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DIRECTORATE OF LOGISTICS ANALYSIS

D Log A - RN - 9502

EVALUATION OF SIMULATION SOFTWARE PACKAGES FOR D LOG A

by

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ABSTRACT

The Directorate of Logistics Analysis (D Log A) would like to provide our sponsors with computerized simulation tools using a rapid application development environment to assist them in the decision making process. The state of technology is such that animated simulation is possible and could be used to achieve this goal. This study evaluates several simulation software packages available on the market, to decide which best suits D Log A's needs. The results of this study suggest Promodel, Arena and Witness are capable of meeting our needs. However, Promodel was chosen as the most cost-effective package because the distribution of run-time versions of models can be done at minimal cost.

RESUME

La Direction de l'analyse logistique (DAL) voudrait fournir à ses clients un outil informatisé de simulation utilisant un environnement de développement rapide d'applications, pour les aider au processus décisionnel. L'état de la technologie est tel que la simulation animée est possible et pourrait être utilisée pour atteindre ce but. Cette étude évalue plusieurs logiciels de simulation disponibles sur le marché, pour choisir le meilleur pour les besoins du DAL. Les résultats de cette étude suggèrent que Promodel, Arena et Witness sont aptes à rencontrer nos besoins. Toutefois, Promodel a été choisi comme le plus efficace en terme de coûts, parce que les version exécutables des modèles peuvent être distribuées à coût minime.

TABLE OF CONTENTS

EVALUATION OF SIMULATION SOFTWARE PACKAGES FOR D LOG A

BACKGROUND

1. Over the years, D Log A has developed many analytical models of logistics systems. These include Life Cycle Cost (Ref 1), Recursive Optimal Sparing Analysis Model (Ref 2), and Automated Level of Repair Analysis (Ref 3) which are now contained under the Logistics Analysis (LOGAN) shell (Ref 4) to support major acquisition programs. As optimization may not always be the goal of our analysis, D Log A developed a simulation model called A Simulation of Inventory Management (Ref 5). This was a purely analytical tool and of little use to sponsors. This directorate would like to provide sponsors with simulation tools using a rapid application development environment to assist them in the decision making process. Distributing models directly to sponsors has worked well for the LOGAN model and appears to be the best process for both D Log A and sponsors for the future. Currently, the state of technology is such that animated user-friendly simulation is possible and could be used to achieve our goals.

2. This report identifies several criteria which the directorate feels are desirable in any simulation package. Several candidate products will be identified and reviewed against the defined criteria. Analysis will be conducted to determine which software will provide the most benefit per dollar cost.

AIM

3. The aim of this study is to evaluate several simulation software packages available on the market, to decide which of these best suits D Log A's need to become self-sufficient with respect to the development of simulation models, and subsequently to direct the acquisition process.

ASSUMPTIONS

4. It is assumed that money will be available to obtain simulation software in the next fiscal year, and that additional monies will be available to assist in the development of simulation models required to satisfy the needs of current and future sponsors.

CRITERIA

5. A document entitled "The Requirement for Simulation in Logistics Analysis" (see Annex A), was forwarded to several simulation software companies. This document identified the complexity level of our requirements, together with a list of "must have" and "nice to have" features envisioned by this directorate.

6. The returns from the software companies will be evaluated using a benefit/cost analysis. Each of these features could be identified as either a cost or a benefit. Areas which were considered "must have" include:

a. Acquisition Cost - The system must cost no more than $30,000.00. This figure was arbitrarily chosen as an estimate of the amount that might be available to purchase simulation software. If none of the software firms had been able to meet this criteria, it is likely that the assigned dollar value would have been increased accordingly. Fortunately all the returns met this criteria;

b. Interoperability - It is imperative that the system import data and export results from available spreadsheet and database management systems. This requirement is necessary to save considerable data entry time by seamless transfer of information (benefit);

c. Platform - The system must be available for use on existing stand alone PCs and future networked PCs operating either with DOS or Windows operating systems (benefit);

d. Distribution - Executable Models must be distributable to clients for their use. Development of a model that cannot be provided to the sponsor at a reasonable cost reduces the utility of the model. The sponsor has to have affordable access our models (cost);

e. User friendly/development - The simulations developed must have a good graphical user interface (GUI). One friendly enough for clients to execute models built specifically for them. If clients are unable to easily use the final product, it is unlikely that any model will be implemented (benefit);

f. Animation - The software package should provide animation. Results of a run will best be interpreted if users can see the model functioning. Bottlenecks become readily apparent and the effects of any corrective actions are seen immediately (benefit);

g. Training - Sufficient training must be readily available to meet the demands of the directorate with its constant turnover of staff. The intent with this is to ensure new staff obtain training as soon as possible upon their arrival. This training would provide new staff with the knowledge required to provide sponsors with rapid application development solutions to their problems (cost); and

h. Customer Support - Troubleshooting and Consulting Services must be made available to assist in the development of future models (cost).

7. The following features were considered "nice to have":

a. Complexity - It is desirable that the software language be some form of object-oriented language. This would allow the various building blocks, used to create a simulation, to be reused in a variety of situations without the requirement to create new code. An extension of this requirement is that since D Log A does not employ programmers and we would not be satisfied with a system that required a considerable amount of code generation and debugging. It would also be desirable to have the basic features of our logistics models already built into the software (benefit);

b. Familiarity/users - This refers to the number and proximity of user groups (benefit); and

c. Life Cycle Cost - Given that we stay within our acquisition budget, the lower the cost the better. This would apply to all of the costs in the life cycle not just acquisition cost (cost).

8. It is understood that, in some cases, the list of "musts" and "wants" given above may seem contradictory. For example, the want to minimize costs, seems to conflict with the extensiveness of the modelling requirements of the candidate systems. Similarly, most systems, that are easy to use, cannot handle the level of complexity that may be required by this directorate. Despite these concerns it is felt that several simulation packages exist which could satisfy the identified needs and most of the desirable features.

9. Based on these features, a set of criteria was developed which were used in our benefit/cost analysis. Five software packages will be considered and a score for each will be obtained for their cost and benefits. The goal is to obtain a simulation software

package that provides the most benefit for the dollar. This list of costs and benefits is shown in Table I.

TABLE I
Benefit Cost Criteria

Goal to Select Appropriate Simulation Package	
Benefits	**Cost**
- animation - - interoperability - platform - development - complexity - familiarity	- acquisition cost - operating cost - training - customer support - distribution

CANDIDATES

10. The preceding criteria were forwarded to seven firms (see Annex A). These firms included:

a. Insight Logistics - A Canadian company that produces and distributes a variety of software from England including Inertia, Instrata, Intastok, Incepta, and Genetik. Genetik is the base language used to produce the other packages. The simulation package is **Instrata;**

b. Engineering Technologies - A Canadian Company that distributes software developed by Systems Modelling of Pennsylvania. System Modelling has been involved with software production for many years and has developed tools such as Siman, Cinema, and most recently **Arena**. Siman is

currently in use at Director Land Operations Research (DLOR). It is understood that Arena includes, both Siman and Cinema;

c. AESOP - A German company that produces the software package known as **Simple ++**;

d. Imagine That - An American Company that produces the simulation software package **Extend.** This software is in use in Directorate of Mathematics and Statistics (DMS) on a MacIntosh;

e. Promodel - An American company that produces a product called **Promodel.** This package is in use at Royal Military College (RMC) and 202 Workshop in Montreal;

f. AT & T ISTEL - An American company with distributors in Canada that produce a product known as **WITNESS**; and

g. Pritsker Corporation - An American company that produces a product known as **SLAMSYSTEM.** This product has been used by D Log A in the past (see Ref 6) but the licensing of support services has been allowed to lapse.

11. Besides these firms, consideration was given to CACI of California who produces several products such as Simprocess, Modsim, and Simfactory. One of the authors (IT) attended a training program with this firm and determined that Modsim was not suitable for use in D Log A because it required extensive code generation beyond the scope of this directorate.

12. Pritsker Corporation and Imagine That did not provide a return to our request. Engineering Technologies, Insight Logistics, AT & T and Promodel provided a detailed

return plus a demonstration of their products. Due to distance constraints, AESOP simply forwarded a written description of the features of their product.

EVALUATION

13. The returns which were received were reviewed taking into consideration the list of musts and wants given in Table I. This process will list the criteria and review each product with respect to each of the criteria. A relative ranking will be assigned to the software for each of the criteria which will help form the basis for scoring the subjective benefit criteria.

14. Cost - The criteria forwarded to the software companies indicated that the cost had to be no more than $30,000.00. All of the firms that responded were able to meet this requirement. A summary of acquisition costs is given below:

a. Promodel - $13,900.00 (US);
b. Instrata - $20,945.00 (US);
c. Arena - $16,000.00 (US);
d. Witness - $21,000.00 (US); and
e. Simple ++ - $25,000.00 (US).

It should be noted that the above are full retail values for each software. Additional options are available for the purchase of Arena. The first option is to purchase an upgrade package to DLOR's software SIMAN. The upgrade price is $4,800.00 (US) and is available until 5 Dec 95. This would necessitate a sharing of the product between DLOR and D Log A. While the cost of this upgrade is attractive, difficulties may arise with the scheduling of the shared software. These difficulties could be compounded should either D Log A or DLOR cease to maintain their current office space. Therefore, this option will not be considered. A second option is to purchase Arena at a 10% discount or a price of $14,400.00 (US). This price is available if DLOR purchases the

upgrade for Arena. While no timings were stated it is assumed that this price would be for a limited period after which the original cost would prevail. The cost for Witness is the highest of a range of values beginning at $5,000.00 (US). Note that the quote from InStrata was received in Canadian dollars and that the exchange rate for the third week of Jan 95 was used to convert the amount to US dollars. This price was valid until the end of the year and the cost may revert to the regular price of $25,400.00 (US).

15. The ranking of these products based on the preceding is as follows: Promodel, Arena, Witness, Instrata, and Simple++. If a suitable Witness package could be procured at a lower price, it would change its position relative to the other software.

16. The second portion of cost refers to the operating costs and this is split into maintenance and training costs as follows:

		Maintenance Fee	Training Cost
a.	Promodel	$2.2K	on training slot for a year, additional training is $900.00 per person
b.	Instrata	$4.5K	$2,400.00 (for six)
c.	Arena	$2.0K	$900.00
d.	Witness	$3.15K	$1,500.00
e.	Simple++	$3.75K	to be negotiated

All software includes first year maintenance, upgrades, and customer support for their products. Costs for subsequent years are indicated above. Training costs are for courses offered at either the company's head office or at their Canadian subsidiary (if applicable). Given the quantitative information above, the ranking for maintenance cost are: Arena, Promodel, Witness, Simple++, and Instrata. The ranking for training costs are as follows: Instrata, Promodel, Arena, Witness, and Simple++. AESOP does not have

an office in North America, but they have indicated that they would provide training in Ottawa at a cost to be determined by the number of participants and the length of training (3-5 days). The cost of the training does not include travel costs.

17. Interoperability - All software packages indicate that they have the capability to exchange spreadsheet and database information either directly or through an SQL interface. There does not seem to be any significant difference between the programs.

18. Platform - All software except Simple++ are currently able to operate on a some type of PC. Simple++ runs on a UNIX system, but is scheduled for conversion to Windows during the second quarter of 95. We removed Simple++ from further analysis for the time being. Although Arena's brochures indicate that the minimum RAM requirement is 8 MB, DLOR staff have indicated that they will require a minimum 16 MB RAM to run Arena effectively. Promodel indicates a requirement for 8 MB of RAM.

19. Distribution - All of the software packages provide for distribution of "run-time" versions of developed models - at a cost. Clarification was required from a number of the firms and the prices for distributing run-time versions is as follows:

ProModel -	$ 995.00 (US);
Arena -	$ 5000.00 (US);
Witness -	$ 5000.00 (US); and
Instrata -	$ 20945.00 (US).

Promodel have indicated that the amount given above is a worst case scenario, and that, in most cases, run-time versions with up to ten parameters could be distributed at no additional cost. Arena requires a minimum purchase of six run-time diskettes; therefore, the actual cost is $30,000.00. Instrata requires that an entire software package be purchased (at a cost of 21K) to issue any models which have been developed. Thus

Instrata will be removed from further consideration. We have only ProModel, Arena and Witness remaining on our short list.

20. Development - It was desired that any software under consideration be easy to use and easy to learn. All of the software seem to have well developed GUIs. Arena, Witness, and Promodel were demonstrated to have Windows capability. Also as part of the development criteria, it is reiterated that the software has to be readily accessible to developers. If an outright purchase is made, then the software would be maintained at D Log A and staff would have ready access to the software. If, however, the software is to be shared with DLOR then there is likely to be a reduction in accessability. This study will only consider the scenario of an outright purchase. From the demonstrations, Arena amd Promodel seemed equally easy to use, whereas Witness appeared slightly more difficult.

21. Animation - All of the software packages provide animation as a feature of their products. Arena is able to provide simulated three dimensional animation whereas Promodel's and Witness' animation is restricted to two dimensions. Thus Arena provides increased benefit.

22. Complexity - Of the remaining software packages uinder consideration none were specifically object-oriented languages. However, they all allowed the development of customized templates for modelling building blocks which provides similar features to object-oriented models. No code generation is required in these cases and the modules can be reused as desired. In terms of handling complexity, Promodel seemed to have slight advantage over the others and Arena a slight advantage over Witness.

23. Familiarity - Consideration should be given to software which is used by groups or units having close proximity to D Log A. This is desirable in order to exchange ideas and questions relevant to the development of models. As the precursor to Arena, Siman is being used by DLOR. Staff in that section may be familiar with the underlying

constructs used in Arena, and may be able to provide assistance with complex issues. Promodel is currently being used by DND members at RMC and at 202 Workshops in Montreal. Assistance could be obtained by telephone or fax. It is also being used by the private sector in the Ottawa region. The Witness is being used by various sections of foreign military departments and Canadian Industry, but currently not by DND. The ranking for this criteria would be Arena, then Promodel with Witness far behind.

RESULTS

24. Having reviewed the software with respect to the criteria, three separate tables were prepared using Lotus 1-2-3. The first provides a cost score for each software. Criteria ratings were obtained by dividing the software's cost by the cost of the sum of all of the software packages for each criteria. A cost score for each package was then obtained by summing the product obtained by multiplying the software's criteria ratings times a criteria weight. Initially all criteria weights were set to 0.25. The lower the cost score, the more attractive the simulation package.

25. A second table was prepared for the benefit criteria identified earlier. A subjective rating scale of 1 - 10 was used to determine values for this table. A score of 10 indicates that the particular software was considered the best for a given criteria and other packages were rated relative to the best. If appropriate, ties were allowed. Criteria rating were determined by dividing the assigned score for a software package by the total score for each criteria. The benefit score was obtained by summing the product of the criteria ratings times the criteria weight for each software package. Initially equivalent weights were assigned each of the criteria. In this case, the higher benefit score indicated the more suitable software.

26. A third table provides the benefit/cost score obtained by dividing the benefit score by the cost score. The results indicate the amount of benefit deemed to be received for the cost. The higher the score the more suitable the software.

27. The results based on our three remaining packages are shown in Annex B. In this analysis, we can see that the Witness package is completely dominated by the other two packages. That is, for every criteria Arena and ProModel are as good or better than Witness. So no matter what the weights of the criteria Witness will be last. Thus we can remove it from further consideration. We now have only two packages remaining: ProModel and Arena.

28. While the preceding analysis indicates that all of the criteria have equal importance, this is not normally the case. From a cost perspective, long term costs were felt to have the greatest impact. Therefore recurring costs were given more consideration than one time costs. As D Log A distributes its models to sponsors, it is important to keep the cost of this distribution to a minimum. Thus, the distribution of run-time versions was given a weight of 0.5. It is anticipated that maintenance and support costs will be required for a period of up to five years to ensure currency of the software, thus this criteria was given a weight of 0.3. The user-friendliness of these products reduces the need for training, and while training is a recurring cost, it is felt that much of it can be done "in-house" and thus the weight for training was set at 0.05. This left a weight of 0.15 for acquisition costs. These weights were determined by the authors following discussions with the director and other staff and are referred to as relative weights.

29. Weights used for the Benefit criteria were developed in much the same manner. The ability of the software to handle complex issues while providing for ease of development were considered the criteria of the utmost importance. Second in importance was the need to provide animation which is useful when attempting to support a decision based on a model's results. Availability of groups or individuals using similar software was considered to be the least important criteria. Relative weights were assigned as follows: Complexity 0.35, Development 0.35, Animation 0.20, and Users 0.10.

30. Tables were prepared for three options:

b. Option 1 - This option mirrors Annex B for ProModel and Arena, but uses the identified relative weights and is shown at Annex C;

c. Option 2 - This option reduces the cost of Arena to the discount price of $14,400. Relative weights are used and the results are given in Annex D; and

d. Option 3 - This option reduces the cost of Promodel distribution to zero. Relative weights are used with the results given in Annex E.

31. The benefit-cost ratios for these options are given in Table II below:

TABLE II
Benefit-Cost Ratios for Options 1-3

	Option 1	Option 2	Option 3
Promodel	1.43	1.42	1.87
Arena	0.78	0.78	0.70

The results show that although Arena has a higher benefit score, Promodel has a significantly higher benefit-cost ratio than Arena for all identified options. It may be argued that too much emphasis was placed on the distribution criteria (a weight of 0.50), but even if we reduce the weight for this criteria to 0.10 and increase the weight for the support criteria to 0.70, the results indicate that Promodel and Arena are virtually tied (see Annex F). As the emphasis of this directorate is to provide support to clients, the adjustment of weights by this magnitude is not considered realistic.

CONCLUSIONS

32. This research note has focussed on the requirement to obtain a simulation capability within D Log A. A set of criteria was developed and forwarded to a number of candidate firms. Returns included, both quantitative and qualitative information with which the authors were able to construct a set of rankings for each of the criteria. Weights were assigned to these criteria based on their relative importance to the directorate and scores were developed for costs and benefits. From these scores, a benefit to cost ratio was obtained which indicates the benefit obtained per dollar cost. Scores were obtained for three cost options identified in paragraph 29.

33. Promodel clearly stands out from the other software when the benefit/cost ratios are reviewed. Assignment of weights reflecting the criteria's importance to the directorate emphasize this outcome. The three options chosen all reflect the need for D Log A to become self sufficient with respect to the development of simulation models. In each of the three options, Promodel clearly provides the most benefit for the cost. Arena is a distant second followed far behind by Witness.

34. From the above, it is felt that the purchase of the Promodel simulation software would best suit D Log A at this time, primarily, because it has comparable capability to the other packages but a significantly reduced cost of distribution of run-time models.

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ANNEX A

THE REQUIREMENT FOR SIMULATION IN LOGISTICS ANALYSIS

INTRODUCTION

1. The Director of Logistics Analysis (D Log A) reports to the Senior Assistant Deputy Minister (Materiel) (ADM(Mat)) of the Department of National Defence (DND). He leads a small group of Defence Scientists and Military Officers working in the field of Operational Research in support of the ADM(Mat) branch [1]. A major part of D Log A's workload is the development and maintenance of logistics analysis models for use in studies of equipment acquisition [2], supply and transportation systems [3], maintenance and engineering management [4], and combat service support [5].

2. The Director of Logistics Analysis sees the need to acquire a simulation development package to enhance the existing modelling capability of the Directorate. In particular, the ability of animation to demonstrate the effectiveness of optimized logistics systems is seen as a major benefit of modern simulation technology. In the following paper, we will describe the requirement for a simulation software package for D Log A. We will also describe the criteria that will be used to evaluate contending simulation packages.

THE MODELLING REQUIREMENTS

3. The modelling system must be capable of handling the complexity of models that we develop in the directorate. Although these models are quite diverse and complex, they have a large amount of commonality. Therefore, reusable subsystems, such as those provided in an object oriented programming language would be highly desirable.

Logistics Support Analysis

4. In our work in support of equipment acquisition, we have a series of analytical models for estimating life cycle costs [6], optimal spare parts provisioning [7] and optimal maintenance concepts [8]. These models are part of a package called LOGAN [9] and have been developed over many years. The idea behind LOGAN is that all three models can utilize a common database developed during the equipment acquisition process. The database is divided into two major components: the equipment data and the maintenance facilities data.

5. The prime equipment that is purchased in a Major Crown Project usually consists of many hundreds of parts. Some of these parts are line replaceable units removed at the operational site. Other parts are shop replaceable units removed from the line replaceable unit at the second, third or fourth line facility. Thus, the equipment is described as a hierarchy with the prime equipment at the top and the line replaceable units, shop replaceable units, components and sub-components at the bottom. There can be any number of "indenture" levels. These parts are all tracked separately and optimization computer models that recommend the number of parts of each type to purchase are central to LOGAN.

6. The maintenance concept, also called the level of repair, must be established before the spare parts provisioning optimization. For each component, the level of repair analysis attempts to determine the most cost-effective facility to conduct the repair. This process considers the training and utilization of maintenance technicians, the cost and availability of test equipment and tools, the cost of manuals and reference material, among other things. There are usually a number of repair facilities in the system. The first line of maintenance is usually conducted at the operating site. The second line is usually regional. The third line might be central and the fourth line is usually a civilian contractor. Maintenance of the sub-units and components could conceivably be conducted at a number of sites depending on the failure mode; however,

in general, the lower the level of the part, the higher the line of maintenance. It would highly desirable to have a simulation model in which the maintenance concept could be easily reconfigured to demonstrate our analysis results.

7. Animated simulation of the operating and maintenance systems is seen to be a necessary requirement of LOGAN. The demonstration of LOGAN results using animation would provide user agencies with added confidence in the model recommendations. It would be a major selling feature of our logistics analysis techniques. At the current time, we have A Simulation of Inventory Management (ASIM) [10] that was developed in the object oriented language Smalltalk. Unfortunately, this program does not currently have any animation, although we believe Smalltalk has animation objects. ASIM does, however, provide a framework for a simulation of LOGAN. Thus a simulation language that is based on an object oriented language like Smalltalk might be very suitable.

Supply and Transportation Systems

8. The Canadian Forces Supply System (CFSS) is currently being upgraded with a modern computer system and modern inventory management concepts [11]. The CFSS handles millions of items in hundreds of facilities across the country. There is a constant ongoing effort to optimize the system by reducing inventory holdings and improving the transportation system [12]. The CFSS Upgrade program sees the need for a simulation of the supply system which can be used to evaluate changes that might be envisioned. D Log A has been involved in the specification of this simulation system.

9. Although D Log A has not attempted to model the entire supply system by themselves, we have spent considerable time modelling the supply depots [13]. This work was carried out using SLAMSYSTEM. There was no attempt to animate the simulation and it is not known whether SLAMSYSTEM can handle the quality of

animation we require. It was also felt that SLAMSYSTEM may not be able to handle the level of complexity that would be required for more general simulations.

Combat Service Support

10. D Log A has been working over the past few years on the logistics requirements of military combat operations [14]. In the past, military combat was simulated using war games and the logistics was assumed to be sufficient to support the operations. We are currently attempting to integrate our logistics models with the war games to develop a more realistic simulation of combat. At present, we have only considered aggregate classes of supply. In the future, we will need to specify the actual supply items that are required. Current war game technology is very graphics oriented. The movement of combat entities over the geographic features can be modelled in some detail. We are currently examining various approaches to handling different geographic locations, different climatic conditions and different levels of intensity in the conflict in our logistics models [5].

OTHER REQUIREMENTS THAT MUST BE SATISFIED

11. There are a number of other criteria that must be satisfied:

a. The system must be able to import data and export results from available spreadsheets and database management systems.

b. The system must be available for use on our existing stand alone PCs and future networked PCs.

c. Executable models must be distributable to clients for their use.

d. The simulations developed must have a graphical user interface friendly enough for clients to execute models built specifically for their environment.

e. The system must cost no more than $30,000 to acquire.

f. Sufficient training must be readily available to meet the needs of the directorate with its constant turnover of staff.

DESIRABLE FEATURES

12. There are a number of desired features of the simulation package that would seem to contradict other essential requirements. For example, the system should be easy to learn and easy to use. However, we realize that most "easy" systems cannot handle our level of complexity. Similarly, we would like the system to be no greater than $30,000 and the lower the cost the better. But we recognize that our modelling requirements are significant and the final models may cost much more than that. It would be desirable for the simulation package to be written in an object oriented language so that we could use the existing framework developed in ASIM and so that objects built for one application could be reused in other applications. But we are not professional programmers and would not be satisfied with a system that requires a large amount of code generation and debugging. It would be desirable to have the features of a logistics model already built into the software and the availability of consultant support services to help us build our models would be highly desirable. We will conduct a Multi-Criteria Cost Benefit Analysis [15] to determine the most desirable software package among the systems that satisfy our essential requirements.

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ANNEX B

EVALUATION WITH EQUAL WEIGHTING

COST MODEL FOR SIMULATION CHOICE						
PACKAGE		ACQUISIT	TRAIN	SUPPORT	DISTRIBUT	
PROMODEL		13900	900	2250	995	
ARENA		16000	900	2000	5000	
WITNESS		21000	1500	3150	5000	
	TOTAL	50900	3300	7400	10000	
						COST SCORE
PROMODEL		0.273	0.273	0.304	0.090	0.235
ARENA		0.314	0.273	0.270	0.455	0.328
WITNESS		0.413	0.455	0.426	0.455	0.437
	WEIGHTS	0.25	0.25	0.25	0.25	

BENEFIT MODEL FOR SIMULATION CHOICE						
PACKAGE		DEVELOP	ANIMAT	COMP[LEX	USERS	
PROMODEL		10	7	10	7	
ARENA		10	10	9	10	
WITNESS		7	7	8	2	
	TOTAL	27	24	27	19	
						BENEFIT SCORE
PROMODEL		0.370	0.292	0.370	0.368	0.350
ARENA		0.370	0.417	0.333	0.526	0.412
WITNESS		0.259	0.292	0.296	0.105	0.238
	WEIGHTS	0.25	0.25	0.25	0.25	

BENEFIT COST RATIO ANALYSIS			
	BENEFIT	COST	BENEFIT/COST
PROMODEL	0.350	0.235	1.49
ARENA	0.412	0.328	1.26
WITNESS	0.238	0.437	0.55

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ANNEX C

EVALUATION WITH CRITERIA WEIGHTING

COST MODEL FOR SIMULATION CHOICE						
PACKAGE		ACQUISIT	TRAIN	SUPPORT	DISTRIBUT	
PROMODEL		13900	900	2250	995	
ARENA		16000	900	2000	5000	
	TOTAL	29900	1800	4250	5995	
						COST SCORE
PROMODEL		0.465	0.500	0.529	0.166	0.337
ARENA		0.535	0.500	0.471	0.834	0.663
	WEIGHTS	0.15	0.05	0.30	0.50	

BENEFIT MODEL FOR SIMULATION CHOICE						
PACKAGE		DEVELOP	ANIMAT	COMP[LEX	USERS	
PROMODEL		10	7	10	7	
ARENA		10	10	9	10	
	TOTAL	20	17	19	17	
						BENEFIT SCORE
PROMODEL		0.500	0.412	0.526	0.412	0.483
ARENA		0.500	0.588	0.474	0.588	0.517
	WEIGHTS	0.35	0.20	0.35	0.10	

BENEFIT COST RATIO ANALYSIS			
	BENEFIT	COST	BENEFIT/COST
PROMODEL	0.483	0.337	1.43
ARENA	0.517	0.663	0.78

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ANNEX D

EVALUATION WITH DISCOUNTED COST FOR ARENA

COST MODEL FOR SIMULATION CHOICE						
PACKAGE		ACQUISIT	TRAIN	SUPPORT	DISTRIBUT	
PROMODEL		13900	900	2250	995	
ARENA		14400	900	2000	5000	
	TOTAL	28300	1800	4250	5995	
						COST SCORE
PROMODEL		0.491	0.500	0.529	0.166	0.340
ARENA		0.509	0.500	0.471	0.834	0.660
	WEIGHTS	0.15	0.05	0.30	0.50	

BENEFIT MODEL FOR SIMULATION CHOICE						
PACKAGE		DEVELOP	ANIMAT	COMP[LEX	USERS	
PROMODEL		10	7	10	7	
ARENA		10	10	9	10	
	TOTAL	20	17	19	17	
						BENEFIT SCORE
PROMODEL		0.500	0.412	0.526	0.412	0.483
ARENA		0.500	0.588	0.474	0.588	0.517
	WEIGHTS	0.35	0.20	0.35	0.10	

BENEFIT COST RATIO ANALYSIS			
	BENEFIT	COST	BENEFIT/COST
PROMODEL	0.483	0.340	1.42
ARENA	0.517	0.660	0.78

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ANNEX E

EVALUATION WITH NO PROMODEL DISTRIBUTION COST

COST MODEL FOR SIMULATION CHOICE						
PACKAGE		ACQUISIT	TRAIN	SUPPORT	DISTRIBUT	
PROMODEL		13900	900	2250	0	
ARENA		14400	900	2000	5000	
	TOTAL	28300	1800	4250	5000	
						COST SCORE
PROMODEL		0.491	0.500	0.529	0.000	0.247
ARENA		0.509	0.500	0.471	1.000	0.743
	WEIGHTS	0.15	0.05	0.30	0.50	

BENEFIT MODEL FOR SIMULATION CHOICE						
PACKAGE		DEVELOP	ANIMAT	COMP[LEX	USERS	
PROMODEL		10	7	10	7	
ARENA		10	10	9	10	
	TOTAL	20	17	19	17	
						BENEFIT SCORE
PROMODEL		0.500	0.412	0.526	0.412	0.483
ARENA		0.500	0.588	0.474	0.588	0.517
	WEIGHTS	0.35	0.20	0.35	0.10	

BENEFIT COST RATIO ANALYSIS			
	BENEFIT	COST	BENEFIT/COST
PROMODEL	0.483	0.247	1.87
ARENA	0.517	0.743	0.70

ANNEX F

EVALUATION WITH COST WEIGHTS CHOSEN TO SHOW BREAKDOPWN POINT

COST MODEL FOR SIMULATION CHOICE						
PACKAGE		ACQUISIT	TRAIN	SUPPORT	DISTRIBUT	
PROMODEL		13900	900	2250	995	
ARENA		16000	900	2000	5000	
	TOTAL	29900	1800	4250	5995	
						COST SCORE
PROMODEL		0.465	0.500	0.529	0.166	0.482
ARENA		0.535	0.500	0.471	0.834	0.518
	WEIGHTS	0.15	0.05	0.70	0.10	

BENEFIT MODEL FOR SIMULATION CHOICE						
PACKAGE		DEVELOP	ANIMAT	COMP[LEX	USERS	
PROMODEL		10	7	10	7	
ARENA		10	10	9	10	
	TOTAL	20	17	19	17	
						BENEFIT SCORE
PROMODEL		0.500	0.412	0.526	0.412	0.483
ARENA		0.500	0.588	0.474	0.588	0.517
	WEIGHTS	0.35	0.20	0.35	0.10	

BENEFIT COST RATIO ANALYSIS			
	BENEFIT	COST	BENEFIT/COST
PROMODEL	0.483	0.482	1.00
ARENA	0.517	0.518	1.00

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