEPTION OF ELECTRONIC COMMERCE AND INTERNET PURCHASING

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ABSTRACT

The purpose of this paper is to study the perceptions of college students on electronic commerce and use of Internet purchasing. Two hundred students from three universities in three different states were surveyed. Research indicates that most students use the Internet to check company or product information rather than directly purchasing products. One of the major reasons students don't use the Internet for online purchasing is the concern of security. A multiple discriminant analysis was conducted to describe the relative weight of each characteristic of students who tend to purchase on-line.

INTRODUCTION

Advances in microprocessor and communication technology during the last few years has made the Internet the most challenging area in the field of management information systems. Today, millions of people have become aware of the usefulness of e-mail and the Internet for accessing information through PC-modem and telephone lines. The Internet is a computer network connecting more than one hundred thousand individual networks all over the world (Laudon & Laudon, 1996; 1997). Using the Internet, people communicate through e-mail, Usenet Newsgroup, chafting, FTP, Telnet, and World Wide Web (WWW). Millions of web sites have been created for commercial and educational purposes (Lee, Osborne, & Chen, 1996).

The Internet has been used in defense and academic research for many years. The commercial use of the Internet, also referred to as electronic commerce or ecommerce, was not permitted until the early '90s because the government subsidized the Internet (McKeown & Watson; 1997). Forrester Research in Cambridge, Massachusetts expects online sales to increase from $4.8 billion in 1998 to $17 billion in the year 2001 (Furger, 1998). Why is the Internet becoming a powerful tool for marketing and communication? There are many reasons, the main one being that the Internet connects more than 40 million people from 100 countries. Consumers can access information from a remote location through the Internet if they are connected to a telephone line or a network. Another reason that the Internet is becoming a powerful tool for marketing and communication is that it provides a variety of services. For example, e-mail provides communication between consumers and companies, and through electronic data interchange (EDI), buyers and sellers can exchange standard business transaction documents such as invoices or purchase orders. Finally, the ability to combine video clips into the Internet is a significant step in establishing Internet marketing as a powerful communication forum.

The purpose of this research paper is to investigate the perceptions of college students on the uses and successes/failures of Internet purchasing and the concept of electronic commerce. College students represent individuals who are more knowledgeable in technology than individuals in previous generations. This study provides information related to the following research questions:

1. What are the primary functions of college students in using the Internet for purchasing products or services?
2. What are the obstacles to consumer purchasing on the Internet? Is security a primary concern as suggested in the literature? Can different payments be used to avoid the security problems?
3. Which presentation format (hypertext, audio, or video form) in Internet marketing is the most persuasive to consumers?
4. How often do college students use the Internet? How long do college students use the Internet per week (e.g., checking product information)?
5. What products are popular in Internet purchasing and communications?
6. What are the characteristics of the students who use the Internet to purchase products and services?

LITERATURE REVIEW

Numerous studies have been written about the Internet. Many of these studies focus on technical topics, case studies, and the use of the Internet for educational purposes (Carroll, 1994; Kanuk, 1996; Vernon, 1996; Ullman, William, & Emal, 1996; Mahmoon & Hirt, 1995). Knowledge about the Internet, however, is still in the early stages simply because the Internet has become popular only in the last few years. While a fair amount of case studies in e-commerce (e.g., Amazon.com) have been discussed, (Hitt, Ireland, & Hoskisson, 1998), few empirical studies have concentrated on the theoretical construction of using the Internet for consumer purchasing. Technical barriers such as speed, security and maintenance are the main concerns in using the Internet in marketing. With the continuous improvement of hardware and software in microcomputers and communication channels, use of the Internet for consumer purchasing is full of potential.

Jannet (1996) suggests that the Internet, as an interactive marketing tool, has the following three functions: 1) informing consumers about products, services, discounts; 2) creating brand awareness and preferences; and 3) selling products through on-line purchasing. Jannet further indicates that inter-activity is one of the key characteristics why the Internet is so powerful in marketing. To purchase a product, consumers need to get information regarding the product, the price of competitors, as well as other facets of merchandising. The Internet does provide a low-cost, no-hassle, and convenient way to search for this type of information. Most Internet sites provide a full time service (24 hours and seven days a week) for consumers to purchase a product or service.

The present format of e-commerce may affect the consumer's perception about the information appearing on the Internet. Present forms of advertising information are limited primarily to hypertext and still pictures. Video clips have not been widely used because their implementation requires vast amounts of storage and faster transmission speed. In some cases, they are simply too slow to be accessed by every consumer. Fortunately, advances in computer communication technology (such as ISDN) during the last few years have made transmission of digital video information a viable method in Internet marketing.

A video-based marketing information system can be used in combination with traditional and/or existing marketing methods. There are three major approaches in using an Internet-based system for marketing: 1) hypertext, 2) audio, and 3) video forms. There are a number of examples in which organizations use an Internet-based system for marketing. First, real estate shows which are broadcast on the Internet enable consumers to view and browse housing information and video clips, eliminating the need for unnecessary travel. Second, a video clip system can be broadcast on the Internet by a movie rental store. Third, prospective travelers can use the Internet to find out information on rates, rooms, and nearby sightseeing attractions for hotels throughout the world. Finally, by analyzing the usage data from the World Wide Web site, hotels can learn more about consumer preferences (Bartolacci, 1996).

OBSTACLES TO INTERNET MARKETING AND E-COMMERCE

Previous literature has discussed the barriers and disadvantages to Internet marketing (Jannet, 1996). There remain some barriers and disadvantages that may lead managers to decide against the use of Internet marketing. The first barrier identified is the relatively small number of consumers reached over the Internet in comparison to other advertising media. The number of businesses and homes equipped for interactive marketing is still small. The second barrier is the impersonality of Internet business. Brand name recognition among consumers demands that the relationship between businesses and consumers exists long before and after the sale.

The third barrier is that security and privacy is a major concern. There are two security weaknesses inherent in the current infrastructure of the Internet (Evereft, 1988). First, the Internet network of high-speed telecommunication lines (Internet backbone) may have problems with one or more of its telecommunication lines breaking, thus, Internet services can be disrupted. Second, because messages and information pass from host to host, they are susceptible to interception and being recorded. There is virtually no law that prevent any Internet service provider (ISPS) from observing, recording, selling, or giving away any information that passes through host computers.

There are various Internet security tools that can help organizations protect their information (Evereft, 1998). The most common security technology for credit card transactions is a Secure Socket Layer (SSL) a type of encryption package that makes language passing through the Internet indecipherable. Unfortunately, according to Furger (1998), half of all e-commerce sites don't use encryption to protect customers.

THE WAY OF PAYMENT IN E-COMMERCE

To protect the consumer's financial and security information, Internet sellers are using a variety of payment methods. Today, there are three ways a consumer can make a payment after purchasing a product from the Internet. First, a consumer can check product information and then enter the credit card information on the Internet. Although this is a simple and easy way to purchase products, many people hesitate to use this method for security reasons. Second, a consumer can check product information and then call the company directly and charge the product to a credit card. Third, a consumer can check product information on the Internet and then mail the company a check.

METHODOLOGY

The primary purpose of this paper is to investigate to investigate the perceptions of college students on the uses and successes/failures of Internet purchasing and the concept of electronic commerce. To answer research questions one, two and three, several null hypotheses have been derived:

Hl: Students spend the same amount of time in a) purchasing products; b) checking product information, or c) checking a company's general information (such as company service information, warranty, or discounts)

This hypothesis is used to answer research question one: what are the primary functions of college students in using Internet for purchasing products or services? Jannet (1 996) suggests that Internet marketing has three different functions (as listed in hypothesis 1). Hypothesis one attempts to determine which function is the most influential to students in purchasing on the Internet.

H2: There is no difference in the type of payment method used by students when ordering products from the Internet. The three ways for consumers to purchase products on the Internet are: a) a consumer can check product information and then enter the credit card information on the Internet; b) a consumer can check product information and then call the company directly and charge the product to a credit card; or c) a consumer can check product information on the Internet and then mail the company a check.

Hypothesis two answers the research questions: What are the obstacles to consumer purchasing on the Internet? Is security a primary concern as suggested in the literature? Can different payments be used to avoid the security problems?

H3: The degree of enhancement of consumer perception from using different presentation format of Internet marketing (i.e., text descriptions, photos/pictures and video clip) are the same.

Hypothesis three is used to answer the research question: which presentation format (hypertext, audio, or video form) in Internet marketing is the most persuasive to consumers?

The other research questions: how often do college students use the Internet? how long do college students use the Internet per week (e.g., checking product information)? what products are popular in Internet purchasing and communications? what are the characteristics of the students who use the Internet to purchase products and services? will be answered using a descriptive analysis from the survey.

A survey questionnaire was administered to test hypotheses Hl to H3. The survey was administered in various business classes. The Friedman test, a nonparametric test procedure was used for hypothesis Hl because ordinary data was collected from the survey. The chi-square (X 2) test was also used to test hypotheses H2 and H3 for equal proportion. The data was coded and analyzed using SPSS/PC+.

RESULTS AND DATA ANALYSIS

The subjects are business undergraduate students from three different universities in three different states: Texas (Central Area), Georgia (Eastern Area), and Washington (Western Area). From July to December 1998, two hundred and one students in eight different classes, from freshman to senior level, were randomly chosen for the survey. Two non-usable questionnaires reduced the sample size to one hundred and ninety-nine for a response rate of 99%. Seven-three percent of the students are from age 18 to 25. Twenty-six percent of the students are above age 25. Twenty-two percent of incomes are between $10,000 to $17,500, fifteen percent of incomes are between $17,500 to $35,000, and eleven percent of incomes are above $35,000. The income levels are fairly distributed. When asked about the knowledge level of computers, fifty-six percent of the participants ranked themselves 3 on a scale of 1 to 5. The remaining participants are evenly distributed throughout the (1-5) Likert scale.

Various questions were asked concerning the purposes of using the Internet for purchasing products or services. A multiple discriminant analysis was conducted to describe the relative weight of each characteristic of students who sometimes, often, and very often purchase on-line. The standardized discriminant function coefficients clearly tell that income level, Internet access at home, computer knowledge, martial status, and employment are important characteristics to determine whether a person who will tend to use on-line purchasing. Age and gender may not have a strong relationship with on-line purchasing. By eliminating age and gender, a linear regression model can be used to calculate a standard weight:

$$Z = 0.575 * X1 + 0.459 * X2 + 0.326 * X3 + 0.317 * X4 + 0.225 * X5$$

Where

Z: Standard weight of on-line purchasing
X1: Income levels (five levels, 1-5)
X2: Internet Access at Home (yes=2 or no=l)
X3: Marital Status (single=l, married=2, or divorced=3)
X4: Computer Knowledge (five levels, 1-5)
X5: Employment (yes=2 or no=l)

We can use this model to calculate the probability of whether a student will purchase on-line. If the Z score of a student is zero, there is 50-50 probability that a student will purchase on-line. If Z is negative, there is less than a 50 percent probability that a student will purchase on-line (Zikmund, 1997).

CONCLUSIONS

Eighty percent of the students responding to the survey use the Internet at least one time per week. Moreover, seventy-seven percent of the students spend at least one hour per week on the Internet. College students tend to use the Internet to check product information and check general information on a company more than to actually purchase a product. When purchasing a product, however, the students indicated that they prefer to check the product information and then mail a check to the company as opposed to using a credit card. This indicates that students are still concerned about giving their credit card number on the Internet. In fact, students indicated that they will not buy from the Internet because of a lack of security. Moreover, they do not buy from the Internet because of the inability to judge the product, and the inability to see or feel the product.

When seeking information about product and services, students most frequently seek information about automobiles, books, and financial services. When purchasing from the Internet, students believe that photos and pictures about the product are the most influential form of product advertising. Finally, students who make purchases on the Internet usually have more computer knowledge than those who never purchase from the Internet.

The main limitation in this study is that the subjects are students who may have limited income. Students, however, may spend more time on the Internet than other types of respondents. For future research, a study could be conducted on alumni, faculty or business men and women to see if their responses are similar to the sample used in this study.

Editors' Note: Tables, references and complete results are available from the authors.

INTEGRATION OF MATHEMATICAL AND SIMULATION MODELS FOR OPERATIONAL PLANNING OF FMS

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ABSTRACT

This paper presents an integrated procedure for operational level planning of FMS. The procedure hierarchically combines a mathematical planning model and a simulation model. The mathematical models alone cannot incorporate all the details of operational level planning of FMS. However, these details can be included by combining mathematical model with a simulation model. The main objective of the procedure is to generate more realistic results at the operational planning level.

In this paper, the procedure is illustrated for part assignment and tool allocation problem in FMS with the help of two numerical examples. Several aspects of the implementation of the procedure are also discussed.

Key Words: Integrated Planning Procedure, Mathematical Model, Operational Planning, Simulation.

INTRODUCTION

Flexible Manufacturing Systems (FMSs) are automated small-batch manufacturing systems consisting of a number of numerical and computerized numerical controlled metal cutting machine-tools linked together via an automated material handling system (MHS). Real-time control of machines and MHS is accomplished by computers and data transmitting links. The main objective of these integrated systems is to achieve the efficiency of automated high-volume mass production while retaining the flexibility of low-volume job-shop production. The flexibility in FMS is introduced via several factors which may include versatile machine-tools, small set-up and tool changing time, relatively large tool carrying capacity and the ability to automatically transfer tools between the machines. These factors allow a part to take alternate route while under process in the system. The possibility of the alternate routings adds an important element to the overall flexibility of these manufacturing systems.

An FMS possesses enormous potential for increasing overall productivity of manufacturing systems due to its flexibility. However, the task of operational level planning of FMS is more complex compared to traditional systems. During the operational planning of an FMS, small batches of parts are selected for simultaneous production in a manufacturing cycle. Several planning decisions such as, part production ratio, tool loading, machine grouping, and resource allocation (Stecke, 1983) are considered at the operational stage.

Numerous research studies are available in literature related to these operational planning problems (for review see: Buzacott and Yao, 1986; and O'Grady and Menon, 1986). In general, the research studies in FMS production planning utilize the mathematical modeling approach to solve the problem. However, these mathematical models do not capture dynamic aspects (scheduling and other time-based factors) of the system. To address the dynamic aspects, discrete event simulation is widely employed (for review see: Gupta, Gupta and Bector, 1989). In typical FMS environment, the operational planning and scheduling problems are addressed at two different levels.

Since at the operational planning level, scheduling aspects are not considered, the results from the mathematical planning models are generally not realistic for FMS (Leung, Maheshwari and Miller, 1993). For example, the machine workload at the planning model results may be highly balanced, but due to scheduling constraints it may not be achievable during the actual operation of the FMS. This variance in the outcome of two models may result in the poor utilization of resources, longer makespan, etc.

In this paper, the part assignment and tool allocation problem in FMS is considered. The solution procedure utilized to solve the problems combines mathematical model with a discrete event simulation model. This procedure provides both optimal and realistic solution to mathematical model by integrating it with a simulation model. The remainder of the paper is organized as follows. The next section, briefly, reviews the literature on operational planning in FMS. Section 3 provides an overview of the problem and solution procedure. Section 4 provides proof of convergence of the procedure. This is followed by presentation of the example problems and the results obtained from these problems. Section 7 provides guidelines for parameter modification based on the example problems.

LITERATURE REVIEW

The operational planning problem in FMS has been extensively examined in the research literature. Mostly, operational planning problem is formulated as a mathematical model. The scheduling and control issues are not considered at this stage. Stecke (1983) formulated the machine loading problem as a non-linear programming model. Several different loading objectives were considered. These objectives included balancing the assigned machine processing times, maximizing the number of consecutive operations of a part on each machine, maximizing the sum of operation priorities, and maximizing the tool density of each magazine. Shanker and Tzen (1985) modified Stecke's (1983) model to include due dates. The modified objective function tries to balance the workload on each machine and to reduce the number of late jobs simultaneously. Kusiak (1985) formulated FMS loading problem as a 0-1 linear integer model with the objective of minimizing total processing cost. However, he considered identical processing time for operations. Sarin and Chen (1987) formulated the machine loading and tool allocation as a 0-1 linear program. Part assignments and tool allocations were determined concurrently incorporating considerations such as tool life, tool slot capacity, and machine capacity. Leung, et al. (1993) formulated part assignment and tool allocation problem with material handling considerations.

Avonts and Van Wassenhove (1988) combined mathematical planning model with queueing network model to solve part mix and routing mix problems. They proposed a solution procedure where a linear programming model results were evaluated using CAN-Q. The results from the queueing model were fed into to the linear programming model. It was shown that combining a static linear programming model with a dynamic queueing model helped in achieving more realistic results for the part mix and routing mix problems.

The scheduling and control has been studied extensively in FMS. Gupta, et al. (1989) reviewed some aspects of FMS scheduling literature. Generally simulation is employed as the evaluation tool at this stage. A selective review of some of these studies is provided here.

Nof, Barash, and Solberg (1979) have studied the control problem in FMS. They have considered three rules for part releasing into the empty system and two rules for part releasing into the loaded system. The releasing sequence is either random or a function of the production requirement of part types. Their research shows that these rules have significant influence on system utilization and production rate. Stecke and Solberg (1981) carried out a simulation study of an FMS to show the impact of the several machine sequencing rules on the performance of the FMS under different loading objectives. They concluded that scheduling rules have significant influence on performance of the FMS. Similar conclusions have been made in a recent study by Montazeri and Van Wassenhove (1990). Carrie and Petsopoulos (1985) conducted simulation experiments to examine the part releasing rules, and part sequencing rules. However, their investigation of an existing FMS shows that neither the part releasing nor the part sequencing rules have significant impact on performance of that FMS.

Egbelu and Tanchoco (1984) explored the system from a different perspective. They tested the effect of vehicle dispatch and vehicle selection rules on the system performance. Their results show that vehicle dispatching rules have significant influence on the system performance. Due to high utilization of the material handling system, the vehicle selection rules did not show significant impact.

Most research studies at the operational level of FMS focus independently either on planning or scheduling problem. Some researchers (Stecke and Solberg, 1981; Shanker and Tzen, 1987; Maheshwari and Khator, 1993; etc.) have considered both problems simultaneously. These studies show that the performance of the system at the operational level is greatly influenced by dynamic factors such as part and vehicle scheduling rules. Avonts and Van Wassenhove (1988) have shown that the results from operational planning model for FMS can be more realistic if dynamic system factors are given some considerations. Hence at the operational stage, planning and scheduling model should be considered together, not separately.

PROBLEM STATEMENT AND SOLUTION STRATEGY

Two operational planning decisions, part assignment and tool allocation, are considered in this research. Part assignment is defined as the assignment of operations of part types to machines. Tool allocation refers to the loading of tools onto machine magazines. We utilized the mathematical model developed earlier by Leung et al. (1993).

The main objective of this research is to present an integrated solution procedure for part assignment and tool allocation problem in FMS. The integrated procedure combines the mathematical planning model with a simulation model in a hierarchical fashion.

The mathematical model determines part assignment and tool allocation based upon static system constraints such as resource capacity, tool life, operation times, etc. The consideration of detailed real-time factors (such as scheduling rules) makes mathematical model rather difficult to solve, if not impossible. However during actual operation of the system, there are several dynamic factors (part scheduling rules, vehicle scheduling rules, etc.) which influences the system performance. The overall system performance is a function of both mathematical planning model results as well as scheduling and control rules (Stecke and Solberg, 1979; Maheshwari and Khator, 1993). For example, a part may experience delays in actual operation of an FMS due to blocking of machines, blocking of the pathways of transporters, starving of machines, etc. However, these effects cannot be directly accounted at the mathematical model level. Consequently, the mathematical model results may become unattainable during actual operation, especially in terms of resources capacities, workload balancing, and makespan.

The procedure described here aims at achieving more realistic results from the mathematical model. The results from mathematical model are evaluated at simulation model. The necessary mathematical model parameters, such as machine utilization factors, vehicle utilization factor, length of the manufacturing cycle, are modified after the evaluation of mathematical model results. Another set of mathematical model results is obtained using these modified set of parameters. The procedure continues till a viable set of mathematical model results is obtained.

Part Assignment and Tool Allocation

The part assignment and tool allocation model is an integer linear programming model. The model is included in the Appendix. Readers are referred to Leung, et al.(1993) for the detailed mathematical formulation. For brevity, we describe the characteristics of the model in principle.

<u>Decision Variables</u>

There are two set of decision variables. The first set of decision variables represents the quantity of each part type whose specific operation is to be processed on a machine using a particular tool type after visiting a given machine for a preceding operation. Second set of decision variables depicts the number of tools of a given type allocated to a machine.

<u>Constraints</u>

The constraint sets include tool life constraint, tool availability constraint, magazine size constraint, machine capacity constraint, material handling capacity constraint, etc. These constraints are briefly addressed below.

• Machines Features. The operational characteristics of the machines such as operation capacity and tool compatibility are included in this constraint set (3). Tool magazine size is also considered (2).

• Operational Requirements. These constraints ensure that all operations are processed and all output requirements are satisfied (5, 6). This constraint set also ensures that tool-life requirements are met at each machine (3).

• Resource Constraints. The assigned time for any resource is formulated to be less than the available time. The resources considered in this formulation are machines, and material handling system (7, 8). Cutting tools availability is also formulated as a constraint set (4).

Objective Function

The objective function incorporates the operation and travel times of parts (1). The travel times are a function of the distance between the machines and the velocity of material handling device. The travel times are multiplied by a factor to represent the empty travel time associated with the material handling device.

Scheduling Rules

A discrete event simulation model is used to incorporate the system details so that mathematical model results can be evaluated. Part releasing, part sequencing and vehicle dispatching rules are considered in this model. Two system parameters, number of buffer spaces and number of pallets, are also taken into consideration. Maheshwari and Khator (1993) have evaluated several different scheduling rules for a similar FMS. Only the rules which were found significant are used in this research.

Part Releasing Rule

This rule assigns priority to the parts awaiting release into the system. There is a finite number of parts circulating concurrently into the system. A part remains on a pallet while in the system. A pallet becomes available when a circulating part finishes all of its operations. A new part can be released into the system on an available pallet according to a priority rule. A releasing rule may depend upon the part characteristics such as processing time requirements, arrival time and number of operations, or upon the global system characteristics such as the up or down state of the machine a part needs to visit, and instantaneous production ratio (Carrie and Petsopoulos, 1985). Following rule was utilized in this research.

• Least Production Ratio (LPR). The production ratio is calculated as the number of parts released into the system divided by the production requirement for the given part type. This rule tries to maintain the desired production ratio throughout the manufacturing cycle.

Part Sequencing Rules

The part sequencing rules deal with sequencing of parts waiting at a machine for processing. An operation processing priority is assigned to a part waiting to be processed at a machine. These priority rules are applicable only if more than one part is waiting at that machine. Several part sequencing rules have been examined in an FMS environment by Stecke and Solberg, (1982) and Montazeri and Van Wassenhove, (1990). The rules used here are:

• Shortest Processing Time (SPT). SPT selects the part for processing for which operation can be completed in the least time. SPT is found to be generally efficient in the FMS environment (Stecke and Solberg, 1981).

• Smallest ratio of imminent Processing Time/Total Processing Time (SPT/TPT). This sequencing rule arranges the parts for processing with a ratio of the processing time for the current operation to the total processing time. SPT/TPT has been reported to be a very efficient rule in terms of throughput rate (Stecke and Solberg, 1982; and Montazeri and Van Wassenhove, 1990).

Vehicle Dispatching Rules

The vehicle dispatching rules are required when a part is to be transported from one machine to another machine or to the load/unload station. Priority is assigned for selecting the part if more than one part is waiting to be transported when a vehicle becomes idle. These priority schemes are called vehicle initiated rules (Egbelu and Tanchoco, 1984). Two different vehicle initiated rules--minimum work in input queue and minimum remaining outgoing queue space--are considered here. In the situations when a part has to select a vehicle, work-center initiated rule, from several idle vehicles, the shortest distance rule is always utilized.

• Minimum Work in Input Queue (MWIQ). MWIQ determines transportation priority according to the work content in the destination queue of the part. Work content of a queue is defined as the sum of processing times of all the parts in that queue.

• Minimum Remaining outgoing Queue Space (MRQS). MRQS assigns transportation priority to the parts according to the state of the buffer in the outgoing queue. A common input-output buffer is considered in this research. This rule attempts to reduce the transportation delay for incoming parts which may occur due to the non-availability of the buffer space at the machine.

System Parameters

The size of buffers and the number of pallets have direct impact on performance of the system (Schriber and Stecke, 1988). It is assumed that the same buffer area is used for both input and output of the parts at a machine. Two different buffer capacities, 5 and 6, are considered in this research. It is assumed that each machine has equal number of buffer spaces. Two different capacities of pallets, 10 and 12, are considered. These are 2.5 and 3 times of the number of machines, respectively.

Iterative Procedure: Integration of Mathematical and Simulation Models

The iterative procedure was first proposed by Leung, et al. (1993). This procedure links mathematical model to a simulation model to solve the part assignment and tool allocation problem in FMS. The procedure is illustrated in Figure 1. Here, the steps of the procedure are restated.

Step 1. Initialize parameters for mathematical model (machine utilization, vehicle utilization, number of vehicles, length of manufacturing cycle, etc.).

Step 2. Solve the mathematical model for part assignment and tool allocation. Obtain machine utilization and vehicle utilization.

Step 3. Input mathematical model results into the simulation model.

Step 4. Collect statistics on system utilization, makespan and vehicle utilization.

Step 5. Compare mathematical results with simulation results.

Step 6. Stop if, simulation outcomes comply with the results from the mathematical model; otherwise go to Step 7.

Step 7. Modify parameters of the mathematical model based on simulation results and go to Step 2.

Insert Figure 1

CONVERGENCE OF THE ITERATIVE PROCEDURE

The utility of the above iterative procedure would be very limited in practice, if it fails to converge. A mathematical proof, that the procedure would converge to an overall optimum value, is rather difficult and will be function of a large number of operational level variables. However, it can be easily shown that if an optimal solutions exist, the iterative procedure will converge, provided some conditions are satisfied.

Lemma 1

There exists a lower bound and an upper bound to the solution of the iterative procedure, if some of the system parameters are predetermined, and if arbitrary slack time is not added to the length of manufacturing cycle.

Proof of Lemma 1

Let's assume that the part-mix ratio and production quantity to be produced are known, however, length of the planning cycle is variable. There are alternative machine and cutting-tools combinations for each operation of the given parts. Then, a lower bound on the makespan can be obtained by assigning parts using machine workload balancing objective.

An upper bound can be determined by simulating the mathematical model results obtained by maximizing the sum of processing and traveling time. The parts will be assigned to the least efficient machining center within the given constraints. All the dynamic delays (scheduling delays) can be accounted by the simulation model. The optimum solution to the procedure will lie between this lower and upper bound, if it exists. If arbitrary delays are introduced between the operations then there can be infinite solutions to the problem. The set of feasible schedules can be limited to a finite set only if no-delay schedules are considered.

Lemma 2

The iterative procedure will attain an optimum solution, if the optimum solution to the iterative procedure exists, and if some of the system parameters are predetermined.

Proof of Lemma 2

The procedure is non-monotonic in nature. However, according to lemma 1, if the production quantities are fixed, a lower (L_b) and upper (U_b) bound to the solution can be determined.

If an optimum solution exists, it will lie between L_b and U_b. Let's assume that value of the planning parameters (resource utilization factors and length of planning cycle) are modified randomly. Furthermore, the solution follows an arbitrary probability density function f(s). Mathematically, it can be defined as:

Probability Density Function	=	$f(s)$,
where, s	=	A solution to the mathematical model, and
s	$\geq$	L_b,
s	$\leq$	U_b.
L_b	=	Lower bound on s, and
L_b	$\geq$	0.
U_b	=	Upper bound on s, and
U_b	$\geq$	L_b.

Let I_s be a small interval between L_b and U_b such that it contains the optimum solution to the iterative procedure. In other words, probability that a solution lies somewhere on I_s is greater than zero ($P(I_s) > 0$). If large number of random samples are drawn (random modification of the parameters at the end of each iteration will provide a random sample on solution space) then there is a finite probability that the solution to one of the sample will lie on the interval I_s. The length of the interval I_s can be made small to reach closer to the solution. In fact length I_s could be fixed on the basis of an acceptable variation between mathematical and simulation models results. Therefore, in general the process will converge to an optimum solution of the iterative procedure.

The above lemma, does not determine the speed convergence of the procedure. However, during the implementation process both upper and lower bounds can be updated at every iteration. Therefore, the spread of the solution range can be reduced at each step. The reduction of the solution space would assist in improving the rate. A mathematical bound on the rate of convergence cannot be obtained due to non-monotonicity of the procedure. Nevertheless, the practical utility of the procedure can be tested, especially if large number of problems are solved using this procedure. In this paper, two numerical problems were utilized to show the implementation of the procedure.

EXAMPLE PROBLEMS

A flexible manufacturing system may consists a large number of machining centers, however a typical number of machining centers in an FMS is usually between 3 and 6. An FMS with four machining centers is considered in this research and is shown in Figure 2. Each machining center has a fixed size tool (40 tools) magazine. It is assumed that tools are allocated at the beginning a manufacturing cycle only. No automated tool transfer is available during the manufacturing cycle.

Insert Figure 2

Tables 1 and 2 show the range of parts to be manufactured in two independent test problems, henceforth referred as Problem 1 and Problem 2. In this research, only part assignment and tool allocation problem is considered. Therefore, it is assumed that part selection problem has been already been solved. Consequently, for each manufacturing cycle number and type of parts are known. But, the part assignment and tool allocation are yet to be determined.

Insert Table 1 and 2

Tables 1 and 2 also indicate operation times, in minutes, to perform each operation of every part type. Operations can be performed at an alternate machining center as well. Table 3 shows the number of parts to be processed, demand of each part type, in the given manufacturing cycle. The length of manufacturing cycle is assumed to be 2400 minutes.

Insert Table 3

The procedure requires to solve two different models-- mathematical and simulation--at each iteration of the procedure. The mathematical model is linear-integer model. It was solved using MPSX/370 version 2.0. The second model, used in the procedure, is a discrete event simulation model. This model was built using SIMAN IV simulation language and Microsoft C. The simulation logic is depicted in Figure 3.

Insert Figure 3

RESULTS

Mathematical Model Results

The mathematical model was solved with the utilization factors (machines utilization and MHS utilization) as 100% in the first iteration of the procedure for both Problems 1 and 2. This was necessary due to the lack of historical data. A common utilization factor was employed for all four machines in the system. Part assignments and tool allocations were obtained. In subsequent iterations, these parameters were modified according to the simulation results. Each time a parameter was modified, new mathematical model results were obtained. Tables 4 and 5 show the parameters and aggregate results for all iterations for Problem 1 and Problem 2, respectively. The parameter modification was based on makespan, mean waiting times, and vehicle utilization.

Insert Table 4 and 5

Simulation Model Results

The mathematical model results were used as the input to simulation model. At this stage, five different operational factors were considered. Only one part releasing rule was used. Whereas, two part sequencing rules, two vehicle dispatching rules, and two levels of buffer size and pallets were utilized to test the results at the simulation model. In all for each run there were 16 combinations (2x2x2x2) for a full factorial experiment. A fractional factorial design (½x2x2x2x2) was used to reduce the number of simulation runs. The results from the simulation model are displayed in Tables 6 and 7 for Problems 1 and 2, respectively.

Insert Table 6 and 7

Results of Iterative Procedure

Problem 1 required three iterations to reach to a solution, whereas, Problem 2 required four iterations. Here, the results at the each iterations for both problems are discussed. A subsequent iteration became necessary for a problem because the results from the mathematical model were not feasible at the simulation level. Thus, some mathematical model parameters were modified at each iteration to get new results.

Iteration 1 Initial iteration started with 100% utilization factor in both the problems. Mathematical model makespan was 2400 and 2360 minutes respectively. However, when the results of the Problems 1 and 2 were simulated, minimum makespan was 2826 and 2869 minutes, respectively. This was about 17% longer than planned period of 2400 minutes. Vehicle utilization was 97% and 78%. Higher vehicle utilization indicates that there was higher empty travel time (e.g., vehicle utilization was 95% and makespan was 2826 minutes. Then, total time vehicles were used would be 0.95*2826 = 2685 minutes. Whereas, the planned loaded travel time was 1038 minutes only). The available loaded travel time on the vehicle should be reduced. On the basis of these results, two planning parameters--vehicle and machine utilization were updated for the next iteration for both the problems.

Iteration 2 New sets of mathematical model results were obtained using 90% machine capacity and 50% vehicle capacity. The mathematical model results were still infeasible at the simulation level. Vehicle utilization was 97% in the case of the Problem 1 and 78% in the case of the Problem 2. However, the results were closer to the mathematical model results compared to the results at iteration 1. This shows that solution is moving in the right direction.

The higher utilization of the vehicle resulted in relatively longer mean waiting time as well. In other words the reduction in the waiting time was very small from iteration 1 to iteration 2. Therefore for the next iteration, number of vehicles was increased to 2 and available vehicle time was further reduced to 35%.

Iteration 3 This iteration didn't require any solution of mathematical model. At that stage only material handling capacity was increased on the basis of simulation model results. However, the material handling capacity was not a binding constraint at the mathematical model stage at iteration 2. Therefore, increase in the MHS capacity would not change the mathematical model results from iteration 2 to iteration 3. A new set of simulation runs were made with increased capacity of MHS. The results show that the mathematical model results became feasible at simulation model for Problem 1. The makespan achieved at the simulation stage was 2395 as compared to 2400 at mathematical model. The iterative process terminates here for the Problem 1.

However, results were still not viable for the Problem 2. There was approximately 10% difference in the length of manufacturing cycle. But vehicle utilization was low--about 43%. Hence, any further increase in the vehicle capacity would not reduce the length of manufacturing cycle. Consequently, machine utilization was reduced to 80% for mathematical model for Problem 2.

Iteration 4 A new set of the mathematical model results was obtained for the Problem 2. The simulation and mathematical models results were within ±1.2% of the each other. The iterative process was terminated.

The results show that the solutions from the mathematical model without considerations to the utilization factors are not viable at the simulation level. Therefore, resource capacities at the mathematical model must be adjusted by utilization factors so that its results are feasible at both the levels.

Despite the lower material handling requirement in the example problems 1 and 2, the vehicle utilization was relatively very high. This was due to the fact that large amount of the empty travel is involved in the system layout under consideration. This layout allows only unidirectional travel of vehicles. Consequently, every loaded travel is accompanied by a significant amount of unloaded travel. This reduces the available time for loaded travel on a vehicle to less than 50% of the total time.

GUIDELINES FOR PARAMETER MODIFICATION

A link between mathematical and simulation models is established using modification of the planning parameters. The rate of convergence of the procedure is dependent on the modification of parameters. Therefore, it is important to have certain guidelines to adjust the parameters at every iteration.

Selection of Initial Parameters

Initial starting point is very critical to the iterative procedure. If good start point is selected, a faster convergence of the procedure can be expected. The initial parameters can be selected on the basis of the historical data on the system and the parameters of the problem under consideration. Further investigation is necessary to establish guidelines for initial parameter selection. If no reliable historical data is available, then procedure could be initiated with 100% utilization of all the resources.

Modification of Parameters

1. Increase in MHS capacity (more number of vehicles) can be effective if vehicle utilization is large at the simulation model.
2. Machine utilization factors should be considered for adjustment if simulation model cycle length and planning period differ by more than a predetermined fraction, e.g., 0.05.
3. Machine utilization should be reduced, if part waiting time is large. This adjustment requires some judgement because part waiting is also dependent on the number of pallets. If number of pallets increases, overall waiting time also increases. Therefore, if longer waiting time is contributed due to the number of pallets, than adjustment of utilization factors may not be desirable.
4. While adjusting machine utilization parameters, the available machine capacity should be maintained at a level so that all the parts can be assigned. In both the problems, overall machine workload is approximately 70% of the total available time on the machines. That is, 30% of the time machines is idle to adjust scheduling delays. Most of the unassigned machine time was on the alternate machines (less efficient machines).
5. The length of the planning period can be adjusted if the utilization factors and vehicle capacity do not achieve a viable solution in a given number of iterations.

CONCLUSIONS

In this paper we provide a procedure for operational planning of FMS which combines a mathematical planning model with a simulation model. The procedure is developed to solve part assignment and tool allocation problem in FMS. The procedure has three main components--an integer programming model, simulation model and parameter modification. Main objective of the procedure is to obtain the planning model results which are viable at the operational level.

It was demonstrated that the procedure would converge to a solution of a problem. However, no limits on the rate of convergence was established. The implementation of the procedure was illustrate with help of two examples. The results of these problems showed that the procedure could converge faster, hence, could be useful in real world situations. The examples illustrated that resource utilization factors had considerable impact on the viability of mathematical model results. Thus, effective linking of mathematical and simulation model is necessary to obtain viable results. The values of the utilization factors depend upon several operational elements. Estimates of the utilization factors can be obtained from historical results. The planning procedure can be used for further adjustment of the value of the utilization factors and other planning parameters.

Further examination on the optimality and the rate of convergence of procedure is needed. The procedure does not consider whole feasible region, instead it utilizes a point search. Every iteration represents a point in this search procedure. Therefore, some overall optimality testing criteria should be developed or else the procedure may terminate at a local optimal solution. Similarly, limits on the rate of convergence must be established. The practical utility of the procedure will be very limited if convergence of the procedure is slow. Nevertheless, two problems showed that a relatively faster convergence is plausible. The procedure in above two cases converges in 3 and 4 iterations respectively.

APPENDIX

The time minimization model can be written as follows (Leung et al., 1993):

Minimize:

(1) $Z = \sum_i\sum_j\sum_k\sum_r\sum_s (t_{ijks} + d_{kr} * 1/v * 1/\beta) * X_{ijkrs} + \sum_k\sum_s \delta * Y_{sk}$

Subject to,

(2) $\sum_s N_s * Y_{sk} \leq S_k \quad \forall k$

(3) $\sum_i\sum_{j\in\sigma ikj}\sum_r t_{ijks} * X_{ijkrs} \leq Y_{sk} * p_k \quad \forall k \in \phi_{ks}, s$

(4) $\sum_k Y_{sk} \leq A_s \quad \forall s$

(5) $\sum_k\sum_r\sum_s X_{i1krs} = Q_i \quad \forall i$

(6) $\sum_r \sum_s X_{ijkrs} = \sum_p \sum_s X_{ij+1pks} \quad \forall\, i,j \in \sigma_{ikj}, k \in \phi_{ks}$

(7) $\sum_i \sum_{j\in\sigma ikj} \sum_r \sum_s X_{ijkrs} * t_{ijks} \leq M_k * \alpha_k \quad \forall\, k$

(8) $\sum_i \sum_{j\in\sigma ikj} \sum_k \sum_r \sum_s X_{ijkrs} * d_{kr} \leq \mu * \xi$

where:

X_{ijkrs} Quantity of part type i whose j^{th} operation is to be processed on machine k using tool type s, after visiting machine r (for its $j\text{-}1^{th}$ operation).

Y_{sk} Number of tools of type s loaded on machine k.
t_{ijks} Processing time of the j^{th} operation of the i^{th} part type on the k^{th} machine using the s^{th} tool type.
p_s Tool life of the s^{th} tool type.
d_{kr} Travel distance between machine k and machine r.
β Fraction of unloaded travel.
S_k Magazine capacity of machine k.
$\{\phi_{ks}\}$ Set of machines k which can hold tool type s.
A_s Available tools of type s.
N_s Number of slots required by a tool of type s.
Q_i Production requirement of part type i for a given planning period.
$\{\sigma_{ikj}\}$ Set of operation j of part type i,which can be performed on machine k.
M_k Available time on machine k.
α_k Maximum utilization of machine k.
μ Capacity of material handling system.
ξ Maximum utilization of material handling system.
δ A very small number.

Editors Note: Tables available from Author

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EXPANSION INTO THE FUTURE: HEALTHCARE AND INFORMATION SYSTEMS TECHNOLOGY

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ABSTRACT

This paper examines the current state of health care information systems. While progress has been made, the industry still needs vast improvement to catch up with technology. An integrated healthcare information system would provide numerous benefits to the industry.

INTRODUCTION

In a world where the local "discount city" maintains an on-line, real-time inventory system, where current stock quotes are just a click away on everyone's web-browser, and where practically anyone and everyone can become an instant "expert" on nearly anything simply by playing around on the Internet, it seems as though the U.S. healthcare system could do something more with information. The United States has some of the top healthcare facilities in the world. But, as far as information goes, it has been slow to institute automated systems.

Today's healthcare information system has not keep up with information science. However, slowly but surely, this status is changing. Many, but not yet most, healthcare providers and insurers have begun to maintain electronic records; healthcare intranets are becoming more common occurrences around the country; even the Internet is becoming a strategic healthcare tool in some areas. But still something is lacking. All of the healthcare players do not have an information system, and those that do are not truly linked. The American healthcare system needs something well-constructed, operationally efficient information system that connects providers, insurers, and patients around the country and can drive American healthcare to the bounds of its capabilities.

This system is needed to provide more enhanced service through offering providers, insurance carriers, and patients advantages in care, billing, and planning. The advantages this system would offer are vital for the growth and continued development of the healthcare system.

However, this information system will not be without limitations. Problems with security, provider use, cost, time, standardization and the continued need for some paper-based records would all place pressure on this information system. However, with the possibilities offered by technology, these limitations can be overcome.

Despite the fact that most areas of business and industry throughout the United States place focal emphasis on information technology, the healthcare industry simply does not. Although high tech proliferates in almost every other area of clinical practice, information technology is often only found in isolated "islands of information" within provider and insurance institutions ("Bringing Healthcare Online" 1). Working toward an on-line, integrated healthcare information system should be a primary objective of the healthcare industry in the next century.

HEALTHCARE AND INFORMATION TECHNOLOGY - THE PRESENT STATE

Across the Unites States today, one does not find a healthcare information system that is integrated and automated. Rather, one finds, amid a sea of relative confusion, a few isolated "islands of automation" which combine with manual, paper-supported operations to create a larger healthcare system. This system can principally be segregated into three, hierarchal levels: level one, local isolated; level two, local integrated; and level three, system-wide integrated.

Local Isolated

A healthcare information system that functions in an integrated, responsive manner, must, at its most basic level, consist of components that operate with a high degree of automation. Today, in the American healthcare information system, this is simply not the case. According to a 1998 survey by the Healthcare Information and Management Systems Society, only two-percent of 1,700 healthcare information executives have a fully operational computer-based patient record (CPR) system in operation, and nearly twenty-five percent have not even begun to plan for CPR systems (Serb 39-40). A separate survey indicates that only slightly more than one-third of the nation's healthcare networks have some sort of electronic patient record system in operation (Menduno 46). Providers receive little incentive from insurance companies to become electronic; the majority of insurance companies do not accept electronic claim filing (Moynihan 62). Without automated records, at the local, isolated level, it is difficult, if not impossible, to exchange up-to-date information within each system itself, let alone with other healthcare entities. However, for those who are automated, advancement to the next level, local integration, is possible.

Local Integrated

Considering how few local healthcare systems operate with automation, it is no surprise how few operate on the next level, integrating within the organization and with other local healthcare systems. However, there are healthcare organizations who are constantly pushing forward to make this possibility a reality. Use of both intranets, which most commonly link doctors within organizations, and remote access capabilities, which allow doctors "unconventional" access to patient information (such as after hours from their homes), is on the rise throughout the country (Serb 40). Some geographic locations have even gone so far as to implement community health information networks (CHIN). CHINs connect hospitals, medical clinics, physician offices, insurance companies, pharmacies, and other related organizations within a specific geographic region. They provide each of these entities patient clinical and financial information via integrated computer and telecommunications capabilities (Lassila 65). One example of a CHIN is the Minnesota Health Data Institute's "MedNet." MedNet is a secure "network of networks" which links major health plans' networks with other healthcare parties within the state (Starr 11). Even given these advances, no healthcare organization has truly integrated with, and few have even explored the next level of system wide integration.

System-Wide Integrated

At the present time, the U.S. healthcare system is anything but integrated. Few, if any healthcare organizations have even explored the possibility of using a system with nationwide access, such as the Internet, in their information pursuits. Some of the systems which do allow national access, such as the government funded Patient Centered Access to Secure Systems Online research project (PCASSO) primarily only address one area of the healthcare information problem-the need for patients to have ready access to their own health records. The issues of linking providers and insurance carriers has not been a forefront issue. Although few healthcare entities have explored this encompassing level of the healthcare information structure, this is the area where ultimate expansion needs to be aimed. It is at this level in which an integrated, efficient healthcare information system must be developed.

CONCEPTUAL MODEL
NATIONALLY INTEGRATED HEALTHCARE INFORMATION SYSTEM

If the healthcare information systems of this country are to be utilized to their fullest potential, eventually, the U.S. will operate with a nationwide, integrated information system. Through this system, each of the healthcare industry's primary sectors, providers, insurers, and patients, will have access to patient clinical data. For this system to exist, several changes will quite obviously have to be made.

All local systems must first develop fully electronic records. These records must be of the type that exist within a "virtual" healthcare information department-authorized users will have system wide, immediate electronic access to patient information (Odorisio 306). Second, a nationwide framework must be made available in which a system to input, store, and retrieve data may be developed. Third, a system must be developed in this framework through which each of the three sectors can input data and access its processed output--usable, accessible information.

Obviously, the first stage, developing a fully automated record system, is under way, but potentially years from completion. The completion of this first stage necessitates a committed effort on the part of healthcare insurers and providers to make this ideal a veritable reality.

The second stage of this process, creating a nationwide framework, could be achieved through establishing a new network that physically connects each authorized sector participant to a main database. While providing a great amount of security, the implementation of such a system would likely be both physically and financially impossible. A more viable solution would be to use what is already in place, the Internet.

Utilizing the Internet would still entail creating a database into which the information from the three sectors could be inputted, stored, and received. Ideally, all information would be stored in a central database, securing the integrity and completion of patient records. However, such an expansive creation would likely be impossible in realistic form. The creation of this database would result in somewhat of a problem with regard to its originator and manager. A privately managed database would create a necessary monopoly, not likely to be viewed with high esteem by federal regulators. A government managed system, through adding another layer of typically inefficient bureaucracy would create what many dislike, too much oversight and, most likely, inefficient operation. Perhaps the best solution would be to adopt a set of standards with which each sector could input and access information, and allow intranets encompassing states or even regions to maintain data warehouses for the input information. Authorized users would be given access to any of these databases through use of a web-browser.

By utilizing the Internet, a viable healthcare information system can be developed to manage the electronic patient records of individual providers and insurers, through participation in geographic intranets. Such a system would offer the healthcare industry the ability to overcome current obstacles and expand with new opportunities.

ADVANTAGES OF INTEGRATED HEALTHCARE INFORMATION SYSTEMS

An integrated, nationwide healthcare information system will benefit its three primary sectors, healthcare providers, insurers, and patients, in a number of ways. These benefits will primarily be recognized in patient care and cost savings. All of the benefits and uses described below are not obtained solely from the large, integrated information system itself. Some of them will be brought about through utilizing the systems and improvements created as a base for the larger, integrated system (such as electronic records and local intranets).

Patient Care

With the use of an integrated healthcare information system, physicians will be provided with easier and more effective access to their patients' clinical data and to relative, possibly critical information.

If an expert system were integrated into the information system, it could potentially save millions of dollars, and possibly quite a few lives. According to the Journal of the American Medical Association, adverse drug reactions fall between the nation's fourth to sixth leading cause of death (Menduno 46). Not a fact to be taken lightly. With the ability to connect healthcare providers through networks, smaller providers could conceivably have access to resources that have previously been out of their reach.

Even if an expert system is not added to the network, care providers will be able to offer patients better service as their status will be measured by much more efficient means. With such a system, doctors will be capable of updating and accessing patient records after hours, gaining a colleague's opinion on a patient's condition (even if they are thousands of miles apart), or reviewing a patient's entire medical history before prescribing treatment.

With an information system that can be accessed via the Internet, even patients can gain passage to their own medical records. In an era where patients, especially those with potentially terminal or lifelong illnesses, are choosing to become more educated about their health, an information system that provides needed details could become invaluable. The PCASSO system already has a security system that would allow patients to utilize such an information system to further their education about their illness. This system classifies each piece of a patient's record into one of five security categories:

- Low: anonymous or "nonpatient-identifiable" data (can be used by researchers, etc.)
- Standard: regular patient information without special sensitivity
- Public Deniable: information that demands extra security, such as HIV status, mental-health records belonging to celebrities
- Guardian Deniable: teenage abortion or other records that can be kept from parents or guardians
- Patient Deniable: information that could cause harm to the patient if known (such as confidential information provided by a relative)

Classification such as this protects the security of patient records, while at the same time, allows individuals the opportunity to monitor their own treatment process. This facet of the information system could potentially become one of the most valuable. As Dr. Dan Masys, director of Biomedical Informatics and associate clinical professor of medicine at the University of California, San Diego stated:

> "In America, to some extent, we still have the Norman Rockwell view of health care, with the physician who knows all and the patient not having to worry about it. But the reality-especially when you become seriously ill-is that there are some very complicated and not-so-black-and-white issues and lots of choices to be made. The better educated you are, the better able you'll be to participate in taking care of your own health (Breckinridge 4)."

Cost Savings

With the cost of healthcare perpetually on the rise, any cost savings are welcome. An integrated, up-to-date healthcare system would offer many such savings.

Saving to Providers. Historically, adverse drug events have cost hospitals $2,200 to $3,500 per ease; the use of a network expert system could eliminate many of these, potentially saving millions of dollars per year (Menduno 45). With such a system, doctors eventually will be able to order prescriptions and check insurance eligibility almost instantaneously, saving valuable time, effort, and hence, money (Serb 39). Further, administrators should also be able to utilize such data to improve operational performance and obtain information to -support crucial decisions (Scheese 56). Utilizing this system, providers should be able to operate in a more effective manner, saving insurance carriers and patients the cost of needless treatment. This advance should conceivably allow care to be evaluated more for performance rather than price (Millenson 46).

Savings to Insurance Providers. An integrated information system should also greatly benefit insurance providers with many cost savings. Currently, insurance premiums are often based on out-of-date or incomplete data--there simply is not an effective means to gain the current data quickly enough. This delay sometimes translates into significant losses-an anticipated $75 to $105 million loss for Aetna and nearly $70 million loss for Oxford, in 1998 alone (Haugh 44). Further, with an inside track on patient records, health management organizations can monitor the effectiveness of contracted, network physicians within the organization. By monitoring performance in terms of cost and results per-episode, improvement in outcomes and competitiveness can be realized (Breckinridge

1). As mentioned above, insurance carriers should also be spared the cost of much patient treatment that is unnecessary.

Savings to Patients. In addition to the more advanced care that an integrated information system will offer, patients should also receive substantial cost benefit. By possessing the capability to access their own records, patients could possibly customize their treatment to meet individual needs, thus avoiding duplicated and unnecessary treatment. Also, as mentioned above, with healthcare providers' possession of a wider base of clinical data, unnecessary treatment will hopefully almost be eliminated.

An integrated, nationwide system should benefit each sector of the healthcare industry sufficiently to justify its implementation and use. However, such a system is not without problems and limitations.

PROBLEMS AND LIMITATIONS OF THE INTEGRATED INFORMATION SYSTEM

In order to be effectively used by the healthcare industry, the information system discussed would be faced with at least five problems and limitations that it must overcome or compensate for in order to become a success. These factors are: security, doctor utilization, cost and time to implement, standardization, and the still present need for some manual records.

Security

As everyone surely realizes by now, the world wide web is not a foolproof, totally secure method of communication. However, enough systems are in place today that protected communication can be accomplished fairly easily. The problem which still exists, however, mainly lies in limiting access to this protected information. Through the use of passwords, as well as limited physical access, electronic records should be provided the utmost security. This qualification is necessary from both a legal and ethical standpoint (Fotsch 27). However, with the use of the Internet, the possibility for unauthorized use of the information system will most certainly always be present.

Doctor Utilization

When a system such as this is in place, office staff will be forced to use it-it will be part of their job description, they will not have a choice. But what about the physicians who are defiant to the use of the system? Possibly due to resistance to change, fear that ethical standards will be compromised, fear that the new system will create more work, or other reasons, physician resistance to the use of networks for clinical purposes could be very much a reality.

A 1998 survey by Healthcare Financial Management revealed that forty-percent of the polled physicians stated "that they probably would not use computers or networks for clinical purposes even if training were provided and services were made available free or at a very low cost (Fotsch, "Medical Intranet" 29)." Quite obviously, this reveals but one thing-doctors must be considered in the design of this network. It is absolutely imperative that physicians feel they are gaining an advantage by using the system.

Perhaps through emphasis on the idea that the physician's office becomes virtually boundless with this system, or through emphasis on the idea that this system will make a doctor's life easier-the benefits of the system must be stressed. Because, quite obviously, if the doctors do not input data, the system has nothing to process, and it becomes a failure.

Cost and Time to Implement

For a provider or insurer that has limited or missing electronic data banks, conversion to an information system such as this will be both time consuming and costly. The key to overcoming this limitation is in discovering the cost benefit that such a system can offer. Simple cost-benefit analysis cannot readily apply to a system such as this. Such a system is not traditional, and requires an alternative method of valuation. To justify the cost that conversion will entail, each sector must come to view information "as a valuable resource that increases individual, departmental, and organizational performance and productivity ... a competitive advantage (Scheese 57)." It is only by this means that such a large expenditure will stand the chance of acceptance ill any organization.

Standardization

Around the country, each individual healthcare provider and insurance carrier has its own method of storing patient data. One might link patient records by social security number, another by an internally assigned identification number, and still another by last name. The point is, there are few, if any, standards that govern the form of medical records. In this current state, a massively integrated information system could never function. Standardization is necessary.

To facilitate the exchange of patient information among applications on a network, users must be able to exchange and correctly recognize unique "patient identifiers" (Fotsch, "Working Toward" 26). In order for this to be accomplished, a patient indexing system must be developed, one which will allow management of discrete clinical data from various systems in a manner that insures all entered information will remain associated with the correct patients and providers (Fotsch, "Medical Intranets" 27). The Health Insurance Portability and Accountability Act of 1996, which requires nearly all claims payers to support electronic claims processing and uniform national standards for code sets and identifiers by the year 2000 is definitely a step in the right direction (Moynihan 62). Clearly, standardization is not merely a limitation that can be compensated for, but an obstacle that must be overcome before any information system such as this can be installed.

Paper Records

Even if a seemingly full-fledged electronic record system is placed within an organization, the need for some paper records does not entirely disappear. Doctors' notes and observations, often recorded on patient charts, still must be consulted for immediate analysis, audits of prescribed treatments, and research (Beckham 56). Until physicians stop using pens and pencils entirely, this need will likely never be overcome--it must simply be dealt with.

CONCLUSION

With the healthcare industry spending $7 billion dollars on information technology annually, and with an expected doubling of this figure by the end of the decade, serious potential for improvement in the way healthcare information systems operate exists (Lassila 64). However, according to Health Care Investment Visions, most makers of healthcare software are not basing their business foundation on "new-generation technologies" such as the Internet ("Tech Tomorrow" 38). Certainly something can be done with the U.S. healthcare information system. But, will this something ever be accomplished?

The current healthcare information systems in this country are limited by a number of factors. All patient records are not electronic. Without electronic records, exchange of information within an organization and among organizations can hardly be accomplished in a timely and efficient manner. Further, the healthcare information systems of today exist in relative isolation. Few are connected through shared networks, and those that are link at the local level, not in a nationwide system. For the healthcare industry to take full advantage of the potential of information technology, a nationwide, integrated healthcare information system should be developed.

Such a system would offer numerous advantages to each sector of the healthcare industry. This system will allow healthcare providers to offer better care through more efficient dissemination of knowledge to physicians, via expert systems, colleague evaluation, and patient opinion. Further, this system will offer cost benefits to the healthcare provider, insurer, and patient. Combined, these two areas of potential advantage should create a more accepted and productive healthcare system.

Although this system would offer its users a number of advantages, it is not without limitations. Problems with security, usage, cost, standardization, and the ever-lasting presence of paper records would have to be overcome or dealt with in order for the system to operate with any degree of success. However, given the advantages such a system would offer, these limitations seem to be surmountable obstacles.

An integrated, nationwide healthcare information system would provide everyone with a more efficient, affable operation: Although the benefits well-justify this endeavor, reaching this point will be a long, hard struggle. There is no doubt the healthcare system in the United States will eventually reach this point, but how, and when, are far different questions.

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SERVICE ENCOUNTER MISMATCHES: ISSUES IN INTEGRATED IT JOB DESIGNS

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ABSTRACT

As the services sector becomes a larger component of the national economy, it becomes increasingly critical that the management of service operations be addressed systematically. One concern is the interaction of service employees and the technology installed into making up the job design. Effectively matching job design and technology leads to effective service encounters, while mismatches cause short-run or long-run problems for the organizations.

Organizational mismatches between job design and supporting infrastructures, primarily the technology selected, can give rise to the use and exercise of judgment and discretion by service encounter employees that from the viewpoint of the organization or the customer is extraordinary, conflicted or perverse. Perverse judgments debilitate the organization and degrade the quality of the service encounter. Conflicted and extraordinary judgments ultimately debilitate the organizations and may degrade the quality of the service encounter if some customers should perceive others as having received preferential treatment. This paper explores dynamics in managing operations, technology, and human resources that give rise to the exercise of such judgements with the intent to construct a conceptual framework that will explain such judgments and the behaviors that issue from them.

THE COMPUTER SKILLS COURSE: MAKING THE MOVE TO CD-ROM BASED INSTRUCTION

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ABSTRACT

Many colleges and universities are rethinking their introductory computer skills course pedagogy. Students come to the university with varying levels of computer knowledge; somehow the course must handle this diversity. Traditionally, the instructor teaches toward the middle experience level, often losing the novice computer users and boring the experts. The wide-scale availability of CD-ROM instruction for the various office automation packages makes the concept of computer-based instruction viable.

In this paper, we report on our team's experiences in making the transition from an instructor-led to a CD-ROM based course. We begin by describing our motivation for moving to this new instructional method and the process by which we selected the specific CD-ROM package. Then, we discuss the course syllabus and structure, followed by a discussion of the pluses and minuses of the program. After detailing the assessment results for both students and faculty, we present the lessons learned from the experience -- what we did right and what we did wrong -- and offer guidelines for other schools considering the move.

INTRODUCTION

The student body at Columbus State University, like that at many schools, is diverse. Non-traditional students make up a large part of our student body. Some students enter our classes after more than a twenty-year absence; others come to us fresh from their high school graduation. These factors, combined with differences in secondary school curricula from the many counties that send us students, result in classes filled with students who run the gamut from novice to expert computer user. Nowhere does this present more of a challenge than in the introductory computer skills course.

In the skills course, students are exposed to Windows 95 and a complete office automation package. We currently use Microsoft Office 97 Professional, which is the standard for the university. Students also learn electronic mail (Pegasus), the Internet and World Wide Web, and the university's other on-line resources, including GALILEO, the state of Georgia's on-line library system.

Recent changes to the university, the most significant being the move to a semester system, motivated us to examine the course and suggest improvements. Another consideration was the rapidly growing number of Computer Information Systems (CIS) majors and other students who needed to meet university computer literacy requirements. Faculty were compelled to teach more courses in the major, and vacancies at the introductory level needed to be filled creatively, with minimal impact on the bottom line.

Throughout the 1997-98 academic year, we explored the various options for the course. We are limited to small classes as our computer lab only seats 28 students. Although we might have gone to a large lecture room for some portion of the class, we did not welcome the idea of our students not being able to practice the skills immediately after we demonstrated them. We were also concerned with the various levels of computer knowledge that permeated the typical class. All of these factors led us to consider a CD-ROM tutorial package for the course.

This paper proceeds as follows. In the next section, we discuss the rationale for switching to a CD-ROM course and the evaluation process by which we selected the software for the course. Then, we present the course syllabus and structure that was used in Fall 1998 and the revised version being used Spring 1999. The problems and pitfalls we experienced along with the positive aspects of the course are detailed in Section 4. A discussion of assessment methods -- both student and faculty -- comes next. Finally, in Section 6, we offer some guidelines for universities considering such a move.

RATIONALE FOR THE CD-ROM COURSE

Students arrive at CSU with a variety of skills. Some need extensive training in everything from moving a mouse to keyboarding. Others know most of the material in the course. This wide range of skill sets makes classroom management difficult. Those with more skills deem the class boring; those with few skills believe the class moves too quickly.

With the move to a semester system came a change in the focus of the course. General IS topics were moved to the Introductory MIS class (now required for all business students) and this class focused more on basic computer skills. As the textbook previously used was no longer appropriate, we had incentive to explore other options.

The University had recently instituted computer competency requirement for all students; our course would meet that need. This, and the increased demand from College of Business students for the course, forced us to examine our options, as scheduling upper division classes became more difficult and already scarce resources were stretched further. Two possible options were larger lecture classes (moving the class from a lab setting) and greater use of adjuncts. Neither option was attractive, as we believed these options would reduce the quality of the course. Instead, we looked for a solution that would facilitate establishing common goals and a common syllabus across all sections of the course.

We determined that a CD-ROM, tutorial-style course would be the best approach. We needed a product that focused on skills rather than IS concepts, provided external and independent measurement and assessment ability, and simplified instructional efforts. The package we selected (E-Course by Course Technology) was chosen in large part because it used a live interface for the tutorials (i.e., students need a copy of Office 97 to run them). The E-Course testing system. Skills Assessment Manager (SAMs) not fully functional at time of selection) would also use a live environment. Moreover, the package included Microsoft Office User Specialist (MOUS) certification as a possible outcome.

COURSE SYLLABUS AND STRUCTURE

We are now using the CD-ROM package for the second semester, and we have learned a great deal in a few short months. In this section, we present key features from the syllabus and discuss what works and what does not.

Our first pass at the course was somewhat structured. We decided that we would cover the basics of Windows 95, our computer network specifics (library and e-mail access) and the Internet during the first few weeks of class. This meant that the instructor would be lecturing for most of the time early on, until the students learned to operate the system and use the CDs. Attendance was never required, but was encouraged, especially early in the semester.

Tests were scheduled for specific days. Thus, students had to be ready to take the test on each section of the software package (Word, Excel, Access, and PowerPoint) by the specified dates. Tests on each module were spaced so that all four modules, plus the introductory material, could be completed in the 15 weeks of the course. Students with previous exposure to the material, and those with more computer ability, could opt to take the tests before the scheduled date.

Some students took all the tests early, but did not finish the course significantly ahead of schedule. A few took all the tests during the first month of class and only had to complete the integrative project toward the end of the semester. Most, however, kept pace with the schedule we established, although many of these students stopped attending class regularly.

Our primary concern with this approach was that there was no tutorial provided that focused on integrating all the packages. We designed a project that required students to use the Mail Merge feature in Word to send letters to students selected from an Access database. The project also required them to use Excel to sort test scores and assign a letter grade. The project was not assigned until the last week of the semester, and this was problematic for the students. Most were in 'crunch mode' by that time with all their classes, and the project required them to pull on information they had not seen in three months.

For the current semester, we changed the project so that students are presented with it in smaller doses, after completing each module. Thus, once they have finished Word, they will do a Mail Merge project. As they finish each subsequent module, they will add another piece to the project, until they complete the same assignment as previously.

PROBLEMS, PITFALLS, AND POSITIVE ASPECTS

Although we spent considerable time selecting the software and planning the course, we still encountered problems. There were also many positive instances. In this section, we will discuss both the pluses and minuses of the course.

Problems and Pitfalls

Of greatest concern were the SAMs testing modules, which were not completed in time for use last semester (they had been promised early in the semester). The only tests available (e-Test; simulated working environment) do not meet all of our requirements. Another problem we experienced was in setting up the software on our computer network.

The Tests

Our philosophy in this course is that students should develop either a specific skill or the ability to discern that skill (i.e., use the Help function, read a manual, search the menus). We also are not concerned with how the student accomplishes a task. Putting a section of text in boldface type, for example, can be done using the format menu, using the **B** icon on the formatting toolbar or pressing CTRL B on the keyboard. How the student performed the task did not matter to us. Moreover, if the student had no idea how to perform a task, we believe that going to the help menu is an acceptable option. The e-test designers disagreed with us, and the testing module requires that the student complete every task in a preordained manner. This infuriated the students and the instructors.

We coped with this difficulty by offering a practice test for the first module (Word) and then allowing students to take any test a second time. After the first few testing efforts, students learned to read the directions for each question carefully, and follow them exactly. This greatly improved their scores, but testing remains a sore point for the reasons mentioned above.

Another problem with the tests is our inability to time them. The tests are loaded on one of the network servers. Instructors use a special CD-ROM to activate a specific test. Once the test is active, students can begin working on it. The process for turning the test on and off is cumbersome, and it is easy for the instructor to forget to stop access to the test. Once students begin a test, they can spend the entire class period on it; there is no way to turn the test off, so there is no simple way to limit the amount of time students spend on the test. Finally, test results are not written to a file that the instructor can access. Instead, they can be printed or saved to disk (the student must select this option at the start of the test). Occasionally, the printer jammed and test results were lost when a student failed to follow instructor directions to both print and save to a local disk.

Finally, there were only four tests (in each skill area) from which to choose. While this at first thought might seem adequate, consider that we typically have 6 different classes. Students in each class may take a test early and may take a re-test. Trying to ensure that information about the tests does not circulate is difficult. However, each test has approximately 80 or more skill sections closely linked to the CD tutorials. While instructor control of test content is not possible, the number of questions does make it difficult for a student to memorize the questions and pass them to another student. A more serious concern is the inability to randomize the questions. Therefore each student in the exam starts with the same question. While most students are intent on their screens, instructors do have to monitor roving eyes.

Working with Computer Services

We are fortunate to have an excellent support staff in our Computer Services department. We experienced numerous problems in setting up the software despite this. During the first two weeks of school, students in the class went to the computer labs on campus and loaded their CD-ROMs on the PCs so that they could use the tutorials. Loading software -- any software -- on university computers is not allowed. The penalty is removal from the lab and loss of computing privileges for one day. So, as students followed their instructors' directives in the open labs, they were tossed out of the lab and unable to log into the network. This problem went unresolved for the duration of the course; students were able to practice only in the College of Business labs, which are available limited hours. The vendor did not provide complete information regarding the network requirements, loading and operating instructions, so there was an on-going dialogue between the vendor and Computer Services.

The First Three Weeks of Class

Once the course "gets rolling," it is a very rewarding course to teach. The most difficult and challenging part of the course occurs in the first three weeks, when it seems as if every student in the class needs special attention.

Invariably, some students' IDs and passwords do not work. These students are often immediately frustrated with the course, the instructor, and the university, especially when they are told that they must go across campus to the Computer Center to solve the problem. Other students, because they have extensive computer knowledge, do not listen carefully to our instructions and quickly become lost and annoyed with the campus system. Still others log on right away and sit bored and angry that they have to watch the instructor help all the other students.

We have not found a solution to this problem; we fear it may exist forever! Some coping mechanisms that we have discussed, but not implemented are:

having a graduate assistant (or two) present for the first two classes to help students get acquainted with the computer

splitting the initial course sessions up into smaller blocks of time with fewer students so that more individual attention may be given

The situation described above is one reason we have not yet moved to very large lecture classes for some of these class meetings.

Forgetfulness

We have already mentioned that it is easy for instructors to forget to limit access to a test after students have logged into it. Another instance of forgetfulness comes on the part of the students, who often leave their CDs in the computers. Although we have told them to write their names on the CDs, many have not. All 'nameless' CDs found are turned into the lab monitors and, if not claimed, used by students in upper division classes refreshing their skills.

The Positive Aspects

There were many positive aspects of the course. As mentioned above, students work largely at their own pace, and consult the instructor only when they need clarification on certain topics. The instructor becomes "The Guide on the Side" rather than "The Sage on the Stage," and can devote more time to students who need it most. More experienced students are thrilled to move swiftly through the tutorials (if they choose to do them at all), and the novices are excited that they can move at a pace with which they are comfortable. In addition, many students have found that they can work on the tutorials and projects at home and thus reduce commuting time. We have also had a number of students indicate that their spouse and children are also using the tutorial at home to learn the same skills.

The tutorials provide a tracking feature that enables instructors to check a student's efforts. When a student experiences a problem with a concept, the instructor can simply check the disk to diagnose the trouble. In some instances, student-faculty conferences ended almost as soon as they began when the instructors asked for the tracking disk. Students immediately "volunteered" that they had not been spending quite enough time with the materials, and that perhaps they should go to the lab and spend some time on the concept.

ASSESSING THE COURSE

Our initial foray into CD-ROM based instruction seemed to be going well, but we believed that a true assessment could be done only by examining the students' evaluation of the course and the instructors' evaluations of the students. In the section that follows, we discuss both.

Student Assessment Methods and Results

Students completed four tests in the class for totaling 400 points, and another 100 points worth of projects. Tests were given in Word, Access, PowerPoint, and Excel. The four mini projects during the first weeks of class focused on Windows 95, the Internet, electronic mail, and the library resources, and totaled 60 points. At the end of the semester, students had a 40-point project that integrated all four application software packages. Students were given the opportunity to take any test a second time as long as they took the first test when scheduled.

The average test grade across four classes was 88.7. Once zero grades (for non-attendance) were subtracted, the grades on any test ranged from 47 to 100. The average project grade was 81. The first project set had an average grade of 92, while the final project's average grade was 69. Many students chose to either not attempt or not complete the project, depending on their grade at semester's end. As the project was only worth 45 points, it would not change a very low B to and A (50 points were needed for that). Thus, many students chose to do only enough of the project so that their grade would not suffer.

Faculty Assessment Methods and Results

Students in the College of Business typically complete a faculty evaluation form for each business course they take. For this paper, instructor evaluations were first reviewed separately and then compiled into a single report. The details are presented in Table 1.

Some shortcomings in the current evaluation form were noted. The form was designed for an instructor-led course; many of the questions were not appropriate for this class. For example, *The instructor comes to class well prepared.* Although the first few weeks do involve lecture, we believe that many students have forgotten those weeks when the evaluations are completed during the final week of the semester.

Table 1: Instructor Evaluation Summary

Evaluation Question Scale: Strongly Agree = 5; Strongly Disagree = 1	Instructor				Aggragate
	1	2	3	4	
1. I have developed a better understanding of the subject by taking this course	4.70	4.37	4.76	4.70	4.64
2. The course objectives are clearly identified	4.48	4.39	4.85	4.60	4.58

3. The course objectives were achieved	4.40	4.08	4.75	4.75	4.58
4. Attendance in this class was worthwhile	3.61	4.63	4.06	4.21	4.27
5. The text for this course is useful	3.12	4.78	3.65	2.65	3.89
6. I enjoy the subject matter	4.65	4.95	4.43	4.75	4.67
7. My present grade in the course is (A = 5; F = 1)	4.53	4.84	4.60	4.45	4.60

* note aggregate numbers are not simple averages due to different numbers of students in each class

Another problem with the form is that it provides only limited information about the text and CD-ROM used in the course. Question five refers only to the text; it is impossible to tell whether students thought the CD-ROM was useful. One other factor that might have skewed results from the evaluation is that those student who completed the course early were not present on the day evaluations were distributed.

To probe the students' attitudes toward the course more deeply, we turned to their written comments. These were overwhelmingly positive. A sample of the positive comments is presented below.

Positive Comments from Evaluations

(The SW) was easy to use and very helpful.
I liked being able to work at my own pace
The package prepared me well for the tests
I would recommend this (course) to others
There is the advantage of review as often as necessary
I have greatly enjoyed the class and learned a great deal
The software allows you to work at your own pace
A great class to take
I liked the setup of the tutorials
Love the self-paced system
Extremely effective
I was completely computer illiterate at the beginning… now I have an A

There were some negative comments. A few students did not like the tutorials; many of them thought the tests were too strict because they did not allow them to use alternate methods to complete tasks. Some students felt they had to spend too much time working on their tutorials. Finally, some students complained about the limited locations to practice the tutorials on campus. Overall, however, the percentage of negative comments was far lower than that of classes taught using traditional methods.

IMPLEMENTATION GUIDELINES

In this section, we present some guidelines and issues to consider before moving to a CD-ROM based course. First, we underestimated the time and effort it would take to get the course up and running on our university's computer system. We also did not think through the Computer Services policy banning students from loading software of any kind. Had we done so, we would have realized that the software we selected was not the optimal software for the university, as it requires loading onto the hard drive of the computer.

We also did not check out the tests carefully enough, although we were limited because the testing system was not yet developed (but only promised) during our evaluation period. We believed we would, at most, use the original tests for the first weeks of the course before switching to the new customizable testing; we are still using the original package and awaiting the new one.

We also made some mistakes designing the final project. First, we assigned it too late in the semester. It should have been used as reinforcement for learning after each software package was completed. We also gave it too little weight in the total point count, which allowed students to skip the project entirely and not suffer any consequences. Finally, the initial project was simply too difficult for most of the students.

Despite these shortcomings, if the enrollment figures are any indication, the course is very successful. We are offering nearly twice the number of courses this semester as we did one year ago, and still classes fill as soon as they are announced. Students share their positive experiences with each other, and demand for the course is expected to continue.

Next year, we hope to employ an additional person (at the instructor level) to teach many of the sections of the course, and an Honors section is planned. The course is rapidly becoming the "bread-and-butter" course for the department. Its enrollment and staffing allow us to maintain small, personalized instruction in the upper division courses.

As with any new software or change in instructional methods, there are bound to be unforeseen problems. There are also unforeseen benefits. In many cases students volunteered that the class structure was what they needed as busy parents with hectic life styles. In addition, many were pleased with the ability to review complex topics via the tutorials as often as needed. We have also noticed that students initially devote long hours to the tutorials, gain high levels of expertise, and then sometimes get overconfident. Overconfidence has led to lower than expected grades on the second skill exam.

Because the class does not require attendance every class period, some students have failed to appear for scheduled exams. These students are rapidly learning better time management. Others appear at every class and are able to get the more individualized attention they require.

Our syllabi now contain several days of required attendance. On those days we review hints for solving some of the project issues, demonstrate special features, and demonstrate new technology. This approach seems to keep the students motivated.

We believe that the self-paced approach is appropriate for traditional and non-traditional students. It allows students to progress at their own pace and the text selected supports external validation of course content. Class management requires new skills and faculty must be prepared for a wider range of questions than when they have specific topics scheduled in a traditional lecture setting. We have found these challenges to be rewarding and stimulating.

ENTERPRISE RESOURCE PLANNING SOFTWARE IN GRADUATE BUSINESS PROGRAMS

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ABSTRACT

Business education has been largely function-centric since it emerged from its origins in Schools of Economics. Curricula were based on a core of fundamentals; studies in such areas as Accounting, Economics, Finance, Information Systems, Management, Marketing, and Operations Research. Recent radical downsizing in corporate America and related innovations such as business process reengineering have led function-centric business organizations into the post industrial information age. Strategic value chain principles have been widely applied in many businesses. Enterprise-wide computing solutions have approached being, for the first time, a unifying business technology. Enterprise resource planning software (ERP) is becoming a way for firms to organize their strategy within this technology. This paper recommends that business schools grappling with curricular revision issues consider using the ERP structure of these software packages as an organizing theme for such revisions.

INTRODUCTION

Business education has been largely function-centric since it emerged from its origins in Schools of Economics. Curricula were based on a core of fundamentals; studies in such areas as Accounting, Economics, Finance, Information Systems, Management, Marketing, and Operations Research. Most programs offered an end of program capstone course in business or management strategy. Economists' theory of the firm often became lost amidst disconnected and unrelated course offerings. Meanwhile, the radical downsizing of corporate America and innovations such as business process reengineering led function-centric business organizations into the post industrial information age. Porter's (1985) Value Chain principles have been widely discussed in the business research literature and have been applied in many businesses.

Originally, computers were used to automate existing business systems. Breakthroughs in client-server architectures have led to the creation of enterprise-wide solutions in commerce and industry that have approached being, for the first time, a unifying business technology. A German software firm, SAP AG, is the leading enterprise resource planning software (ERP) firm today (Curran, et al., 1998). Founded in 1972, SAP has defined over 800 business practices and modeled them using graphical representations of events and tasks (Blain, 1997). Many leading firms have adopted SAP or other ERP software implementations. This paper recommends that business schools grappling with curricular revision issues consider using the ERP structure of these software packages.

For many firms, these software packages have allowed firms to do many things that were impossible with earlier, non-integrated software (Atre and Storer, 1995; Borthick, 1992, 1993; Elliot, 1996). Online analytical processing (OLAP) software (Callaway, 1995; Fairhead, 1995; Ricciute, 1994) has enabled managers to compile and analyze their planned and actual results in a variety of ways. Hammer (1999), notes that ERP software is an integrating tool. As such, it combines with OLAP and data mining technologies to give managers integrated enterprises.

Business schools have been under continual pressure to revise their curricula. In the early 1990s, business schools once again began to feel pressure from the outside to revise curricula that had lost touch with the needs and realities of business practice. Distance learning, accreditation standards, new missions, and other changes in the business education environment are requiring institutions to develop new levels of what management theorists call "organizational plasticity" (Gioia and Thomas, 1996; Kimberly and Bouchikhi, 1995).

In the next sections of this paper, we will provide a description of ERP software and present arguments for using ERP software as an organizing theme for MBA curriculum revision today.

ERP SOFTWARE

Berman (1998) notes that 70% of the largest 1,000 U.S. firms have implemented ERP software such as SAP, Baan, J. D. Edwards, Oracle, or PeopleSoft. Many firms in the next tier, with revenues ranging from $50 million to $1 billion, are considering implementing such software. ERP software requires a consideration of, and often modification of, the business processes of a firm. As such, its implementation is often accompanied by a complete review and examination of the business processes of the firm. Since it is enterprise-level software, it demands a conscious integration effort that includes all elements of the firms activities and processes.

Hammer (1999) explains that using ERP software forces firms to become integrated enterprises. Such enterprises demand extremely high levels of teamwork, understanding of key business processes, and distillation of business knowledge. In the course of implementing an ERP system, firms often find themselves moving both authority and responsibility from upper levels of management down to the operational levels. This allows people in the firm to break down traditional barriers and work toward shared goals in the collective spirit so often discussed but seldom before implemented. Individual departments simply do not have the ability to sustain an existence as individual empires secluded in functional silos.

In a typical ERP software package, the enterprise solution is built from existing modules that accomplish information gathering and processing activities for individual business processes (Curran, et al., 1998). In many cases, such as the logistics modules, the integration is accomplished not only within the enterprise, but also extends outside the firm to other participants in the industry's value chain. The exact titles and specific purposes of these software modules vary somewhat in ERP packages offered by different vendors. In this paper, we will use some of the SAP modules to illustrate our approach.

SAP was founded in 1972 to provide integrated business software for large enterprises that integrates all elements of an organization's activities (SAP, 1999). The software is designed to show results for such things as specific supply chains and customer relationships in addition to providing the usual outputs needed by a large organization to keep its bills paid, its financial statements prepared in a timely fashion, its sales and distribution network under control, and its human resources function operating in conformity with myriad laws in multiple jurisdictions.

The main SAP modules include: financial management, control (which accumulates costs by cost center, activity, order, project, and/or profit center), treasury management, capital investment management, production planning and control, sales and distribution, human resources, plant maintenance, materials management, and enterprise control. Some of the more specialized modules include applications for conducting electronic commerce, managing foreign exchange transactions, and doing business in particular geographic areas of the world. SAP also offers specialized vertical integration for specific industries such as automotive, banking, chemicals, real estate, health care, construction, oil, utilities, and retail.

Other ERP vendors offer a similar range of modules (Baan, 1999; Edwards, 1999; Oracle, 1999; PeopleSoft, 1999). In all cases, these ERP vendors offer complete integrated business solutions. Many large firms have used outside consultants to help them install these ERP software packages. The need for consultants arises, in large part, because these are more than just software packages, they change the way firms do business and the way firms think about themselves doing business.

ERP SOFTWARE AS A CURRICULUM-ORGANIZING THEME

The integration and need to rethink business organization structures that flow from ERP software implementations provide tangible way to implement those desired goals in MBA curricula. Instead of haphazard stabs at implementing teamwork and shared goals in MBA courses, ERP software principles provide a structure for implementing these features that is used increasingly in major corporations today.

In addition to providing a tangible model for implementing soft skills such as interpersonal communication and team-building activities, ERP software can provide an organizing theme for other elements in the MBA curriculum. For example, most MBA programs include courses in accounting. These courses are usually taught by professors that have done considerable research and have high degrees of expertise in one of the narrow areas of academic accounting. The use of ERP modules to organize the accounting elements of the MBA curriculum could lead to a completely different set of courses.

Instead of one financial accounting course and one managerial accounting course, a business school may decide to have a financial management course based on that module and then offer a course in control that was based on the ERP controlling module. Such a course would include elements of cost accounting, management theory, organizational design, human behavior regarding incentives, and related topics. The ideal instruction in such a course may come from a team of professors rather than one with a high level of specialization. Alternatively, a seasoned business executive who has taken an executive-in-residence appointment might be an ideal instructor for this course. The treasury management module and the capital investment module might work well in a reengineered finance course. In all cases, these modules could be used to emphasize the integration of business processes across the enterprise. For example, both the financial accounting course and the finance course might use elements of the financial management module to show the integration of fixed asset accounting with the capital investment process.

Similar opportunities abound for use of other ERP elements as structuring themes for MBA courses. The sales and distribution module could be used to organize and integrate marketing and management course offerings. The enterprise control module would be an excellent fit with strategic management or business policy courses, as would the industry-specific module for conducting electronic commerce. International business courses could use the international development modules for one or several geographic areas. Courses in real estate or health care management would find modules specific to those industries available to support teaching in those areas.

Some MBA programs, such as Bentley and Carnegie Mellon (Crowley, 1999), are including specific tracks or degrees that emphasize information technology. Classes are held in Internet-enabled, networked classrooms that allow students to use ERP and other software directly in finding solutions to business problems. Federal Express has joined with the University of Memphis to create an Internet curriculum model that is available for adoption at business schools (Roman, 1997). This model was created in response to the severe shortage of information technology professionals that have a good understanding of business processes.

CONCLUSIONS

The world of business is enthusiastically adopting ERP software. Schools of business can gain a practitioner's edge by using some elements of these software offerings as an organizing theme for curriculum revisions that are currently underway. By using ERP software to tie courses to business processes, MBA curricula will give students a reason to engage in teamwork and goal sharing activities. This approach can also give students a better view of the integrated enterprise of the future.

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SAP: A LITERATURE REVIEW AND IMPLEMENTATION STUDY

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WHAT IS SAP?

*S*ystems, *A*pplications, and *P*roducts in Data Processing (SAP, pronounced "S-A-P") is the world's leading enterprise resource planning (ERP) software and the world's fifth largest independent software vendor (Hernandez, 1997, p.2). SAP AG was founded in 1972 after unsuccessfully convincing their employer, IBM, to pursue developing their idea of an integrated software package (March & Garvin, 1996). Three of the four founders are still active in running SAP and though a public corporation, 75% of the stock is still owned by these founders (March & Garvin, 1996, p.1). SAP's 1998 third quarter revenues are up 54% (5.9 billion DM) from the same time last year, while SAP's staff has grown 53% (SAP AG, 1998). In 1988 SAP entered the United States, Australia, Latin America, Mexico, and Canada with the establishment of SAP America. SAP's European division encompasses Africa and the Middle East, and SAP APA comprises the Asian Pacific region.

SAP's pioneer product, R/2, was developed for mainframe use. R/2 is still being implemented (in updated versions) today at companies such as General Mills and Eastman Chemical. However, R/2's development will cease at the end of 2004 leaving many customers without system support. R/3, which combines a client-server architecture software package with a relational database, was introduced in 1992 with roaring success. Comparisons and contrasts of the various SAP software offerings are provided in Table 1. R/3 alone has been installed over 19,000 times worldwide (SAP AG, 1999). Because of overwhelming consulting fees ("Fewer than 20% of SAP implementations are done without integrator's help" (Caldwell, 1998, p.1).) and the technical complexity required to implement such an omnipresent system, SAP recently introduced AcceleratedSAP (ASAP). ASAP is aimed at the "mid-market", that is, companies with total annual revenues between $200 and $500 million dollars per year (Busse, 1998, p. 97). SAP introduced ASAP to standardize and expedite implementation. ASAP contains 100 business scenarios that "accelerate" and guide rapid configuration. "One key change in the ASAP methodology compared to the traditional SAP implementations is the absence of business process reengineering (BPR). ASAP suggests that the enterprise implement SAP using the existing business processes, also known as the 'as-is' environment" (Hiquet, 1998, p. 18). ASAP was also a response to growth in object-oriented "wall-to-wall" software packages and intensified competition with PeopleSoft and other ERP package companies.

NEED FOR SAP

The implementation of technology is used to create competitive advantages for firms by allowing them to compress business process cycle times. Today's businesses operate in real time and therefore require the ability to fluidly react to changing markets and situations. Formerly, systems were automated and implemented along functional business lines; that is, accounting had a distinct system from human resources and manufacturing and so on. These "functional silos" operated well within their own areas, but communication and understanding among the areas was limited. SAP introduced ERP software that flattened the "silos" allowing many business processes to occur concurrently and functional areas to communicate effectively. SAP's "wall-to-wall" approach allows companies to be fluidly dynamic, or to react instantaneously to changing business requirements. "It might be argued that the sort of functional integration afforded by an enterprise system is becoming one of the conditions of doing business rather than a source of differential advantage" (Wall & McKinney, 1998, p. 7).

Table 1:
Contrasting R/2, R/3, and ASAP

	R/2	*R/3*	*ASAP*
Architecture	Mainframe; Cannot currently translate R/2 data into R/3 as data structures differ	Client-Server	Client-Server
Platform	Mainframe	UNIX and NT	UNIX and NT
Still Being Implemented?	Yes	Yes	Yes
Companies Using this System	Dow Chemical, Eastman Chemical, General Mills, BASF	GTE, Century Furniture, Ocean Spray	Capstone Turbine, Cultor Food Science
Y2K Compliant?	No; Will require patches not available yet	Yes	Yes
Web-Connectivity for e-commerce?	No; Adapter available from another software company to offer real-time connectivity for R/2	Yes	Yes
Heavy Consultant Use?	Yes	Yes	Not normally
Date of Extinction of SAP Support	December 31, 2004	N/A	N/A

BUSINESS PROCESS REENGINEERING

In the case of SAP, the process of reengineering is divided into two significant parts. Firstly, SAP provides a system that is integrated and uses best practices. In this function, SAP acts as the technology enabler. Secondly, SAP is not only an enabler of significant change, but also a driver of such change. SAP forces the reengineering team to be specific in how it wants to organize and integrate the business processes. In order for a company to implement SAP effectively, it is imperative that the application be focused and specific to the project charter. Many companies continue to operate with mixed and often conflicting organizational structures, processes, and standards. Successful implementation of SAP requires the project team to perform twelve functions:

Analyze your current systems.
Analyze your business requirements and strategy.
Define and configure your organization.
Configure your master data.
Configure your transaction data.
Design, develop, and test any data interfaces.
Design, develop, and test any printed forms to be printed by the system.
Review the requirements for reporting.
Test the configuration, data entry, and reporting thoroughly.
Train your users thoroughly.
Document your specific procedures for entering data, preparing reports, your configuration, and any custom programs or procedures.
Load your data and start the new system (Rockefeller, 1998, p.11-12).

Business process reengineering is only successful 20-30% of the time. Regardless of the costs associated with SAP, if BPR is successful, SAP pays for itself many times over in increased efficiencies and lower costs. Further, in flattened organizational structures, the flow of information and knowledge is critical. SAP provides the platform for enterprisewide communication. No longer does the right hand of the operation have to wonder what the left hand is doing. SAP communicates resources required, scheduling, work flow, etc., instantaneously. When BPR fails, SAP is often cited for the failure. How fair is this assessment? As an example, FoxMeyer Drug Co., a 5.1 billion dollar company, cited SAP as the main reason for its bankruptcy (Stein, 1997). The company had invested 65 million dollars and two years into the SAP implementation process. However, undertaking such an effort may have come too late. The FoxMeyer case begs several questions. Firstly, how deep and sincere was FoxMeyer's commitment to SAP? How well had they prepared for the implementation and how well did they support it? Had FoxMeyer perhaps invested sooner, SAP may have been its very salvation. ERP software implementation is a timely and costly venture, either a worthy and planned investment or a futile and late attempt at redemption. The fact is, SAP is often cited as the critical factor in a business' attempts to reengineer. Perhaps the failure of SAP to save many companies from their death grips is unfair, if it were unlikely the companies would have survived anyway.

The implementation of SAP allows a company to effectively induce change but not easily. A company's ability to select a project it can support and manage, to appoint the right people to the various positions, and to walk the line between energizing personnel and calming their fears is not a small task. Successfully and skillfully managing change is a distinct competency that emerges from the integration of BPR and IT.

HOW SAP AFFECTS THE ORGANIZATION

How does a company improve its chances of a successful SAP implementation? SAP is no doubt a violent change to the "*way business was done.*" That is what SAP should be. Why? Because SAP is a proven method to streamline all business processes. Stovepiped companies did not rely on communication. Expertise remained in the stovepipe, and knowledge was power. SAP flattens the stovepipes. SAP turns the company upside down by design. No longer do functional silos operate singularly; they no longer exist. The company dynamically and collectively reacts. SAP requires that employees understand the consequences of their actions, and that departments must operate on company objectives rather than departmental objectives. SAP mandates that information is everywhere. Managers no longer control the flow of information and knowledge. The shift from focusing on competitive objectives to focusing on superordinate objectives means that centralized power is taken and redistributed as necessary. Spans of control and responsibility broaden. SAP requires that employees, managers, and departments work in tandem. Management must take steps to reduce and to soften the resistance to change which usually accompanies a SAP implementation. The trend towards using ERP software for internal change and the expected volatility after implementation are mirror images to the external environment facing many of today's firms. Sometimes, savings or downsizing can be accomplished without implementing SAP. However, as more companies use ERP software to reengineer their business processes, the need to use software such as SAP is not so much for competitive advantage as it is to level the playing field. After SAP implementation, the organization can expect structural changes, changes in the ways of work, and cultural changes.

SAP can change an organization's structure by the creation of new business processes and the reorganization of functional areas. Although the implementation may have taken years to complete, the total system change may feel sudden, and the organization becomes "paralyzed rather than energized" (Wall & McKinney, 1998, p.3). SAP is a business initiative not an IT project and needs to be formulated long before the software is installed. The organization's structure should be redesigned to capitalize on the integrated nature of SAP. Reshaping corporate structures around business processes can affect management methods and job definitions. The traditional barriers between functional departments need to come down, and the broad nature of SAP forces parts of an organization to work together. By bringing an organization's members together, a firm may combat some of the expected resistance by forming cross-functional teams with managers and end-users. The teams need to voice concerns, keep a steady stream of feedback, and communicate expected results, anticipated changes, and the rationale behind all the newly felt stresses. As the company's foundation is destroyed and rebuilt, management must create a new structure that is prepared to manage change. Rather than merely streamlining processes, SAP redesigns a company's business processes (Curran, 1998). For example, "Owens-Corning's R/3 system is part of an ambitious growth initiative, and the information provided by the system is making it possible for customers to purchase all the building materials they require in one single call, rather than placing separate orders for each type of material. At the same time, the company's structure, which previously consisted of a loosely amalgamated group of companies that each had its own product lines and pricing schedules, had to come up with a single product list and a single price list. This mandate was initially resisted by many of the various plants and managers" (Wall & McKinney, 1998, p.2).

In addition to structural changes, SAP may cause changes in employee ways of work and employee culture. After SAP goes live, an employee's daily tasks may differ greatly. And if all goes well, the end result should be a flat organization with a centralized system and a decentralized and empowered workforce capable of wise decision making in real time. Often though, distress, resistance, and even chaos are what ensue after implementation. Some employees learn the system but expect to do their jobs in the same way. SAP may be viewed by employees as an interference and not as an improvement in their ways of work. Employees may now have to spend more time entering information into the system. Other employees may have to give up the source of their power within the organization—information. The information is now used by many, and the power once felt by a few is now distributed to the many willing to gain from SAP. If people try to remain in their enclosed, functional areas, the benefits of SAP will never really materialize. SAP not only demands changes in the ways of work but also changes in the way employees think. Employees may never know the total capabilities of SAP if they are only taught to perform a certain number of steps. Without understanding the ramifications of an individual's actions, mistakes may increase their reliance on IT personnel. Employees now require more training than in the past to learn how to use the new system. As acceptance increases and the system becomes more efficient, one can expect a drastic cultural change called downsizing or rightsizing. After Owens-Corning implemented R/3, the expected, first-year downsizing was approximately 400 jobs (Wall & McKinney, 1998, p.2). The elimination of jobs at Owens-Corning was then expected to rise in the following years with the successful consolidation of functions through SAP. These changes may be thought of as positive by the organization, but are dreaded by many employees. Lacking concern for uniqueness or human needs, employees must conform to SAP's standardized model. The reduction of non-value activities and improved structural changes can benefit the organization. However, SAP's cookie-cutter package may stifle creativity and innovation, which in the long run may lessen a company's competitive advantage.

SUCCESSFUL IMPLEMENTATION STEPS

Wall and McKinney (1998) offer several planning steps that improve the likelihood of a successful SAP implementation. Firstly, companies must identify stakeholders and insure they are kept apprised of the implementation process. These stakeholders should understand what SAP will do for their organization, how they will be affected by SAP, and what is expected of them during and after implementation. Secondly, Wall and McKinney suggest that organizations allow for evolution. Planning the implementation is important. However, adapting to change ensures that the final product is a better fit for the organization. The implementation as seen on the front end of the project will likely be different than as seen at the conclusion of the project; therefore, understanding the need to adapt and embrace these changes as opportunities will increase the likelihood of success. The authors quote a consultant as saying, "Implementing an enterprise system is 20% IT and 80% managing change" (Wall & McKinney, 1998, p. 2). Further, starting simple and expanding functions and processes later adds to implementation success. This approach is akin to seeing the forest before seeing the trees. Thirdly, management must prepare the organization for the changes to come. By including all employees at every step of the implementation process, they will feel an "ownership" in and deeper commitment to the project's success. Further, their involvement in the implementation process will educate them gradually and thoroughly. Fourthly, organizations must embrace two-way communication. SAP implementation requires enormous commitment from top management, and simultaneously requires constant feedback from end-users. As end-users are those responsible for the day-to-day responsibilities, they can offer the SAP implementation teams and management insight into how to make the implementation most successful. Focusing on fitting SAP *into the business,* rather than focusing on the technology will channel the implementation into the organization, rather than relying on the organization *fitting into SAP*. Next, involving line managers from the outset of the project is critical. These individuals possess the deepest knowledge about how to optimize their operations. Finally, companies must justify the expenditure on SAP. Defending the cost of SAP may be difficult at all levels in an organization. Subordinate employees and top management alike must understand the necessity for SAP.

LIMITATIONS

SAP implementation will differ from company to company. Many companies choose to implement some modules of SAP while relying on their old systems for other divisional functions. However, as "wall-to-wall" software is defined, any implementation short of full integration will only realize suboptimized results. SAP is designed to link and flatten an organization and any effort to exclude functional areas will provide less than optimized results. "Anything less than a relatively comprehensive implementation of a product like SAP R/3 can fail to produce the benefits the organization hopes to receive" (Gibbs, 1998, p. 2). Further, many companies have chosen not to implement SAP for various reasons. With Y2K just around the corner, hasty implementation of SAP to replace legacy systems may be fraught with failure. Unisource Worldwide wrote off $168 million already spent on SAP implementation citing that the SAP rollout could not be completed in time for the next millennium (Stein, 1998). Yet another example of a costly end to SAP implementation is Westinghouse Savannah River Company. Reasons cited for the cancellation included budget cuts and lack of management support. Westinghouse had previously suffered major job cutbacks, and many speculated the cancellation of SAP implementation was welcomed (Stein, 1997). Implementing ERP software often runs far over budget, a fact even top management has difficulty swallowing. The changing nature of implementations, customization, and expensive consultant fees often drive SAP projects through the company's financial stratosphere. Further, SAP is simply not compatible or sufficient to deal with many companies' needs. SAP was unable to link Apple Computer's stovepiped functions and was unable to accommodate Dell Computer's sales volumes (Wall & McKinney, 1998).

Table 2
Strengths and Weaknesses of SAP R/3 and Surrounding Issues

Strength	**Weakness**
R/3 and ASAP architecture is flexible	**Replaces multiple data systems with one powerful, scalable system**
Escalating costs associated with installation and training	**Risky venture**
Real-time applications	**Highly truncated financial closes (Anonymous, 1998)**

Slow to develop Internet-related software (Anonymous, 1998)	**Reliance on costly consultants**
• **Single, virtual file system (Anonymous, 1998)**	• **Single data entry point (Anonymous, 1998)**
No planned long-term coexistence between R/2 and R/3	**Consultant fees approximately 25% of total ERP budget (Wall & McKinney, 1998)**
• **On-demand costing (Anonymous, 1998)**	• **Eradicates non-value-added activities**
Product obsolescence—pulled plug on R/2 before all R/2 implementations have been completed	**Takes approximately two to five years to get up and running (Bartholomew, 1998)**
• **Cost savings through reduced headcount and increased efficiencies**	• **Boosts customer service, teamwork, and worker empowerment**
SAP's own glue for connecting different systems (ALE) cannot connect R/2 and R/3	**Until recently, horizontally biased system (Greenbaum, 1998)**
• **Integrates and automates basic business processes**	• **Trend towards verticalization system changes (Greenbaum, 1998)**
Possible application failures—ERP software outages average 2.8 hours/week (Dryden, 1998)	**Must submit to SAP's way of doing business**
• **Off-the-shelf ERP software is cheaper than creating custom ERP software**	• **Project scope increases**
One-size-fits-all model does not always meet requirements for manufacturing's customer choice need (Greenbaum, 1998)	**IT and network infrastructure for SAP R/3 may be insufficient to support companies with mass transaction volumes (Anonymous, 1998)**
• **R/3 three-tier client server architecture provides portability**	• **Potential for a greatly improved control environment**
SAP standardization may cause companies to lose some of their uniqueness/competitive advantage	**Slow progress towards interface development between SAP and third-party software**
• **Real-time review and tracing of erroneous transactions (Gibbs, 1998)**	• **Lower risks than installing custom software**
SAP AG is not service-oriented company (Anonymous, 1998)	**German product needs to become more Americanized**
• **Shortens BPR process**	• **Links over 75% of company's activities (Greenbaum, 1998)**

Politics and lobbying are necessary to influence SAP AG to provide specific industry needs in the next product release	**SAP AG is product company not solutions company**
Pre-configured, process templates	**R/3 can run on any of the major hardware platforms, operating systems, or relational databases**
Unable to integrate approximately 25% of company's activities (Greenbaum, 1998)	**Distributed environment not as stable as mainframe environment**
Automatically calculates exchange rates and can operate in multiple languages	**Strategic possibilities of system difficult to quantify**

TOP ERP COMPETITION

The top five ERP software rivals are SAP, PeopleSoft, Baan, Oracle, and JD Edwards. Competition is fierce, but each vendor has special strengths. Through innovation and acquisition, all five have developed value-chain strategies for their applications, and all but Baan have announced plans to offer their software over the Internet. SAP and PeopleSoft are the leaders in ERP market share and are respectively positioned as No. 1 and No. 2 among the top five vendors. Besides occupying the two largest slices of the ERP market pie, SAP's and PeopleSoft's strong financial results reported last July are widening the gap between the top two and remaining three (Stein, 1998).

PeopleSoft Incorporated's traditional strength is in human-resource planning but has expanded to encompass all areas of an organization. The majority of PeopleSoft sales are in the United States, which may enable it to remain protected from current global economic troubles. One of PeopleSoft's current endeavors is to integrate its ERP software with sales-force automation. Reacting to specific industry needs, PeopleSoft is tailoring its software to the demands of its customers. And like SAP, PeopleSoft has been able to attract large, brand name customers. Recently, "SAP signed a contract with aerospace giant Pratt & Whitney, while PeopleSoft inked deals with Toyota Japan and Seagram" (Stein, 1998, p.1).

Oracle Corporation's version 11 of its Oracle Applications suite provides more than 45 modules available in 29 different languages, is used in more than 50 countries, and supports the networked computer (Michel, 1998, p.4). Many new changes to the suite are based on customer demands and needs, and Oracle appears to be the initiator in plans for leasing its software over the Internet. "Oracle plans to target midsize customers over the Internet with a 'pay-as-you-play' ERP offering" (Stein, 1998, p.1). Another way Oracle differentiates itself from the others is by being "the first ERP software provider to integrate support for flow manufacturing into its ERP system. This technique is the next generation beyond just-in-time and soon will dispel the notion that there are no more savings to be had by changing manufacturing processes. Expectations of the new flow manufacturing capability will hopefully establish Oracle as a 'thought leader' in the area of pure manufacturing technology" (Michel, 1998, p. 4).

The Baan Company's product, Baan Series, is built on "an open architectural platform that supports a set of special interfaces designed to facilitate smooth linkage between software components. The special interfaces, called Baan Open Interfaces (BOI), can blend seamlessly with third-party applications" (Michel, 1998, p. 4). And according to Don Drury, company vice president, Baan is actively moving towards small and mid-sized manufacturing markets. Drury says, "We see a large opportunity in the midrange market especially when you look at the ability we have to package components in areas like supply-chain management and sales force automation with our ERP backbone" (Michel, 1998, p. 6).

JD Edwards' OneWorld open–systems ERP software is geared towards the lower end of the midrange market. The software suite "employs business objects on a configurable network computing (CNC) architecture. This architecture allows users to deploy components from JD Edwards' software products as well as systems from third-party suppliers on the same network" (Michel, 1998, p. 7). JD Edwards has the smallest market share of the top five and in the past, has been underrated by analysts (Stein, 1998). But, OneWorld appears to be gaining strength and valuable customers to make it a contender in the ERP software market. For the quarter ending April 30, 1998, "JD Edwards recorded license revenue of $76.4 million, up 49% over the same period last year" (Stein, 1998, p. 2).

CONSULTING

When R/3 was created, SAP AG decided to devote its resources to product development and limit the services provided with the software. "SAP decided it would seek only 20%-30% of the R/3 implementation business" (March & Garvin, 1996, p. 2). The remaining R/3 implementation business would be left to consultants. Consulting firms work closely with SAP forming competitive alliances that are mutually beneficial, but not exclusive. ERP consulting has become a highly lucrative and desired service in wall-to-wall system changes. Consultants can either work directly for SAP, consulting firms, or as an independent consultant. The top consulting firms which offer SAP expertise are Andersen, Deloitte and Touche, Ernst and Young, KPMG Peat Marwick, and Price Waterhouse (Wall & McKinney, 1998, p. 2). We had the opportunity to interview an independent consultant, Ravi Gollakotta. Gollakotta is ready to start a new ERP project in California.

Ravi Gollakotta is a functional consultant for companies desiring to integrate their systems with the help of an ERP software package. Currently he is a project manager for a Middle Eastern company, but soon will leave to become project manager for International Business Systems in California. He will help the firm implement an ERP software package that is a competitor of JD Edwards' ERP software. He has expertise in SAP and other ERP software systems.

Gollakotta (personal communication, October 21, 1998) sees industry experience as the most valuable skill necessary to become one of the few sought after ERP consultants. According to Gollakotta, SAP consultants have one of two roles: functional or technical. Technical consulting is often the stepping stone to functional consulting and can be broken down into two subcategories: programming and administration. The area of technical administration is the primary responsibility of the database administrator (DBA) and is concerned with security issues in regards to the new SAP system. Using SAP Basis, the DBA lays the foundation for the SAP parent system. "The R/3 Basis Software, also called middleware, is the architecture that provides the environment for the R/3 system" (Hiquet, 1998, p. 36). The programmers will then create modifications to the parent system, specific to the firm. The modifications are based on the company's needs and are not found in the original SAP package. Over time, many technical consultants are able to gain valuable industry experience, which enables them to advance to the role of functional consultant. Gollakotta was able to leapfrog the role of technical consultant because of his industry experience.

The role of the functional consultant affects the entire enterprise. Gollakotta's job is to analyze a company's business processes and judge whether these processes can be incorporated into the SAP environment and whether SAP can provide superior business processes over the company's current processes. Using his industry experience, Gollakotta can move beyond the standardized SAP package and use a different approach from company to company.

Much of a functional consultant's difficult work is completed prior to software implementation. The first step involves mentally preparing an organization's workforce for the changes to come and to provide a "feel" for the strange, new system. The changes are continuous and often interrupt the organization's traditional ways of work for extended lengths of time. According to Gollakotta, time per project depends on many factors including the project scope and the size of the organization. The implementation can also be accomplished in stages, one module at a time. Gollakotta said the time spent on each project varies according to the number of modules implemented. If more modules are implemented, more time is needed to complete the system. Because of the design of SAP software, SAP's implementation is often quicker than rival ERP software, but it is also a more complex system. WC Bradley in Columbus, Georgia, implemented three modules of Oracle's ERP Applications software took approximately one year to go live. In SAP implementation, one can expect approximately a year to accomplish three or four of the basic modules such as Sales and Distribution or Materials Management. Based on Gollakotta's experience with the more complex systems, one can expect one to three years to complete SAP implementation beyond four modules.

FIELD STUDY: GLOBAL CONSUMER PRODUCTS COMPANY

A global consumer products company has recently chosen SAP R/3 for an integration project for their 11 existing Human Resource systems. The project is currently scheduled to go live on April 1, 1999. The manager of the project and member of the company's information systems department met with our authors to discuss the scope and implementation of the project. A Year 2000 issue with the legacy mainframe HR system drove the system change decision. The initial analysis pointed to a packaged solution outside the current system versus rewriting the old system code. PeopleSoft and SAP were chosen as the top candidates for the project. After some analysis, SAP was chosen over PeopleSoft due primarily to the enterprisewide capability of SAP versus PeopleSoft. At this time, the project team is in the construction phase of the project. They are utilizing the configuration utility of SAP R/3 to configure the system to mimic existing business processes. The project team estimates that 90% of the business processes they will incorporate will remain unchanged after SAP implementation. The project manager stated that this configuration process is where most of the technical complexity of SAP implementations arises. Due to the difficulty of bringing such a high level of learning into an organization so quickly, most companies utilize consulting firms for this activity. This consumer products company has utilized a limited number of consultants for the project. Consultants have been used for some programming and for functional expertise to help with configuration.

The company has chosen to implement SAP with a unique project structure. Most of the companies researched have implemented SAP in a holistic approach, including most of the business processes. This company has taken SAP as a solution on a per project basis. The project team indicated that several of the legacy systems are still relatively young. These systems still work adequately and have yet to realize their payback. The company concluded that these systems do not need wholesale replacement at this time. They have chosen to let business need dictate which systems to replace. SAP was chosen as the project solutions' whiteboard. All subsequent projects that require a software suite will be evaluated against SAP. Each project will have to prove that SAP is not the right answer. This approach is also different in that each project has a separate implementation team that integrates SAP. The only common team is an enterprisewide SAP support team. The various teams still utilize data from common sources, and the individual teams "sync up" at least weekly via teleconferences, e-mail, and Lotus Notes groupware.

The company studied estimates the cost of just the Human Resource SAP R/3 integration to be 13-16 million dollars. No job decreases or increases are expected, just the realignment of positions to support the more coordinated roles. The system will be implemented on a HPUX (Unix) operating system. The project manager stated the major benefits the company hopes to gain from SAP are to reduce the effort required for information systems to support a business process and to increase the transportability of information systems professionals throughout the company. The project manager further stated that the only resistance to the change has been from the IS professionals who feel they do not have the time or do not want to learn the new system. In regard to his impressions about SAP initially versus presently, the project manager indicated that his expectation of the software has been greatly surpassed. He is confident that SAP R/3 is the right answer for this consumer products company for now and the future.

CONCLUSION

SAP implementations are complicated, time consuming, and expensive. "As a backbone for business processes, R/3 made possible projects of a scale that had not previously existed. When implementation was linked to the massive redesign of business processes, project scope escalated dramatically. As a result, it was difficult to disentangle the costs and time for implementing R/3 from the costs of affecting the major cultural and organizational changes associated with reengineering" (March & Garvin, 1996, p.11). However, the combination of forethought, planning, and flexibility may help to smooth the many difficulties associated with such implementations. Reengineering must be understood and embraced by all affected as a mechanism for organizational change. Employees must cope with massive changes in their jobs, their organizational positioning, and their decision-making processes. Organizations must orchestrate SAP implementation systematically by coordinating both the necessary business decisions and the interpersonal dynamics required by such momentous change. Companies must search for sustainable competitive advantage through differentiation. SAP software enables and drives seamless business processes and allows companies to reap efficiencies and redirect resources into differentiating products and services. SAP is flexible and scalable, thereby making it extremely powerful if successfully implemented. While countless examples of failure exist with SAP implementations, it is with a keen eye that one observes that commitment of resources, leadership, and vision are ever present in successful integrations. SAP requires employees and managers to work just as seamlessly, knowledgeably, and cooperatively as ERP software.

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DISASTER RECOVERY PLANNING: METHODOLOGY AND IMPLEMENTATIONS IN REGIONAL ORGANIZATIONS

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ABSTRACT

According to the National Fire Protection Agency, 43% of businesses struck by a disaster never reopen and 29% close after three years (Hawkins, 1998, p. 61). As organizations grow increasingly dependent on information technology for day-to-day operations, a disaster affecting the organization's ability to operate its information systems would be comparable to a natural disaster. In fact, this systems failure might be coupled with a natural disaster. Therefore, Disaster Recovery Planning has become a critical issue in information technology management. This paper addresses the following topics: definition of disaster recovery planning, risks of disaster, risk management, prevention measures, preparation for such a disaster, recovery alternatives, social and legal issues.

The paper provides a good basis for an organization to examine disaster recovery or for students to explore this topic beyond the limited textbook treatment of it. Following this review of disaster recovery planning and its methodology, studies of the process at local organizations, all of which wished to remain anonymous in any publications, are presented. The paper provides both the prescriptive background on disaster recovery and a view of current practices.

INTRODUCTION

Disaster Recovery Planning is the act of drafting alternative business processes when regular or normal processes cannot be performed. Disasters come in a variety of forms and can strike at any time. When vital business operations, such as communications infrastructures, are affected and mission critical systems are compromised, disasters are amplified. These alternative plans must be flexible enough to be partially or fully implemented depending on the nature of the disaster. Isolated business or service disruptions, as well as large scale community wide disasters have shown that a well designed and tested enterprise wide continuity plan must be in place. Ensuring that an organization’s assets, operations, commitments and relationships are protected is a critical element of staying in business. Organizations must be prepared and plan ahead. Unfortunately, a disaster is usually the test of the thoroughness of these alternative plans (Moore, 1997, p. 13).

The planning and response to catastrophes vary according to cultural norms. For example, Islamic countries devise and write disaster plans. However, the effectiveness and efficiency in which the plans are implemented into operations are likely to be affected by a pervasive fatalism and the acceptance that the "Will of Allah" will prevail, regardless of what is planned. Similarly, the Japanese attitude towards disaster planning is based on ancient traditions, rigid social and business cultures, and a vast maze of bureaucracy. In many developing countries, for example Southeast Asia and parts of South America, economic growth has exceeded urban planning and physical development. Therefore, disaster recovery planning may not work given the state of the transportation systems and emergency services in these countries (Gates, 1998, p.61). Businesses are always exposed to disasters. These disasters have no respect for cultural, economic, social, political or environmental factors. In a global and ruthlessly competitive environment, those unable to respond rapidly in the aftermath of a disaster will soon lose customers regardless of culture or geographic location.

Organizations are faced with many decisions that have enormous implications when planning for disaster recovery. With the move to information technology, recovery has become even more important in sustaining critical business operations. "A study done at the University of Texas at Arlington found that 85% of businesses are totally or heavily dependent on information systems to stay in business and that losing these systems can cost up to 40% percent of daily revenue. For some organizations, an outage of one hour or less that interrupts the flow of crucial information can cost over $100,000 in lost revenue. An AT&T study showed that nearly 60 percent of financial companies, nearly 50% of service companies, and over 40% of retailers would be seriously affected in less than eight hours without their major information systems" (Overman, Cook, Sandberg, 1995, p. 18). Some potential losses faced by an organization are illustrated in the diagram below. The items are not ranked in order, because they are different from organization to organization:

Loss of Life
Loss of Business
Loss of Critical Applications
Loss of Critical Employees
Loss of Revenue
Loss of Competitive Position
Loss of Customer Goodwill
Loss of Communications
Loss of Building Facilities
Loss of Power
Loss of Security
Loss of Information
(Bates, 1992, p.22)

To prepare for potential disasters in information technology, large corporations spend up to six percent of their information technology budget on consulting, application software or outsourcing related to disaster recovery planning (Girard, Dillon, Ung, 1998, p.14).

Worrying about loss of data or failure in data communications during disasters is not just for large companies with mainframes anymore. As more businesses become dependent on data operations, companies of all sizes should prepare for data losses. An increasing reliance on distributed client/server and local area networks (LANs), rather than mainframes, calls for disaster recovery planning tailored to these new systems. Most new applications are written for distributed networks; therefore many companies are moving essential operations from mainframes to client/server networks. As more computers and databases are involved, possibly located in different parts of the country, companies gain more flexibility in responding to customer needs. However, a distributed network and the increased number of machines can be harder to track and manage. In addition, one machine crashing has less impact than the loss of a mainframe. For example, a company may lose the inventory database for one of its distribution centers or billing records for an entire region. Planning for all the possibilities makes disaster recovery more complex.

Disaster Planning is a simple phrase that encompasses a vast amount of responsibilities. To effectively plan for disasters, issues such as risks of disasters, risk management, prevention, preparation, recovery alternatives and social and legal responsibilities must be considered. Also, disaster recovery planning entails complex analysis, foresight, coordination and extensive testing. These activities should not be taken lightly. With the advancement of information technology and businesses comprehensive use of technology, disaster planning has become even more important.

RISKS OF DISASTER

As IT has become more widely used, so have the threats to system's safety and continuity. The threats of disasters to information systems come in a variety of forms such as natural disasters, environmental hazards, human errors, intended threats, and structural threats. Other factors include procedural dangers in the processing of computer related tasks, risks from the process of selecting and adapting information technology, and threats from applying business systems related to the utilization of constructed software. According to Comdisco, the leading causes of IS disasters are

Flood/Storm…………...20%
Hardware problem……19%
Power outage…………16.5%
Fire/Explosion…………12%
Earthquake…………….7.5%
Hurricane………………6.5%
Building shutdown…….4.5%
(Radding, 1996, p.114)

Another significant threat of disaster on information systems is caused by computer crimes. The occurrence of this type of threat has risen steadily in recent years due to the proliferation of computer usage in all industries. The Y2K crisis is one of the most emanate threats to all organizations' computer systems. Those lacking adequate backups will be faced with an uncertain future.

Natural Disaster and Environmental Threats

Natural disasters refer to earthquakes, hurricanes, tornadoes, thunder storms, floods etc. Environmental threats include power failures, radioactivity, leakages, fires, insects, rodents, dust, and other pollutants. The impacts of these hazards are similar. They may result in physical destruction of computer systems, loss of data, or even the loss of the entire business. Restoration and renovation can be long. Sometimes companies may never be able to recover or continue their operations. Not only can an organization be affected, but also society as a whole can be severely impacted.

The Great Hanshin Earthquake, which hit Kobe, Japan, on January 17, 1995, was one of the most significant and devastating disasters in history. The earthquake, which measured seven on the Japanese scale, caused about 6,000 deaths, 16,000 injured, and destroyed 55,000 buildings. The loss was approximately $200 billion in Kobe alone. The disruption of business in Kobe also caused a chain reaction in other parts of the world. For instance, the shutdown of Sumitomo’s metal manufacturing plant in Kobe made it impossible for Toyota’s motor plants in other parts of Japan to continue their production. The reason was Toyota relied solely on Sumitomo for brake shoes and its just-in-time inventory management system, which heavily depended on IT, left little inventory for the plants to use. Business was interrupted outside Japan as well. In the U.S., production of IBM’s ThinkPad laptop computers and Apple Computer’s PowerBook computers, which relied on displays manufactured in Kobe, was also severely affected (Emerson, 1996, p.14).

Procedural and Structural Threats

Procedural threats originate from the lack of understanding of procedures and regulations of the information system. These threats mainly come from human errors. The majority of today's computer users are not highly trained programmers, but rather inept users. The chance of hitting a "delete" key inadvertently or running an update program at the wrong time is high. Sometimes even skilled programmers may make careless mistakes when designing or installing the IT systems.

Unintentionally revealing secrets such as passwords is another type of human error that can result in disastrous consequences. People often use names, birthdates, or social security numbers as their passwords simply because they are easy to remember. However, they are also easy for hackers to break in. Hackers can write a program to randomly select the most common names, generate dates and social security numbers to break the code, enter the system, and then destroy or contaminate data (Gragg, 1994, p.41).

Dangers may also come from the structure of the information system. The concentration and unclear definition of responsibilities and rights due to the application of IT, unrealistic delegation of duties, and inappropriate personnel management can all contribute to computer system failures. The friction between departments and the absence of restrictions on specific assignments can also lead to disaster.

Inappropriate recruiting decisions are a threat to the information system as well. As skilled IT workers are in great demand, companies may neglect the process of background checking of applicants. The focus on “Do you know programming?” when recruiting may later lead to damages like embezzlement, internal computer crimes, theft of trade secrets, workplace violence or legal liability for a worker's criminal actions outside the company. “Getting a bad apple in IS can be a lot more catastrophic than a bad apple in other areas because of the terrific opportunity they have to accomplish and cover up their activities," said John Case, president of John Case & Associates in Del Mar, California (Nash, King, 1997, p.12).

The misuse of an organization's procedures and regulations and the lack of consistent procedural application can become intentional threats to the information system.

Intentional Threats

As information technology assists organizations in improving productivity, increasing efficiency, and providing better services, it also adds to the vulnerability of distributed systems. Computer crimes are on the rise as we move into the "infosphere." Dangers to software and data are more prevalent due to the increased utilization of networked systems.

On November 2, 1988, a program, which was later identified as the Morris Worm, attacked thousands of computers on the Internet. The worm "traveled" from one computer to another and caused the computer's processing speed to steadily decline. This was the first notable incident which focused the IS personnel's attention to the importance of network security and made them realize that disasters can strike in any form (Avolio, 1998, p.1). Viruses are not accidental. Hackers have designed and intentionally distributed them on the network. Viruses can get to a well-protected system through e-mail transmissions, the loading of program disks, and downloading programs from bulletin boards. Worms are programs that can replicate and penetrate a computer system. Criminals find them extremely convenient for gathering secret data. "An expertly designed worm can raid a database and leave no evidence of itself behind; a user might never know that someone else now has a copy of the company's secrets" (Gragg, 1994, p.41). A modem makes a computer vulnerable because it lets outsiders dial up the computer. Skilled hackers can write programs to generate and dial random telephone numbers and break into the system. Trojan horses are illegal programs within another program that remains dormant until a specific action triggers the virus to be activated. Software bombs are also disastrous. An employee may write a program that would erase all the company's payroll files if his name were ever erased. The bombs can go off on at a certain time on a certain date, or just based on logic (Gragg, 1994, p.41).

RISK MANAGEMENT

One of the critical issues faced by executives today is managing the risks associated with the proliferation of information technology in their organizations. Risk management is a relatively new concept. It identifies measures needed to protect the business from perceived risks, assesses what resources the business needs, and determines how the business would be affected by risk. Without offices, factories, telephone systems, or computer networks, an effective disaster recovery strategy becomes sound financial planning. Risk management's objective is to preserve assets, maintain the incoming stream of cash, and minimize outgoing cash flows (Borowka, 1991, p. 57).

Responsibility for the disaster recovery function normally resides within the department where the risk has been identified. However, with the growth of new technology, the process of identifying the total risks facing a business has been exacerbated. Some companies employ a risk manager to perform the risk management process. The risk management process can be described in the following steps:

Step 1: Assessment of Assets

Determine the value and importance of assets such as data, hardware, software and networks.

Step 2: Vulnerability of Assets

Record weaknesses in the current protection system in view of all potential threats.

Step 3: Loss Analysis

Assess the probability of damage and specify the tangible and intangible losses that may result.

Step 4: Protection Analysis

Provide a description of available controls that should be considered, their probability of successful defense, and their costs.

Step 5: Cost-Benefit Analysis

Compare costs and benefits. Consider the likelihood of damage occurring and the successful protection from that damage. Finally, decide on which controls to install (Bates, 1994, p.123).

In evaluating risks, organizations must first quantify the probability and maximum threat of each risk exposure. Then the identified risks must be further categorized between those that are within a company's control, and therefore preventable, and those which are not. In addition, risks need to be prioritized. Some risks may expose a company to a small degree of financial loss; others may fatally damage an organization (Bannington, 1996, p. 27). A business needs to take steps to reduce the exposure to preventable risks, if not eliminate the risks altogether. The cost of eliminating risks, however, may well exceed the maximum possible loss arising from the risk. Petty cash fraud may be undesirable, but the cost of employing additional staff within the Accounting Department may outweigh the costs associated with the problem. Effective new working practices, procedures and policies may be the only action required. This action can be simple, inexpensive, and yet effective. The same concept may be applied to information technology (Borowka, 1991, p. 58). "An ounce of prevention is worth a pound of cure". Therefore, a detailed assessment of the risks to the integrity of the organization and its properties needs to be implemented and regularly reviewed as part of the security function.

PREVENTION

Before disaster strikes, companies must address the issue of computer security. Of the 150 companies surveyed, 98% percent of the companies said they had experienced an unauthorized entry within the last year (Anthes, 1995, p.20). Since the heart of a business' operations can be found in its information systems, companies should take certain steps to eliminate or decrease unauthorized entry. Acts of God can not be predetermined or prevented, but unauthorized entries can. Companies can decrease the threat of disaster by using methods to safeguard computer hardware, software, data, and networks. The security system should accomplish the following goals: prevention, deterrence, and detection. Preventive methods can be established to ensure that unauthorized personnel or disgruntled employees do not gain access to system operations. These methods include security alarm systems and access control entrances. The security system can detect physical intrusion. Access controlled entrances also limit entrance to authorized personnel only. Access is determined through a computerized system that scans a badge or requests a password for entry. The password allows authorized users access privileges with limited access to files and data as determined by a supervisor. However, passwords are not sufficient because they are easy to crack and people use them incorrectly. Therefore, technical devices can be used to identify the users by physiological means, like fingerprinting, iris pattern, and retinal scan, thereby insuring the person's identity. Physical security is the defense barrier unauthorized personnel must cross to gain entrance to system operations. Security can also be established within an information system. Encryption encodes regular digitized text into scrambled text or numbers thereby ensuring that data is read only by the intended user. Firewalls provide internal security by regulating the traffic between networks. The firewall forces access policies to be implemented and utilized.

PREPARATION

After risk assessment and preventive measures for a company's information systems have been identified, disaster recovery planning must then prepare for the worst, for example, the loss of vital information technology. A plan should be developed based on the analysis of risks and the impacts potential disasters might have on a company's business and its customers. The plan should meet several primary goals such as protecting the hardware and software from internal and external threats, minimizing the impact on the business, and establishing detailed procedures (Bates, 1992, p. 4-5).

An important part of disaster recovery planning is developing a disaster recovery team. An organization must select, train, and equip an emergency response team to plan, prepare for and respond to any type of disaster. This team will be responsible for deciding what areas the disaster plan will cover and for ensuring that the plan is compatible with the company's loss control philosophy. The team should have expertise in operations, safety, security, disaster impact, finance, labor practices, legal issues, facilities, information systems, and corporate communications. Listed below are steps that can help an organization develop a disaster recovery plan (Bates, 1992, p.10).

Step One: The Planning Process

Management should be aware of the potential disasters its systems might face and should commit to developing strategic backup and recovery plan. The organization must conduct a business impact analysis and consider the legal consequences of not having a plan. Management should develop a disaster recovery team who will select external recovery sites. Finally, management should determine the budget requirements for the plan and ensure that they enforce the budget.

Step Two: Physical Protection

Management should conduct an inventory of its internal systems and facilities. The inventories should include a physical check of the cable systems, power systems, hardware and software security, disk arrays and servers. In addition, organizations should consider environmental conditions that may affect system and facility operations.

Step Three: Connectivity

LAN to LAN, LAN to WAN, and public network access communication equipment and modem communication should be secured.

Step Four: Physical Recovery

Cable systems, media access units, servers, terminal, PCs and workstations must be physically protected. If these systems are destroyed then a plan to recover/replaced lost equipment is necessary. A plan to accommodate inaccessibility to buildings should also be developed.

Step Five: Departmental Recovery

The initial planning should start with the individual department. Backup systems such as mirroring, duplexing and virtual disk systems should be developed and network and communication recoveries should be prepared.

Step Six: Implementation and Testing

The plan should be implemented and tested to discover deficiencies in the plan and make necessary adjustments.

Step Seven: Maintenance

The plan should be constantly evaluated and updated to keep up with organizational, technological, and environmental changes (Bates, 1994, p. 123).

Preparation lessens the impact a business suffers from a disaster. The more prepared a company is, the less financial loss it will suffer. According to the National Fire Protection Agency, 43 out of every 100 business struck by a disaster never re-open, and 29 percent close after 3 years (Hawkins, 1998, p.61). Senior management must take the lead in making their employees aware of disaster recovery by involving and making it a significant part of day-to-day operation. Prevention and preparation in the long-term will be beneficial for everyone involved.

RECOVERY ALTERNATIVES

Companies can attempt to develop disaster recovery plans in-house with their existing people and equipment. The associated costs include time and equipment. However, the risk exists that there will not be enough time to develop the plan because of the daily responsibilities and crises that all companies face. The cost to develop the plan in-house can range from approximately $100,000 to over $200,000 depending on the resources and equipment used (Bates, 1994, p. 42). Companies can also use auditors to help develop the plan. Most large accounting firms are becoming very active in assisting companies in developing these plans. Companies can expect to spend about $1500 to $2000 a day for auditor's advice. In most cases, these firms have the respect of management. Therefore, advice and recommendations are more likely to be accepted (Bates, 1992, p. 35). Independent consultants in the disaster recovery industry can be hired to work with a company on their plan. Their expertise and costs are subject to individual review. The costs for consultants can vary. Companies can expect to pay approximately $1000 to $1500 per day, plus expenses for a good consultant. However, companies should not let a consultant write the entire plan. Companies must be active participants in the research and development of the plan. The plan must be constantly updated and tested (Bates, 1992, p. 36).

Two of the leading disaster recovery vendors, with 70 to 80 percent of the market share, are SunGard Data Systems and Comdisco Disaster Recovery Services, Inc. Revenues from disaster recovery vendors are expected to reach $8.1 billion by 1999 (Ouellette, 1997, p. 115). These vendors offer several different disaster recovery options. Depending on the size, complexity and urgency of the computer environment as well as the type of disruption, different recovery strategies may be required.

Maintenance Agreements

For smaller computer installations, a maintenance agreement with an equipment vendor may be used. The vendors provide recovery and/or repair of damaged computer equipment. The vendor may also provide equipment to the company in the event the computer system is destroyed. The equipment would be used to replace an organization's servers with replacement units that are configured to the organization's pre-determined requirements. Some standard agreements may not cover damage or loss of equipment caused by external factors like flood or fire. In this event, a supplementary agreement may be needed.

All companies should work with their equipment vendors to ensure the company has an accurate inventory of their computer equipment and is aware of the vendor's responsibility during a disaster. A company must have the following information from the equipment vendor:

Equipment on site
Date of installation
Serial numbers
Revision numbers of the hardware involved
Maintenance contracts available and those the company already have
Any contractual obligations vendor may have in support of the systems and hardware
Availability of spares in the company's area
Procedures a company should follow during and after a disaster
Escalation lists for emergencies (on and off hours)
Costs of replacements
Systems and services provided after a disaster
Any help they can give in disaster planning
Availability of roll-in type replacements.
(Bates, 1994, p. 98).

Quick Ship Program

Another alternative is a quick ship program that offers replacement hardware delivery to the organization or an alternate site usually within three to five days. Estimated costs can be as low as $300 a month (Rothstein, 1998, p. 27). This method is best for companies where computer recovery within a week or longer will be enough to keep the company going.

Electronic Vaulting

Electronic vaulting of critical data to a vendor or to a company's own equipment at an alternation site is also an option. This option involves transmitting and storing data in mass. Once an organization's server has been repaired or replaced, the data is retransmitted to the server.

Mobile Recovery Facilities

Sometimes bringing the recovery location to the site is more convenient than trying to relocate everything to a separate location. Mobile recovery facilities are self-contained, trailer mounted computer rooms. Computer equipment may be preinstalled or delivered separately and electrical power generation may be an option. Recovery times for mobile facilities are usually a week or longer.

Hot Site

A hot site provides a fully operational, duplicate computer system in a prepared location with live, tested communications capabilities. This option allows companies to recover damaged computer operations in about 24 - 72 hours (Rothstein, 1998, p. 28). Hot site locations should be chosen outside a forty to fifty mile range away from a company's present location. This prevents the hot site location from possibly being affected by the same disasters affecting the company's location.

Although this option is more expensive, it is critical to the survival of many companies. Each company who signs up with a hot site vendor must pay a subscription fee for the privilege of having the hot site available. The cost of the subscription can range from $500 to $50,000 per month, depending on the complexity of the organization's needs. Additionally, a declaration fee is required by some of these vendors to move into the hot site. This fee adds to the cost and is a one-time charge that could range from $1000 to $50,000, which makes the hot site available for a fixed number of days (usually 30 to 45). The cost per day to stay at the hot site is also variable, depending on the service arrangement. The cost range on a daily basis is approximately $1000 to $10,000 for a typical user. Some vendors charge by the day, others by the hour or CPU power needed. To stay at a hot site longer than agreed upon, to add tests, or to add equipment/support needs are all extras (Bates, 1994, p. 109).

Warm Site

Warm sites are similar to hot sites but are used less often. Warm sites provide many but not all of the needed features. A company can deliver their own equipment and set it up. This takes longer but is less expensive than hot sites.

Cold Site

A cold site is an empty computer room with the basic electrical, environmental and support facilities in place, awaiting installation of replacement equipment. A cold site is used when the organization's main site is inaccessible. Recovery to a cold site may require one to two weeks. The costs for cold sites are considerably less expensive than for hot or warm sites.

Mirrored Site

Some companies cannot afford to miss even a day of operations. In this event, a company might choose a "mirrored site." A mirrored site contains all of the hardware and communication facilities necessary to assume the entire processing load. However, some mirrored sites might contain less processing speed and capacity than the primary site due to financial considerations. Companies using mirrored sites might send nightly backup tapes and load those tapes so that recovery only involves reconstructing the current day's transactions. Other companies transmit transactions continually from the primary to the mirrored site. In that case, those mirrored sites can pick up the workload almost seamlessly.

Vendors

Numerous uninterrupted power system vendors exist. Table 1 indicates a partial list of these vendors including their location:

Table 1: Uninterrupted Power System Vendors

Vendor	Location
Abacus Controls	Somerville, NJ
Best Power Technology	Necedah, WI
Clary	San Gabriel, CA
Controlled Power Company	Troy, MI
Elgar	San Diego, CA
Exide Electronics	Raleigh, NC
International Power Machines	Garland, TX
Liebert	Columbus, OH
Nova Electric	Bergenfield, NJ

(Bates, 1994, p.145)

Companies specializing in disaster recovery planning software are also available to help customers develop individualized plans. The following table indicates a partial list of these vendors, including product name:

Table 2: Disaster Recovery Vendors and Products

Vendor	Product
CHI/COR Information Management, Inc.	Total Recovery Planning System
Comdisco Disaster Recovery Services, Inc.	Compas
EDP Security	Disaster Plan 90
Executive Compumetrics, Inc.	Corporate Recovery
Information Management Technology	Total Business Recovery System (TBRS)
Parnassus, Inc.	Coseco

Profile Analysis Corp.	Recoverpac Recoverpac II Riskpac Federal Riskpac
Strohl Systems	Multilevel Planning System Single Site Planning System DRP-EZ
System & Business Solutions, Inc.	Continue-The Disaster Recovery Solution
Target Marketing Group	DP-AID-2001 DP-AID

(Bates, 1994, p.147)

Companies should consider the availability, reliability, ease of use, cost and legal or operational constraints when deciding on an appropriate disaster recovery plan and/or vendor.

Disaster Recovery Contracts

An important step in developing a sound disaster recovery program is determining the needs of the organization, then finding a vendor and agreeing upon a contract. A basic contract covers monthly charges, allotted monthly processing hours and the equipment configuration of assigned dedicated resources. Any disaster recovery provider should offer contract terms that fit the particular needs of an organization. The disaster recovery field is highly competitive. Armed with the right information, companies can often negotiate to get the features they need at a price they can afford. In the beginning, an organization may want to sign a contract for a six-month term with some automatic extension at the end. This contract gives the company leverage to get out of an unsatisfactory arrangement, while at the same time protecting the vendor's investment if the service is as advertised (Underwood, 1997, p. 52). A company must also understand the language of the contract to be sure they can hold a vendor liable in the event the vendor fails to provide adequate service.

Another important part of the contract is for the supplier to guarantee that the organization will have access to the recovery facility in case of a disaster. A company must be careful not to select a vendor that will not guarantee access or that restricts the facility usage to a certain time frame. This restriction will delay the recovery process. The contract should contain provisions for a specific amount of facility usage as part of the base cost of the service. For example, a certain amount of hours should be allocated to complete installation of the software onto dedicated resources and to test and maintain the system.

Before a company signs a contract, it should get all charges defined to avoid any surprises. The company should also determine any optional services that are available and their costs. The contract should not be too narrowly written so that any changes through growth, upgrades or switching architectures can be handled without penalties. Companies should also understand if the contract is self-renewing and the costs of any buyout provisions. After the contract has been signed, an organization must periodically reevaluate the contract to make sure their disaster recovery plans are being adequately covered.

SOCIAL RESPONSIBILITY

Whether the disaster is natural, environmental, or technological, companies are rising to the call to accept additional responsibilities in the aftermath of a disaster. The recovery process for a company can be long, tedious, and expensive. Even though businesses remain concerned about the bottom line, they have not forgotten the ingredients that provide the mixture to make the bottom line. The mixture includes company employees, loyal customers, and the surrounding community.

Employees

In the aftermath of a disaster, companies encounter the overwhelming task of restoring operation. Some companies sponsor Employee Assistance Programs. These programs are responding to developing trends and changing attitudes by expanding their scope of service (Haskins, 1994, p.16). In the case of disasters, the expanded services now include providing counseling for traumatized employees and their families. The services focus on the trauma the victims are facing and address the emotional and mental aspects of such trauma. Certain companies go a step farther. Burger King is an example. Hurricane Andrew destroyed the Miami-based Burger King. After setting up a temporary office, the company began to address a list of primary concerns that included its employees, specifically, the physical and psychological well being of effected employees. The Vice President of Human Resources said, "In order to get Burger King on its feet, we had to get our people on their feet." Ensuring all of the employees that their jobs were secure, Burger King went on to provide crucial assistance. They served meals all day long in front of the damaged headquarters. They sent out construction crews to repair employee homes. In addition, they put down deposits for apartments for the employees that were homeless. By suspending the company's managed healthcare program and emergency room deductible, employees were able to use any hospital facility or doctor available for medical treatment. By setting up toll-free telephone line, Burger King helped the employees keep in touch with the status of the company's repairs. The toll-free lines provided information about various services that the company was currently offering. Finally, holding a mass meeting for area employees and their families, Burger King highlighted the available benefits and services the employees could use. They had representatives from various fields, including finance, medical, and legal, available to answer employees' questions. Burger King was a model company in accepting social responsibility (Matthes, 1992, p.9).

Customers

Realizing that lives have been torn apart, businesses have gone beyond the call of duty to not only aid its employees, but its customers as well. For example, banks have streamlined the loan approval process. Loan approval and receipt of check can be done within a 24-hour period. The loans are unsecured and offered at a discount rate. In addition, principle and interest payments are deferred for 90 days for certain loans. Certificates of Deposits can be redeemed early without incurring a penalty payment. Often these services are offered in an effort to relieve some of the stress associated with disaster.

Where does a company's responsibility end towards its customers? For example, a bank's system crashes as a result of a computer virus. How will their customers get money to buy food, clothing, or pay rent? The general response is that companies do not incur a social responsibility under such circumstances. However, a moral obligation to customers does exist. The Federal Employees Credit Union (FECU) in Oklahoma City exemplifies this position. Within 48 hours of the bombing, the FECU was back in business. CEO Florence Rogers felt a moral obligation to keep working and serve its members despite the fact that 18 of the 33 FECU staff had died. With the remaining staff, Ms. Rogers opened a temporary credit union. The credit union felt extreme pressure to restore operations, since many of its 15,800 members were in the middle of planning funerals for family members who had perished in the blast (Linert, 1996, p. 38).

Communities

Businesses not only provide these humanitarian services to their employees and customers, but to communities as well. For example, in the aftermath of Hurricane Andrew, Anheuser-Busch and Humana Inc. Healthcare each gave $1 million to the relief campaign, American Express contributed $100,000, Barnett Bank contributed $500,000 and AT&T gave $100,000. Coca-Cola provided thousands of gallons of drinking water, while other companies donated food, clothing, and building supplies (Szabo, 1992, p.37).

Companies aid communities by assisting disaster response teams, like FEMA. For example, wildfires burned 70 miles of telephone cable served by GTE California. Although the destruction of the fire cost the company approximately $5.5 million, GTE set up emergency lines for the firefighters, provided cellular phones and fax machines to Emergency Response Teams, and set up local command centers in the effected areas. These steps benefited the community by speeding up the recovery process. GTE also benefited because they were able to gain access to the damaged cables to repair or replace them (Szabo, 1992, p.37).

When disaster strikes, insurance companies do not get citizens back on their feet, the federal government with a great deal of assistance from the corporate community bears primary responsibility.

LEGAL RESPONSIBILITY

A company may face legal consequences as a result of not having a comprehensive disaster recovery plan. Since federal and state laws are finding it difficult to keep up with the ever changing technology, industry regulatory agencies are establishing rules regarding disaster recovery (SunGard, 1995, p. 1). The banking industry was the first to experience direct regulatory requirements for recovery planning. The Office of the Currency (OCC) issued Banking Circular 177 in 1983. This document alerted banks to the importance of recovery planning. Banks and organizations servicing banks must annually certify the existence of written recovery plans. The OCC and Federal Deposit Insurance Corporation have cited financial institutions for noncompliance of these regulations. Failure to comply can result in forfeiture of a bank's charter (SunGard, 1995, p. 3). In 1986, the Internal Revenue Service adopted regulations to protect tax information maintained on computer media. The regulations require offsite protection as well as documentation, including formats and label descriptions, of computer records maintaining tax information. Tax records must be readily available and accessible even if the primary facility is not (SunGard, 1995, p. 3).

A study in 1991 by the General Accounting Office (GAO) reviewed the level of systems security and controls in six stock markets: The American Stock Exchange, National Association of Securities Dealers, The New York Stock Exchange, The Midwest Stock Exchange, The Pacific Stock Exchange, and The Philadelphia Stock Exchange. The results are as follows:

5 of the 6 were cited for systems security and control weaknesses
4 of the 6 did not have a documented business recovery plan
3 of the 6 had no backup computer capability

The GAO instructed the stock markets to take immediate corrective action. In addition, they had to keep the Securities and Exchange Commission apprised of market risks associated with outstanding weaknesses that are not corrected. Presently, all of the exchanges have improved their recovery capabilities (SunGard, 1995, p.2)

The courts are beginning to hold company officers responsible for not having recovery plans. In assessing liability, the court weighs the probability of the loss compared to the magnitude of harm, balanced against the cost of protection. Not only can companies be held responsible for lack of business continuity planning, but also disaster recovery professionals can be charged with negligence. Comparable to doctors and lawyers being sued for malpractice, recovery specialists are held accountable for the actions and advice they give customers.

FIELD STUDIES

Company X

All companies, no matter the size, should have a disaster recovery program in place. One of the individuals in charge of the Disaster Recovery program for a Fortune 500 company within the Columbus, Georgia area shared some of their disaster recovery plans. The company wishes to remain anonymous, therefore it will be referred to as Company X. Company X uses products from many different software vendors to backup and restore data in the case of a disaster. Their main vendor is SunGard Disaster Recovery Services. Company X also uses in-house written procedures. A detailed step-by-step disaster recovery manual was developed and is stored off-site to use in case of a disaster. Company X allocates about 1 percent of their yearly budget to disaster recovery. Company X protects about 720 GB of mainframe DASD, 1.3 TB of network DASD and 35,000 3490E tapes which contain about 2.4 GB of data each. They also have about 13 million lines of code. Company X maintains the following hardware: 448 IBM 3390 DASD devices, 48 StorageTech 3490E tape drives in three StorageTech silos, 8 IBM 3490E tape drives, 6 IBM 3480 tape drives, 4 IBM 3590 tape drives, 1 IBM 3995 optical drive, 1 IBM 9021-972 mainframe CPU and 158 servers.

Company X takes preventative steps in their disaster recovery program. They use environmental safeguards such as halon, UPS systems, physical security systems and disaster recovery tapes are stored at an offsite location. Company X has never had to implement their disaster recovery plan in a real disaster but they perform two off-site disaster recovery tests each year. They recover and test all of their data and applications during this test. This test ensures management that their plan is current and up-to-date. Any weaknesses identified are immediately corrected. The time it would take to implement Company X's disaster recovery program depends on which day of the week a disaster happens. For example, Company X would be able to recover quicker if a disaster occurred on a Monday rather than on a Friday. From their disaster recovery testing each year, Company X has recovered to a Tuesday morning in 36 hours.

City Y

Just as companies should have a disaster recovery plan, city, state, and federal governments should have one as well. City Y is the focus of this field study. Although a mainframe supports the entire city, it is not discussed in this study. The information, provided by the systems engineer, reflects the departmental networks used at the city. There are seventeen different stand-alone networks used in different departments including the following: district attorney's office, planning division, public safety building, emergency management services, risk management, juvenile court, engineering, public defenders office, administration, and the county prison. The largest and most widely used network is administration; therefore, this network will be the focus of the study.

The administration network uses twelve programs. Some of the programs were designed in-house and others purchased from IBM. The department has over 100 pieces of IBM hardware including computers, servers, and printers. Protecting about 2GB of data, the data is backed up daily. The hard drives are mirrored and backed up onto tape. The backups are automated and processed after hours. Monday through Thursday, the backup is incremental which means it only includes the current day's activity. On Friday, the week's activities, programs and data, are backed up and the tape is stored offsite at an undisclosed location. The disadvantages of this recovery plan are that replacement parts are costly and taking the tapes offsite is time consuming.

City Y's systems are protected by reinforced walls and restricted access doors. Internally, the systems are monitored on a daily basis for abnormal activity. The file server is recycled at least once a month. Company Y has a documented, detailed recovery guideline. All recovery planning and procedures are performed in-house. Less than one percent of the IT budget is used for disaster recovery planning because it is not considered to be very important to the continuity of city administrative operations. The administration department has not implemented recovery procedures. However, if the plan was to be implemented, systems personnel think they could recover within twenty-four hours.

Company Z

Company Z designs carpet and manufactures carpet tiles and cloth wall coverings. Company Z employs approximately 7,500 people and their annual sales are about $1.3 billion. The communications engineer at Company Z provided the information for the study. Company Z is very committed to their disaster recovery plan. It is one of their highest priorities. Up to $250,000 per day in revenue could be lost in a "minor" disaster. A disaster on a larger scale could cost the company $2 million per day. In addition, Company Z needs to protect approximately 4 million lines of code and $20 million worth of hardware, which consists of AS/400, Networking, File Servers, personal computers, etc. The company spends a considerable amount of money on their plan and a large amount of employees' time is spent testing and maintaining the program. Company Z spends five percent of their annual budget on disaster recovery and has fortunately never had to implement the plan.

Company Z configures as much redundancy in their systems as possible for preventive measures. Duplicate systems and duplicate communication lines are the keys to preventing a major disaster. Also, extensive documentation is important. The company stores backup tapes of their system offsite. To prepare for a disaster, the company utilizes IBM Business Recovery Services. IBM provides a recovery center and equipment that is identical to the company's equipment. In the event of a disaster, technicians from Company Z travel to the disaster recovery center. With the assistance of IBM, backup information is obtained from the remote locations and redirected to the alternative site. The estimated time to implement the plan is 24 hours. Testing of the plan is done twice a year.

Company Z admits that the strength of its disaster recovery program is its partnership with IBM Recovery Services Center. "IBM is a leader in disaster recovery techniques, whose primary function is to provide equipment and personnel in the event of a disaster." IBM produces the company's standard equipment. The combination of IBM equipment and IBM Business Recovery Services Center improves the ability to recover efficiently and effectively. Company Z acknowledges one weakness of its recovery plan. Because the company is growing so rapidly, it is difficult to keep the disaster recovery plan updated to match current system configurations. Since the company is committed to its recovery plan, the admitted weakness will be eliminated in the near future.

CONCLUSION

Disasters can be dangerous for companies. Minor incidents can break a business, yet in comparison, it takes minimal preparation to deter disaster. Disaster Recovery Planning is not concerned with the disaster itself but with its consequences. In the aftermath of disaster, the time and money spent on data recovery and system replacement could have been used for developing an effective and efficient recovery plan. Threats come in all forms, inside and outside, natural and human, environmental and informational. Without plans for continuity in the case of a disaster, a business is completely exposed. By taking a strategic approach to developing a recovery plan, a company can work through a crisis in a positive manner.

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THE "HI-TECH" APPROACH TO SUPPLY CHAIN MANAGEMENT

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ABSTRACT

In order to remain competitive in the global marketplace, organizations are constantly striving to enhance their efficiency and increase productivity. There are several ways to enhance the productivity and profitability of organizations. This paper addresses the important issue of managing supply chains by using information technology.

A supply chain involves every entity involved with producing and delivering the final product, right from the supplier's supplier to the customer's customer. Supply chain management (SCM) is the process of synchronizing the flow of physical goods and associated information from source to consumption. Supply chain management is a critical managerial function because it can result in a significant gain in productivity.

By using sophisticated communication networks and computer software such as SAP, Baan, and Oracle (known as Enterprise Resource Planning Software or ERP), supply chain management (SCM) has become a powerful technique to improve the way an organization deals with entities in its supply chain. SCM is becoming an increasingly powerful weapon as it reduces inventory costs and increases responsiveness to changing market conditions. In this paper, we study the various issues and techniques concerning supply chain management, including its various advantages and shortcomings.

INTRODUCTION

During the last decade, many organizations have shifted focus from regional and local markets to national and global markets. A major reason for this shift has been the "opening" of markets in many parts of the world in order to embrace the concepts of capitalism and "free" markets. While, globalization certainly opens the doors to massive worldwide markets, it also fosters unprecedented competition from all corners of the globe.

Along with globalization is the increasing sophistication of customers, who demand high-quality products at rock-bottom prices. Modern communications technology and marketing techniques have made consumers very aware of their choices. Unlike the past, when consumers would be willing to wait for specific goods (mainly because of limited supply and competition), today's consumers will not tolerate delays and poor quality. It is almost as easy to order and receive goods from countries thousands of miles away, as from a factory in the next town.

In order to survive and prosper under these highly competitive market conditions, organizations must sharply enhance their market responsiveness, and increase their productivity. New processes need to be developed to cut down costs, enhance product quality and customer service, and to deliver goods and services in a timely manner.

One major problem that plagues most organizations is the process of managing supply chains. Managing modern supply chains not only involves crossing channel (manufacturers, retailers, distributors, and third parties) boundaries, but also functional, cultural, and personnel boundaries. It essentially amounts to getting components and raw material from suppliers in a cost effective and timely manner. Problems in the supply chain results in costly internal problems such as excessive inventory costs and delays in fulfilling customer orders.

The purpose of this paper is to explore some recent innovations, primarily by the use of information technology, in *supply chain management (SCM. SCM* is the process of managing all aspects of procuring materials and supplies from the source and delivering the final goods to the consumer. Effective SCM results in the reduction of both cost and time in the procurement process.

WHAT IS SUPPLY CHAIN MANAGEMENT?

A *supply chain* involves every entity involved with producing and delivering the final product, right from the supplier's supplier to the customer's customer. Supply chain *management* (SCM) is the process of synchronizing the flow of physical goods and associated information from source to consumption. Supply chain management is a critical managerial function because it can result in significant gain in productivity.

Traditionally, inventory management focused on *uncertainty*, which resulted in maintaining large levels of inventory as a hedge against inadequate or unreliable supply. In the course of operating a business, purchase orders seem to get misplaced or lost, checks seem to go astray, and procurement personnel end up "guessing" order quantities (due to unreliable information). The result is that, while some business units are scrambling to acquire certain parts needed for immediate production, other units are wondering what to do with their unused inventory.

To counter suppliers experiencing production problems or deal with unforeseen delay in shipment, inventory managers build a "buffer" inventory to sustain current production. In addition, when setup times are long, there is a need to have large stocks of work-in-process inventory to keep production running smoothly. Excess inventory not only significantly reduces working capital and net income, but also increases the risk of ending up with "obsolete" material. Obsolescence is especially a big problem for manufacturers and distributors of technology equipment, such as Intel, Motorola, Dell Computers, and CompUSA, because older products are simply worth very little.

Effective management of the supply chain, however, is not as straightforward as it used to be. The rapid adoption of lean manufacturing techniques like "just in time" (JIT) inventory management have made the *timing* of materials deliveries critically important. As pointed out before, manufacturers have become increasingly reluctant to carry large inventories. Suppliers must, therefore, make smaller, more frequent deliveries, and must do so in a timely manner, to allow manufacturers to implement JIT.

In a traditional supply system, suppliers and manufacturers operate in a somewhat autonomous manner. Suppliers don't know what manufacturers need until an order is placed, and manufacturers don't know what materials suppliers have available until the manufacturer places an order and gets a response. For organizations that implement supply chain management techniques, the links in the supply-chain are truly intertwined. Suppliers and manufacturers do not just share a business relationship, but also share information, via computer technology.

With a well implemented supply chain management system, the manufacturer doesn't even have to place an order manually. The supplier's information system knows the manufacturer's demand at all times because it communicates with the manufacturer's production information system. Consequently, the supplier knows exactly what materials the manufacturer needs, and when they are needed. Further, in a good supply chain management system, the supplier can adapt instantly to fluctuations or emergencies because it is linked in turn to its supplier, and on up through the supply chain.

Linking manufacturers and suppliers via communications networks is not entirely a new idea – what is new with modern SCM, however, is the *high degree of integration* between the various systems. Electronic data interchange (EDI), which is the most common form of electronic link today between organizations (Mathews, 1998), is used mostly for limited exchange of business information, and conduct simple business transactions (such as electronic fund transfer). SCM not only has all the advantages of EDI, but allows a much higher degree of automation and streamlining. (Achrol, 1997) The biggest problem with current EDI systems is incompatibility (software, hardware, and communication networks). EDI, therefore, has been embraced by larger organizations because of the complexities and costs involved in developing custom software, and networking solutions.

SUPPLY CHAIN MANAGEMENT SOLUTIONS TO CURRENT PROBLEMS

Modern supply chain management systems aim to solve many of the aforesaid problems by creating software that will truly integrate the systems of different manufacturers and suppliers. The breakthrough in supply chain management comes from advanced computer software that falls into one of two categories: enterprise resource planning (ERP) and planning-engine applications (PEA). ERP solutions, a popular category of enterprise software made by companies such as SAP, Baan, and Oracle, organizes and interconnects most day-to-day tasks, such as entering orders, tracking product shipments, scheduling production, and updating sales forecasts and balance sheets." (Fortune, 1997). With this type of software, previously incompatible systems may be integrated. PEA, made by companies such as i2 Technologies, Manugistics, Numetrix, ProMIRA, Paragon, and Q-CIM, support and integrate transaction-based processes, such as shop floor control, shipping, traffic, logistics, and inventory management.

In the initial stages of planning a supply chain management system, modeling is used to test scenarios, and "what if" analyses are conducted (Hough, 1996). When SCM is combined with JIT, production may have to be adjusted on a daily if not hourly basis to perform supply chain management functions in real time (EIL, 1998). Complex algorithms are utilized to maximize flexibility and control (LANframe, 1997). Current software, their capabilities, and some corporations using SCM software are briefly described in the next section.

CASE STUDIES

Supply chain management has its origins in Europe, where the idea originated with a software company called SAP [Fortune, 1997], but interest in the concept is spreading rapidly to all corners of the planet. Today, more than 8000 companies in over 50 countries are using SAP. One survey by KPMG found that the trend is toward "co-ordination at a regional or global level." For instance, PepsiCo Foods, in the United Kingdom, is in the process of creating an extensive software system addressing many areas of its supply chain. (Stevens, 1997).

Manugistics, another leading supply chain management software from Manugistics, Inc., is used by organizations such as Black & Decker, Deere & Co., DuPont, Glaxo Wellcome, and Unilever (Fortune, 1997). Another example is the extensive re-engineering at Lever Brothers, using Manugistics software to integrate data throughout its supply chain, and the system Philips Semiconductor introduced at its facility in Albuquerque, New Mexico. Manugistics software is also used by Amoco, Colgate-Palmolive, Dayton Hudson, Dow Chemical, Frito-Lay, Gillette, Nike, Procter & Gamble, and Safeway.

Kmart Corporation began using supply chain management software about two years ago, based on a recommendation from APICS (American Production and Inventory Control Society.) This involved changes not only in the information systems used by Kmart, but changes were also required that resulted in some physical relocation. Along with these changes, Kmart also implemented strategic partnerships with suppliers. (Lauer, 1997) Kmart employed software from Manugistics.

LANframe produces “ABLE" (Advanced Business Logistics Environment), which claims to perform such functions as managing “the complete supply pipeline... inventory, work in process, and capacity -- over as long a time horizon as [needed]” (LANframe, 1997). Another company, i2 Technologies, calls itself “the intelligent solution for global supply chain management," and offers modeling and customization of its generic supply chain model.

There are also exciting developments taking place on the internet for customers who do not have access to ERP technology. An example is Skyway, a transportation company, that provides a service called Concerto, on the internet, to help customers manage a complete transaction from ordering to warehousing, including tracking shipments. This allows customers to have the advantages of an integrated system without the capital investment. However, other companies that could well afford any system desired also use Concerto, including Lucent Technologies. (Haber, 1997)

CONCLUSION AND FUTURE DIRECTION

Where is SCM headed? Bob Gray, at Gemini Consulting, sees "networks of customers, intermediaries, and suppliers ... operat[ing] effectively as one entity." (Fortune, 1997) The main reason for implementing a SCM system is to increase transaction speed, but according to Mathews, in an EDI survey taken by the TEDIS program, 31% of respondents hadn’t actually measured whether or not performance had increased. Mathews also writes that the two biggest problems encountered by SCM users are “corruption of message contents and messages not being received in a timely manner.” (p. 2)

Of course, there are other drawbacks to completely linking manufacturers and suppliers into enterprise networks, such as security problems, and the possibility of a system-wide crash. Security is not a concern for some manufacturers simply because they don’t realize that there may be security risks, but the possibility of hackers altering or destroying information is very real, (Mathews, 1998) and could cause lengthy (and expensive) downtime.

In addition, there is the possibility of a virus being unwittingly (or otherwise) introduced into the system, and the chance that plain old bad data will cause a cascade of problems up or down the entire chain. Mathews also cites legal uncertainty with regard to the validity and enforceability of messages, an inability to tell if messages were lost or being properly received, and fraud concerns, as SCM problem areas.

A recent area of concern over SCM is a proposed revision to the Uniform Commercial Code, Article 2B. This proposed article will strengthen software manufacturers' legal protection for defective software, and will (some think) unfairly tilt the playing field against consumers. (Murphy, 1997; Wylie, 1996) As SCM software moves from being exclusively customized to becoming applications that are picked up "off the shelf", this is a big concern.

There are other, nontechnical, problems, as well. As use of SCM, and increased efficiency, becomes more widespread, there may be a negative impact on labor markets. And with the added move toward JIT, small suppliers may lose out on corporate contracts, if the small company is seen as less "reliable" than bigger suppliers, or lacks the capital to invest in SCM systems.

Despite potential problems, the trend toward supply chain management will continue. The pressure of competition and the need for efficient production methods is not likely to lessen, and the availability of SCM services on the internet (when recent capacity problems have been resolved) will only cause this technology to expand.

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