A COMPARISON BETWEEN FULL-FUNCTION AND LIMITED-FUNCTION CASE TOOLS IN SYSTEMS ANALYSIS AND DESIGN

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With the pressure from industry to train graduates in the latest systems development technologies, an increasing number of universities are incorporating computer-aided systems engineering (CASE) in their systems analysis and design courses. Study of the literature suggests that management information systems (MIS) and accounting information systems (AIS) curricula should include these new technologies in a practical environment [1, 5, 6, 8]. The classroom use of CASE tools such as GENIFER and BriefCASE for systems development has been discussed by Amadio [2] and Heiat [7]. The purpose of this research is to study the advantages, disadvantages, and the appropriateness of full-function and limited-function CASE tools in systems analysis and design courses.

CASE refers to a set of integrated software tools that create a computerized workbench for the systems analyst to support some or all of the analysis, design, data modeling, prototyping, coding, testing, and implementation [4]. There are a variety of CASE tools in the market intended for various users and systems development activities. This study compares the full-function Excelerator with the limited-function BriefCASE because they are the most widely used CASE tools in universities.

Although Excelerator has been improved continually, it requires substantial hardware and software investment, and it remains difficult to learn and to use.

Index Technology Corporation's Excelerator was the first IBM PC-based CASE product and today is one of the most popular CASE tools in business and education. The functional facilities of Excelerator include: graphics, data dictionary maintenance, rapid prototyping, integrating, data sharing or interfacing, quality assurance, and documentation [11]. The quality assurance facility in Excelerator is called Analysis and is capable of evaluating graphs, dictionary, and prototypes for completeness, consistency, common errors and inaccuracies. Although Excelerator has been improved continually, it requires substantial hardware and software investment, and it remains difficult to learn and to use.

BriefCASE, The Collegiate Systems Development Tool, is the first limited-function CASE tool intended for educational use. For academic purposes BriefCASE is an attractive alternative to the full-function Excelerator because it is easier to use and requires minimal investment in either hardware or software. The functional facilities of BriefCASE include: graphics, data dictionary, screen design, report design, and word processing [3]. Unlike Excelerator, which provides a number of reports that make it possible to diagnose logical errors in specifications, BriefCASE does not provide a quality assurance facility to perform validation checking.

When using limited-function educational CASE tools such as BriefCASE, students are supposed to perform their own validation checking.

Validation checking is one of the most important capabilities of a CASE tool. There are five types of validation checking: syntax and type checks, completeness and consistency checks, functional decomposition checks, cross-checking, and requirements traceability checks [9]. In a full-function CASE tool such as Excelerator, validation checking is performed automatically. When using limited-function educational CASE tools such as BriefCASE, students are supposed to perform their own validation checking.

Purpose and Hypotheses

The two most popular approaches to systems development are the traditional and the structured approaches [10]. The traditional approach relies heavily on narrative descriptions, systems flowcharts, program flowcharts, file layouts, and input/output layouts. The structured approach emphasizes the hierarchical decomposition process by developing data flow diagrams and structure charts. In the structured approach these diagrams are supported by a data dictionary which describes data stores, data flows, data elements, and processes. The graduate systems analysis and design course under study is based on the structured approach and is intended to familiarize students with CASE in a practical environment.

The purpose of this study is to investigate whether students perform differently using Excelerator (a full-function CASE tool) versus BriefCASE (a limited-function CASE tool). With the course requirements of two exams and a project, the following hypotheses were tested:

Hypothesis-1
There is no difference in the First Examination (FE) grade between the two groups.

Hypothesis-2
There is no difference in the Second Examination (SE) grade between the two groups.

Hypothesis-3
There is no difference in the Course Project (CP) grade between the two groups.

Hypothesis-4
There is no difference in the Final Grade (FG) between the two groups.

Research Sample

The research sample in this study consists of 75 graduate students majoring in MIS. These students were from four systems analysis and design classes taught by the same instructor. Excelerator was used in the first two classes of 18 and 16 students; BriefCASE was used in the third and fourth classes of 22 and 19 students. *Systems Analysis and Design Methods by Whitten, Bentley, and* Ho [12] was the primary text used in all four classes. In addition, Excelerator students used *Excelerator for Systems Analysis and Design* by Whitten and Bentley [11], and BriefCASE students used *BriefCASE: The Collegiate Systems Development Tool by* Crow [3].

Measures

The final grade in all four classes was dependent upon two examinations and a course project.

The first examination (FE) contributed to 25% of the final grade and consisted of questions and problems concerning data modeling, data structures, and data dictionary. All four classes were given the same examinations.

The second examination (SE) contributed to 25% of the final grade and consisted of questions and problems concerning functional decomposition, process specification, and structured design. All four classes were given the same examinations.

The course project (CP) contributed to 50% of the final grade. Students worked in interdisciplinary groups of three or four and performed systems analysis and design for a hypothetical video store. All four classes were given the same course project. Three written reports were required throughout the semester:a feasibility study report, a structured analysis report, and a structured design report.

Results and Analysis

Figure I shows a summary of the grades associated with the four classes. Before testing hypotheses 1 through 4, one-way multivariate analysis of variance was used to test whether classes 1 and 2 are samples drawn from the same population. The data for classes 3 and 4 were tested in the same manner.

FIGURE I
Grade Summary by Classes

CLASS 1:Excelerator (n=18)

	MEAN	SD	MIN	MAX	SE	VAR	CV
FE	20.44	2.41	15.00	24.00	.57	5.79	11.77
SE	21.55	3.22	14.00	25.00	.76	10.38	14.95
CP	44.17	2.48	41.00	48.00	.58	6.15	5.61

CLASS 2:Excelerator (n=16)

	MEAN	SD	MIN	MAX	SE	VAR	CV
FE	21.13	2.55	15.00	25.00	.64	6.52	12.08
SE	21.00	2.71	17.00	25.00	.68	7.33	12.90
CP	44.88	2.94	40.00	48.00	.73	8.65	6.55

CLASS 3:BriefCASE (n=22)

	MEAN	SD	MIN	MAX	SE	VAR	CV
FE	22.91	1.85	17.00	25.00	.39	3.42	8.07
SE	22.59	3.33	11.00	25.00	.71	11.11	14.76
CP	41.36	4.15	34.00	47.00	.88	17.19	10.03

CLASS 4:BriefCASE (n=19)

	MEAN	SD	MIN	MAX	SE	VAR	CV
FE	23.05	2.15	19.00	25.00	.49	4.61	9.31
SE	22.89	2.11	18.00	25.00	.48	4.43	9.20
CP	40.68	3.84	35.00	46.00	.88	14.78	9.45

Assuming that $X_{ij}(i=1,2,...n_j, j=1,2)$ are independent, three-dimensional vector observations sampled from two multivariate normal populations with mean vectors μ_j, j=1,2 and common variance-covariance, the hypothesis to be tested is

$$H_0: \mu_1 = \mu_2$$

that the population mean vectors are identical (i. e., there is no difference between the two classes). The sample means for the first two classes have the following values:

	FE	SE	CP
Class 1	20.44	21.55	44.17
Class 2	21.13	21.00	44.88

The matrix of the sums of squares and products among the different dimensions along with the error matrix is given in Figure II.

Four test statistics (Wilk's Lambda, Pillai's Trace, Hotelling-Lawley Trace, and Roy's Maximum Root), all functions of eigenvalues of $E^{-1}H$ (or $(E+H)^{-1}H$), are reported with F approximations in Figure III.

FIGURE II
H=Type III SS&CP Matrix for : GROUP

DF=1	FE	SE	CP
FE	3.92	-3.20	4.08
SE	-3.20	2.61	-3.33
CP	4.08	-3.33	4.25

E=Error SS&CP Matrix

DF=32	FE	SE	CP
FE	196.19	90.56	91.92
SE	90.56	286.44	136.33
CP	91.92	136.33	234.25

FIGURE III
Manova Test Criteria for the Hypothesis of No Overall Group Effect (Class1 and Class 2)

H	=	Type III SS&CP Matrix for:Group	
E	=	Error SS&CP Matrix	
P	=	Rank of (H+E)	= 3
Q	=	Hypothesis DF	= 1
NE	=	DF of E =32	
S	=	MIN(P,Q)	= 1
M	=	. 5(ABS(P-Q)-1)	= 0. 5
N	=	. 5(NE-P)	= 14. 5

Wilks' Criterion
L = DET(E)/DET(H+E) = 0. 93
Exact F = (1-L)/L*(NE+Q-P)/P
with P and NE+Q-P DF
F(3,30) = 0. 75PROB>F=0. 5324

Pillai's Trace
V = TR(H*INV(H+E)) = 0. 07
F approximation = (2N+S)/(2M+S+1)*V/(S-V)
with S(2M+S+1) and S(2N+S) DF
F(3,30) =0. 75 PROB>F=0. 53

Hotelling-Lawley Trace
Hotelling-Lawley Trace = TR(E**-1*H)=0. 07
F approximation=(2S*N-S+2)*TR(E**-1*H)/
(S*S*(2M+S+1))
with S(2M+S+1) and 2S*N-S+2 DF
F(3,30)=0. 75 PROB>F=0. 5324

Roy's Maximum Root Criterion
Roy's Maximum Root Criterion = 0. 07
First Canonical Variable Yields an F Upper Bound
F(3,30)=0. 75 PROB>F=0. 5324

None of the four test statistics reject the null hypothesis of equal means. From the previous tests of the hypothesis, it is concluded that class 1 and class 2 can be treated as samples drawn from the same population. The same tests were applied to classes 3 and 4 with similar results. The test statistics for classes 3 and 4 are reported in Figure IV.

FIGURE IV
Manova Test Criteria for the Hypothesis of No Overall Group Effect (Class 3 and Class 4)

H	=	Type III SS&CP Matrix for:Group	
E	=	Error SS&CP Matrix	
P	=	Rank of (H+E)	= 3
Q	=	Hypothesis DF	= 1
NE	=	DF of E	= 39
S	=	MIN(P,Q)	= 1
M	=	. 5(ABS(P-Q)-1)	= 0. 5
N	=	. 5(NE-P)	= 18. 0

Wilks' Criterion
L = DET(E)/DET(H+E) = 0. 98
Exact F = (1-L)/L*(NE+Q-P)/P
with P and NE+Q-P DF
F(3,37) = 0. 21PROB>F=0. 8885

Pillai's Trace
V = TR(H*INV(H+E)) = 0. 02
F approximation = (2N+S)/(2M+S+1)*V/(S-V)
with S(2M+S+1) and S(2N+S) DF
F(3,37) = 0. 21 PROB>F=0. 8885

Hotelling-Lawley Trace
Hotelling-Lawley Trace = TR(E**-1*H)=0. 02
F approximation=(2S*N-S+2)*TR(E**-1*H)/
(S*S*(2M+S+1))
with S(2M+S+1) and 2S*N-S+2 DF
F(3,37) = 0. 21 PROB>F=0. 8885

Roy's Maximum Root Criterion
Roy's Maximum Root Criterion = 0. 02
First Canonical Variable Yields an F Upper Bound
F(3,37) = 0. 21 PROB>F=0. 8885

Based on the results reported in Figure III, classes 1 and 2 are treated as samples from the same population and are combined into one group called Excelerator. Similarly, with the results reported in Figure IV, classes 3 and 4 are combined into another group called BriefCASE. Next, the testing of hypotheses 1 through 3 is conducted with the Excelerator and BriefCASE groups. Figure V shows a summary of the grades associated with the use of Excelerator and with the use of BriefCASE.

FIGURE V
Grade Summary by Case Tool

Excelerator Group (n=34)

	MEAN	SD	MIN	MAX	SE	VAR	CV
FE	20. 76	2. 46	15. 00	25. 00	. 42	6. 06	11. 86
SE	21. 29	3. 00	14. 00	25. 00	. 51	8. 76	13. 90
CP	44. 50	2. 69	40. 00	48. 00	. 46	7. 23	6. 04

BriefCASE Group (n=41)

	MEAN	SD	MIN	MAX	SE	VAR	CV
FE	22. 98	1. 97	17. 00	25. 00	. 31	3. 87	8. 57
SE	22. 73	2. 80	11. 00	25. 00	. 44	7. 85	12. 33
CP	41. 05	3. 97	34. 00	47. 00	. 62	15. 80	9. 69

As before, it is assumed that $Y_{ij}(i=1,2,...n_{ij}, j=1,2)$ are independent three-dimensional vector observations sampled from two multivariate normal populations with mean vector μ_j, j=1,2 and common variance-covariance. Again, one-way multivariate analysis of variance was used to test the hypothesis

$H_0:\mu_1 = \mu_2$

that the population mean vectors are identical (i. e., there is no difference between the Excelerator and BriefCASE groups) versus

$H_1:\mu_1 = \mu_2$

Figure VI presents the matrix of the sums of squares and products among the different dimensions and the error matrix.

FIGURE VI

H=Type III SS&CP Matrix for : Group

DF=1	FE	SE	CP
FE	90. 85	59. 08	-141. 82
SE	59. 08	38. 41	-92. 22
CP	-141. 82	-92. 22	221. 38

E=Error SS&CP Matrix

DF=73	FE	SE	CP
FE	355. 09	219. 08	216. 05
SE	219. 08	603. 11	290. 54
CP	216. 05	290. 54	870. 40

Four test statistics (Wilk's Lambda, Pillai's Trace, Hotelling-Lawley Trace, and Roy's Maximum Root with F approximations) are reported in Figure VII.

FIGURE VII
Manova Test Criteria for the Hypothesis of no Overall Group Effect (Excelerator Group and BriefCASE Group)

H = Type III SS&CP Matrix for:Group
E = Error SS&CP Matrix
P Rank of (H+E) = 3
Q = Hypothesis DF = 1
NE = DF of E =73
S = MIN(P,Q)= 1
M = . 5(ABS(P-Q)-1)= 0. 5
N = . 5(NE-P)=35. 0

Wilks' Criterion

L = DET(E)/DET(H+E) = 0. 53
Exact F = (1-L)/L*(NE+Q-P)/P
with P and NE+Q-P DF
F(3,71) = 20. 96 PROB>F=0. 0001

Pillai's Trace

V = TR(H*INV(H+E)) = 0. 47
F approximation = (2N+S)/(2M+S+1)*V/(S-V)
with S(2M+S+1) and S(2N+S) DF
F(3,71) = 20. 96 PROB>F=0. 0001

Hotelling-Lawley Trace

Hotelling-Lawley Trace = TR(E**-1*H)=0. 89
F approximation=(2S*N-S+2)*TR(E**-1*H)/
(S*S*(2M+S+1))
with S(2M+S+1) and 2S*N-S+2 DF
F(3,71) = 20. 96 PROB>F=0. 0001

Roy's Maximum Root Criterion

Roy's Maximum Root Criterion = 0. 89
First Canonical Variable Yields an F Upper Bound
F(3,71) = 20. 96 PROB>F=0. 0001

All four test statistics reject the null hypothesis of equal means between the Excelerator and BriefCASE groups. By rejecting the null hypothesis, it can be concluded that the Excelerator group (classes 1 and 2) differs from the BriefCASE group (classes 3 and 4) on the performance measures (i. e., FE, SE, or CP).

Next, the question of which of the three dimensions contributed to this result is addressed. After constructing simultaneous confidence intervals for all three dimensions, it can be concluded that all three dimensions are highly significant. For FE and SE, the classes using BriefCASE significantly outperformed the classes using Excelerator. In contrast, the Excelerator classes significantly outperformed the BriefCASE classes on CP.

Finally, hypothesis 4 was tested to determine if there is any difference between the final grades of the two groups. A univariate analysis of variance was performed resulting in an F value of .02 or $P(F > .02) = .8999$. This result supports the conclusion that there is no difference between the final grades of the classes using Excelerator and the classes using BriefCASE.

Conclusions

CASE has become an essential tool in systems analysis and design. If MIS and AIS curricula are to be relevant, CASE must be integrated into systems analysis and design courses. This study compared the use of the full-function Excelerator to the use of the limited-function BriefCASE, the two most widely used CASE tools in universities.

Students using Excelerator did a better job with their course projects; . . . . However, Excelerator students did not perform as well on their examinations.

The results indicate that different outcomes are associated with the use of full-function versus limited-function CASE tools. Students using Excelerator did a better job with their course projects; Excelerator provided them with more com-

FIGURE VIII
Summary of Advatages and Disadvantages of the Two CASE Tools

BriefCASE

ADVANTAGES
* Easy to learn
* Easy to use
* Minimum hardware and software investment
* Students develop expertise in validation checking since the process is not automated

DISADVANTAGES
* Students do not acquire a true picture of CASE
* Does not support multiple analysts
* Projects tend to contain numerous validation errors

Excelerator

ADVANTAGES
* Students acquire a true picture of CASE
* Support multiple analysts
* Projects tend to contain minimal validation errors

DISADVANTAGES
* Difficult to learn
* Difficult to use
* Substantial hardware and software investment
* Students develop limited expertise in validation checking since the process is automated

plete, consistent, and error-free specifications. However, Excelerator students did not perform as well on their examinations. Using Excelerator with its automatic coversions and validation checking, students do not develop expertise in structured specification.

In contrast, students using BriefCASE performed better on their examinations. The lack of automatic conversions and validation checking in BriefCASE forced them to develop expertise in structured specifications. At the same time BriefCASE students did not do as well in their course projects. Because of the complex nature of the project, it is difficult to deliver an error-free specification document with the limited-function BriefCASE. A summary of the advantages and disadvantages of each tool is presented in Figure VIII.

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