# The Best Computer for The Illinois Dept. of Public Aid

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**SECTION 1**

# Abstract

The Illinois Department of Public Aid is looking to purchase sixteen personal computers to accommodate a future increase in staff. The department is targeting December of 2000 for the purchase of these machines. Currently, the process of selecting hardware in the Department of Public Aid is more of a political process. This review is an attempt to use a more modern analytic decision process, namely the Analytic Hierarchy Process (AHP), to aid in this decision. Four different personal computer models were selected as candidates for this purchase, and will be compared to each other on the basis of cost, speed, ease of use, compatibility (with current software and hardware), and political considerations.

# Introduction

It is the intent of this project to select the best personal computer for purchase by the Illinois Department of Public Aid to be used in the KidCare Program. A total of sixteen machines will be purchased with federal funds in December 2000.

The decision of "best" personal computer will be generated by the use of the Analytic Hierarchy Process (AHP). AHP is a fundamental compensatory methodology that allows individuals and organizations to better structure complexity and synthesize both qualitative and quantitative factors that are a part of every management process. For our discussion "goal" shall be defined as a statement of the overall objective.

Expert Choice is a decision-making software package based on the Analytic Hierarchy Process.

# Analytic Hierarchy Process (AHP)

The Analytic Hierarchy Process (AHP) is not a magic formula or model that finds the right answer. Rather it is a process that helps decision-makers find the "best" answer.

What do we mean by "best" choice? Our operational definition of best choice is that it is the choice that "best meets the objectives".

Decision-making is a process that evolves over time, and almost always involves iteration. We will follow the most widely accepted categorization of the decision-making process first introduced by Herbert Simon in 1960. This categorization consists of three phases: Intelligence – Design – Choice.

The choice phase is what most people equate with making a decision and until recently was almost always made by intuitively trying to synthesize the pros and cons of alternatives under consideration. It is our assertion that the Analytic Hierarchy Process (AHP) can change that process so that individuals and groups systematically identify the "best" one or combination of alternatives.

AHP addresses the issues that plague most decision making models including: analysis vs. synthesis, quantitative vs. qualitative, objectivity vs. subjectivity, and linear vs. non-linear.

In summary, AHP makes it possible for executives to assimilate all the facts, weigh the pluses and minuses, reach a conclusion, re-evaluate, and finally communicate their decision.

The first step in using AHP and the Expert Choice software is to develop a hierarchy by breaking the problem down into its components. The three major levels are the goal, objectives and alternatives.

After arranging the problem in a hierarchical fashion, the next step is to derive ratio scale priorities using pair-wise comparisons. Each node is evaluated against each of its peers in relation to its parent node. Pair-wise comparisons are basic to AHP and there are three modes being numerical, graphical or verbal. When comparing a pair of factors, a ratio of relative importance, preference or likelihood of the factors can be established. When making comparisons in a social, psychological or political context, you may wish to use the verbal mode. Verbal comparisons are easier to make and for qualitative or value driven comparisons, easier to justify.

Once judgments have been entered for each part of the model, the information is synthesized to achieve an overall preference. The synthesis produces a report, which ranks the alternatives in relation to the overall goal. This report includes a detailed ranking showing how each alternative was evaluated with respect to each objective.

Sensitivity analyses can be performed to see how well the alternatives performed with respect to each of the objectives, as well as how sensitive the alternatives are to changes in the importance of the objectives.

The use of the performance sensitivity chart has been suggested by Dr. Forman. This will show the relative importance of each objective as bars, and the relative preference for

each alternative with respect to each objective as the intersection of the alternatives' curves with the vertical line for each objective.

## Background

The Illinois Department of Public Aid is the state agency legislated to operate the federally funded KidCare Program.

This program is responsible for the delivery of medical services to children of low-income households who have no other means of medical insurance. Due to impressive statewide growth, the program is in the process of hiring sixteen additional staff to perform case updates, tracking and clerical changes. It is the goal of this Invitation for Bid to select a vendor to provide and install sixteen computers in December of 2000 to accommodate this growth in staff.

The Invitation for Bid consists of the following sections: 1) Instructions for Submitting Offers and 2) Solicitation Response Forms. The Solicitation Response Forms, completed, signed and returned by the vendor will constitute the offer. There are a number of statutory references in the solicitation that are designated "ILCS". The official text can be found in the appropriate chapter and section of the Illinois Compiled Statutes. An unofficial version of the Illinois Compiled Statutes can be viewed at www.legis.state.il.us/ilcs/chapterlist.html and the Illinois Procurement Code.

**SECTION 2**

# Alternatives

Through the use of Hall's multi-dimensional stimuli approach to brainstorming our team was able to generate several alternatives. From that group, four of the leading personal computers were selected as potential candidates for this project. These products were chosen for their existing track record with the IDPA, as well as market shares and reputations within the computer industry.

All connections for the machines must be able to be connected to the State of Illinois Local Area Network via 10/100 Ethernet or Token Ring and must be able to support Netware 3.X, 4.X, 5.X and Windows NT 4.X.

Compaq is the computer that is presently used by this department, so the staff has some familiarity here. Dell and Gateway are two of the most reputable personal computer manufacturers, and Apple has a proven track record for ease of use and reliability. Although Apple uses an alternative operating system, "SoftWindows" may be required for its current user compatibility and preference.

The computer that was chosen for comparison from each manufacturer was the middle model of the high-end business line of machines. The technical specifications and pros and cons of each machine will be presented in this discussion.

All of the Intel PC based machines were fairly similar in configuration. There were only a few identifying features that would be considered advantageous or disadvantageous for each. A short discussion of these pros and cons, as judged by this team, are also noted.

## Compaq DeskPro EN

Here are the technical specifications for the Compaq model - Deskpro EN. Again, this is the middle model of the high-end business line of Compaq machines.

- Pentium III 733MHz
- 256MB Full cache
- 128MB SDRAM memory
- 30GB Ultra ATA drive
- 10/100 Ethernet
- 10x DVD-ROM
- nVidia TNT Pro graphics card

- 56K internal modem
- 17” Compaq monitor
- Windows 2000

On the positive side, this machine has an excellent high-end graphics card, which would be useful for running high-end simulation or graphics applications. On the negative side, this machine has a DVD drive that is slower than the other alternatives, and the monitor is the lowest model that Compaq sells.

## Dell OptiPlex GX 200

The OptiPlex GX 200 was selected from Dell. As you can see, it is very similar in configuration to the Compaq machine.

- Pentium III 733MHz
- 256MB Full cache
- 128MB RDRAM memory
- 30GB EIDE drive
- 10/100 Ethernet
- 12x DVD-ROM
- No graphics card
- 56K internal modem
- 17” Dell monitor
- Windows 2000

The faster DVD drive is a definite plus for this machine. In addition, this machine contains RDRAM that is considered a superior RAM configuration with faster throughput. A major downside for this machine, however, is that it does not contain a graphics card in the default configuration. Thus, this card would have to be purchased and installed separately. Also, similar to the Compaq machine, this Dell monitor does not perform that well.

## Gateway E3400

Gateway weighed in with the E3400 model. Once again, we see the same technical specifications as the Compaq and Dell machines.

- Pentium III 733MHz

- 256MB Full cache
- 128MB SDRAM memory
- 30GB Ultra ATA drive
- 10/100 Ethernet
- 12x DVD-ROM
- ATI RAGE 128 Pro graphics card
- 56K internal modem
- 17" Gateway monitor
- Windows 2000

The Gateway model is similar to the Dell model with a faster DVD drive, however, it does come standard with a good graphics card. The monitor on this Gateway machine is similar in quality to the rest of the PC's listed above.

## Apple Power Mac G4

The Apple Power Mac G4 was also selected as an alternative for this project, although it is quite different from the other alternatives already reviewed. In fact, it is difficult to compare the technical specifications of the middle choice 450MHz machine of the high-end Power Macintosh line because it is so different from the other personal computers. However, given that Expert Choice is designed to allow one to compare apples and oranges, the reviewers decided that it would be worthwhile to throw this machine into the decision model. The technical specifications are:

- Dual 450MHz PowerPC G4
- 1MB L2 cache per processor
- 128MB SDRAM memory
- 30GB Ultra ATA drive
- Gigabit Ethernet
- DVD-ROM w/DVD-Video (unknown speed)
- ATI RAGE 128 Pro graphics card
- 56K internal modem
- 17" Apple monitor
- Mac OS 9

This machine has many advantages over the other models, including two processors instead of just one. The 450MHz G4 processor is twice as fast as the Pentium III 733MHz processor, and a large amount of cache is standard. This model contains a very fast network card that would allow the department to upgrade its network in future years

without needing to upgrade these machines.  A good graphics card and display are also standard.

An additional benefit is that this machine and company are not affiliated with Microsoft. Given current departmental attitudes toward the Wintel platform, this would also be considered a benefit.

Some drawbacks of the Apple machine are that the operating system is not compatible with currently utilized software programs.  So, either new software would need to be purchased, or a PC emulation program would need to be used.  Another large con is the price that is substantially more than the other machines surveyed.

**SECTION 3**

# Objectives

The goal is the statement of the overall objective. The objectives are what we are trying to achieve in selecting the personal computer, with sub-objectives allowing more specificity in the model. By adding sub-objectives the decision makers can further detail the main objectives of the model.

These are the criteria by which the decision will be judged. We will talk about each of these objectives in more detail.

## Cost

This is the purchase price for each of the systems including CPU, monitor, mouse and keyboard, per the configurations above. As we can see, the Apple machine is quite a bit more expensive than the other alternatives. The other three machines are fairly comparable in terms of price.

- Compaq $2,042
- Dell $1,969
- Gateway $1,884
- Apple $2,998

Two additional considerations that apply to the cost objective are value and existing contractors.

According to the Oxford dictionary, value is defined as the worth, 1) desirability, or utility of a thing, or the qualities on which these depend 2) worth as estimated 3) the amount for which a thing can be exchanged in the open market 5) something well worth the money spent. Since value or worth is, more times than not, affected by relative abundance or scarcity, the ability for a methodology to adjust rank is often a desirable property, we will focus on definition 5).

In order to assess the influence of cost, a step function with ranges for the costs was utilized. As reflected by the total column in Figure 1, the choice for the best computer based on the Cost objective is Compaq with a pair-wise comparison rating of 80.7%. However, a more thorough comparison including all objectives is contained within the following pages.

| cheap | average | expensive | very expensi |
|---|---|---|---|
| 1 (1.000) | 2 (1.000) | 3 (1.000) | 4 (1.000) |
| 1800 | 1950 | 2000 | 2300 |

| Ideal mode | | STEP | Pairwise | Pairwise | Pairwise | Pairwise | Pairwise | Pairwis |
|---|---|---|---|---|---|---|---|---|
| Alternative | Total | Cost Value (L: .200) | Cost Existing Contractors (L: .800) | Speed (L: .037) | Ease of True Plug and Play (L: .333) | Ease of Easy Access Towers (L: .140) | Ease of Aimed At Novice Users (L: .528) | Compatil Current Software (L: .429) |
| Compaq | .807 | 2042 | .37 | .11 | .33 | .33 | .25 | 1.00 |
| Dell | .361 | 1969 | .58 | .11 | .33 | .33 | .25 | 1.00 |
| Gateway | .562 | 1884 | 1.00 | .11 | .33 | .33 | .25 | 1.00 |
| Apple | .378 | 2998 | .13 | 1.00 | 1.00 | 1.00 | 1.00 | .17 |

Figure 1 – Expert Choice Cost Step Function

It is our intuitive belief that the Apple computer, although costing more, represents the best value for a personal computer. This is with regard to performance, ease of use and longevity.

Due to engrained state purchasing practices existing vendors are given preference on all purchases. Although the authors do not agree with this practice, appropriate weight will be assigned to this factor.

## Speed

The speed of the computer is important in terms of daily productivity. That is how much work can someone produce in a particular day using this machine. The speed of the machine is also important in regards to the lifecycle of the machine. Given that the speed of personal computers is increasing quickly, it is important to find a machine that is not only fast now but will also keep up with technology for at least two years.

All Intel machines use a single Pentium III 733MHz processor, while Apple uses dual G4 processors. While not all machines can utilize both processors in the dual processor system, lab tests have shown that one G4 processor is approximately two times faster than the Pentium III. Comparison tests were conducted with the Pentium III 800MHz processor and the G4 500MHz processor. Similar results would be expected between the 733MHz Pentium and the 450MHz G4.

## Ease of Use

The Apple Power Macintosh is well known for its ease of use. Some features that are unique to the Mac are true plug and play capability, and the ability to get on the Internet with 3 clicks of the mouse. Also, the case design of the Power Macintosh makes it very easy to add or remove components as needed.

In addition, the Mac OS is touted as the easiest operating system to use. However, this obviously depends on what people are used to using.

## Compatibility

Another objective for comparison is compatibility with the current and future software and hardware needs of the department. Since the department is currently using Windows based PC's, all of the software is Windows based. This may be an issue that detracts from Apple's ratio scale priority.

The list of currently used software includes:

- Lotus 123
- GroupWise
- WordPerfect
- Crystal Reports

The department is also in the process of expanding and upgrading its internal local area network (LAN). Thus, any machine selected needs to be able to grow with the networking needs of the department.

## Political Considerations

The IDPA and all other state agencies fall under the auspices of the state's main purchasing entity, which is Central Management Services. CMS is responsible for uniform purchasing guidelines that have been in existence for years. Due to the competitive nature and sensitivity of these guidelines, it is very difficult to deviate from these rules. However, deviations do occur and they are usually the result of a provider's political influence and not the products influence. As a result cost, value, and other non-political factors do not receive the same priority, as does politics in decision-making. This means that although a certain product may appear superior to a user, the politics of government may cloud the choice.

**SECTION 4**

# Decision Model

A top down construction of a decision hierarchy focuses on the identification and organization of objectives before evaluating the alternative preferences.

A bottom up approach focuses first on the evaluation of alternatives preferences with respect to each objective before evaluating the relative importance of the objective.

If the decision makers have a good understanding of their objectives then a top down approach is recommended. Otherwise a bottom up approach should be used.

As suggested in the book Decision By Objectives, a little top down structuring can be followed by some bottom up structuring, followed by more top down and so on. This is why we will employ an iterative process with feedback to achieve the decision.

From this point a full compensatory evaluation can be performed including making pair-wise comparisons to derive priorities, synthesizing priorities and performing sensitivity analysis.

## Expert Choice Decision Hierarchy

Below is the Expert Choice decision hierarchy that shows the alternatives and objectives with respect to the goal. Since the pair-wise comparisons have been made in a social and political context the verbal mode was utilized. This type of comparison is easier to make and justify for qualitative or value driven choices. The choices within the verbal scale are "Equal", Moderate", "Strong", "Very Strong" and "Extreme". A more detailed explanation of the methodology is contained in the previous section on AHP.

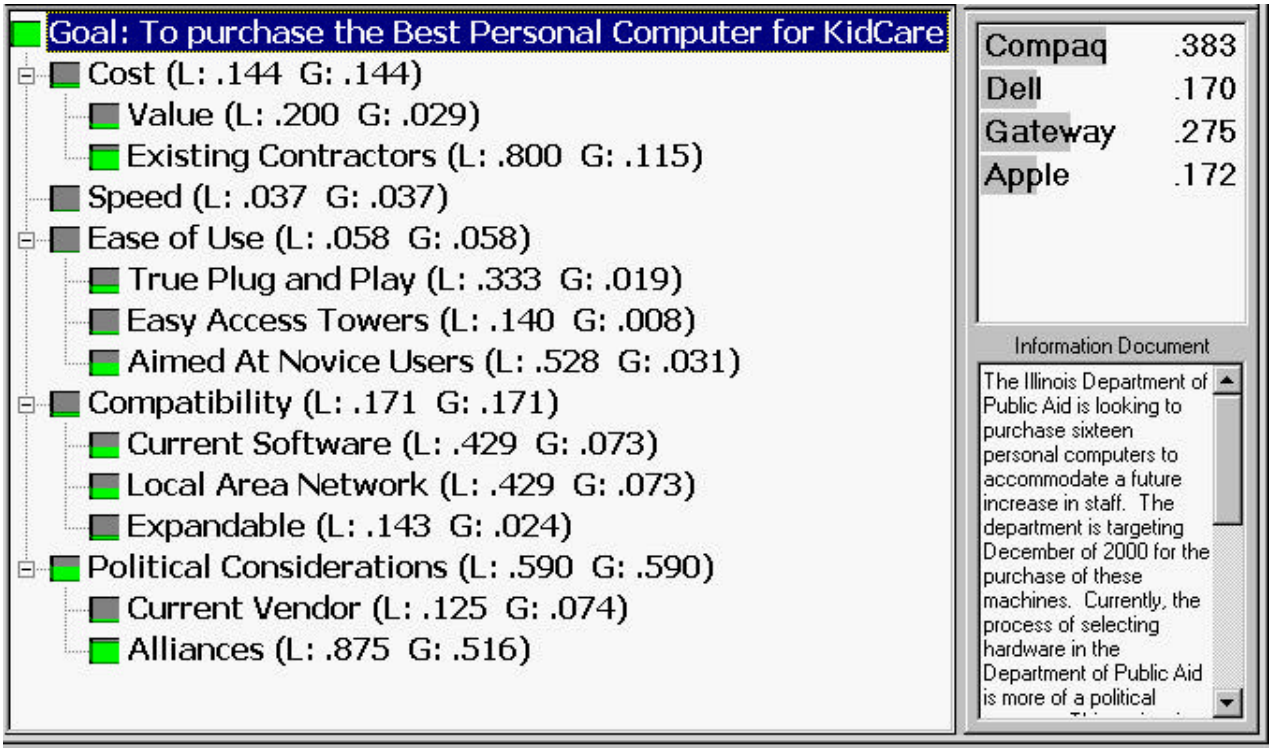


Figure 2 – Expert Choice Decision Hierarchy

You can see from the right box in Figure 2 that Compaq has the "best" overall rating with a ratio scale measure of .383. Gateway is not that far behind with a ratio scale measure of .275, and Apple and Dell follow thereafter with .172 and .170, respectively. Therefore, based on this data the Compaq machine is the "best" overall computer for IDPA.

## Expert Choice Synthesis

Once judgments have been entered for each part of the model, the information is synthesized to achieve an overall preference. The synthesis produces a report, which ranks the alternatives in relation to the overall goal. This report includes a detailed ranking showing how each alternative was evaluated with respect to each objective. With regard to inconsistency, there is an overall inconsistency of .07 or 7%. This indicates that the judgments made via the pair-wise comparisons were consistent. Traditionally, an inconsistency rating of less than 10% is desirable. Therefore, the authors believe a strong degree of validity is contained within this model.

The synthesis conducted here was the Ideal Synthesis. The Ideal mode assigns the full priority of each covering objective to the alternative that ranks it the highest under it. The other alternatives receive a percentage of the priority in proportion to the highest alternative.

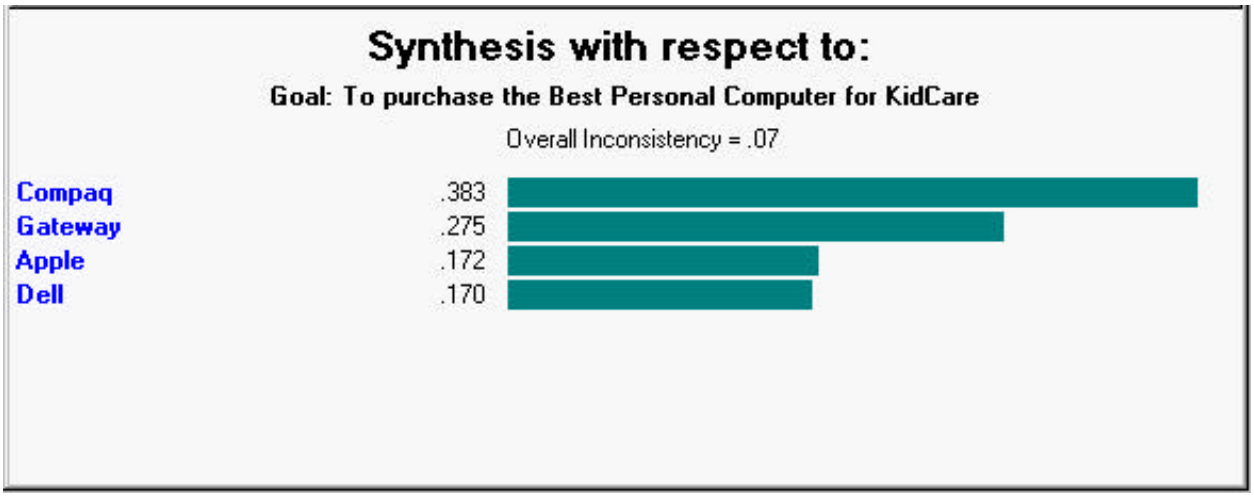


Figure 3 – Expert Choice Synthesis

Again, the Expert Choice Ideal Synthesis Report contained in Figure 3 reflects that based on pair-wise comparisons with derived priorities, the Compaq machine is the "best" overall computer for IDPA.

## Expert Choice Sensitivity Analysis

Sensitivity analyses can be performed to see how well the alternatives performed with respect to each of the objectives as well as how sensitive the alternatives are to changes in the importance of the objectives.

Per Dr. Forman's suggestion, a performance sensitivity analysis was conducted and is shown in Figure 4. The performance sensitivity shows the relative importance of each of the objectives as bars, and the relative preference for each alternative with respect to each objective as the intersection of the alternatives' curves with the vertical line for each objective.

The importance of the political consideration objective can be easily seen in this graph. While most of the objectives have a criteria ranking of approximately 5- 20%, political consideration has a criteria ranking of approximately 60%. This results in the objective of political considerations influencing the overall ranking by approximately three times that of other objectives.

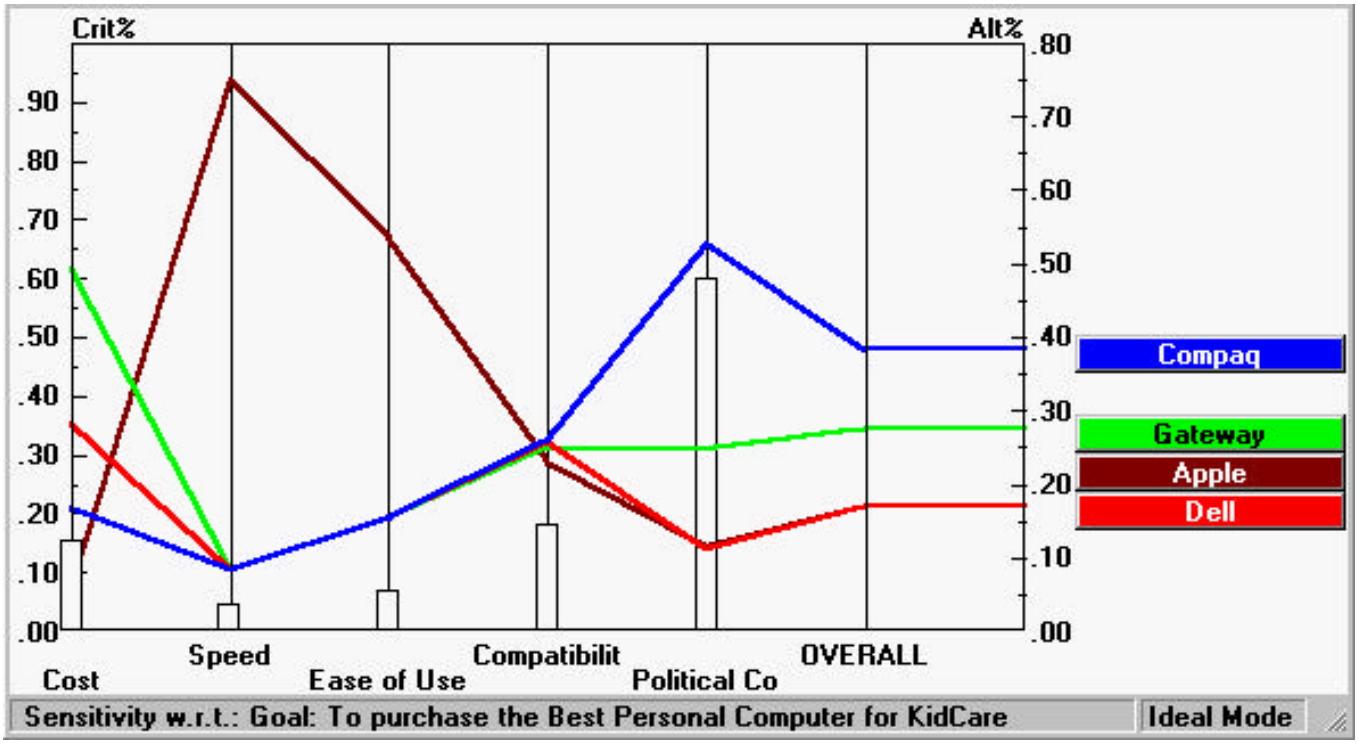


Figure 4 – Expert Choice Sensitivity Analysis

**SECTION 5**

# Conclusions

Based on the pair-wise comparisons with derived ratio scale measurements, we believe that the best overall personal computer for the IDPA KidCare Program is the Compaq Desk Pro EN.

Therefore, it is our recommendation that procurement staff proceed with purchasing sixteen units at a total cost of $32,672. Out year maintenance costs are contained within the FY'01 EDS budget.

Due to the personal nature of this decision for members of our team, both members will review this material, models and recommendations with senior staff. It is our intent to provide IDPA with the best computer and inform Apple Computer about the basis of this decision. From this information it is hopeful that Apple Computer can score at a much more favorable level in future Invitation for Bids.