# IBM Global Services
# 2002 Education Budget and Course Allocation

## The George Washington University
## Executive Decision Making
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# Executive Summary

## General Approach to Budget and Course Allocation

This report covers a project that addresses the issue of budget allocation and course selection for the 2002 education requirements for the IBM Global Services employees. This report includes the following:

- The project plan, including objectives and sub-objectives
- Project methodology and processes
- A recommendation

### Budget Constraints

One of the primary objectives—which are discussed in detail later in this report—was to make the most effective use of a fixed, $200,000 education budget allocated for training employees in 2002. As a result of this project—which analyzed the desired education requirements and established the maximum total organization benefit given the constraint on cost—19 courses have been chosen at a cost of $199,285.

### Course Selection

The courses that were selected for 2002 focused on educating Global Services employees in the following three general areas:

- Computer skills
- Project Management and Leadership Skills
- Soft skills (communications, presentations, etc.)

A total of 19 classes were chosen for 2002 Global Services education curriculum. Twenty-seven courses were considered and evaluated for inclusion in the curriculum. For a complete list of selected courses, see Figure 11. Figure 1 shows the original list of courses considered.

## Project Goal

The overall project goal was to determine the best allocation of resources (funding) for selecting the most appropriate and desired training courses for IBM Global Services employees. This goal was derived from the yearly goals established and communicated by the IBM Global Services Management Team.

## Project Team Background and Experience

Global Services employee Jim DeWinde, PMP, established this project's basic premise. DeWinde—along with fellow George Washington University graduate student Anne Dutton—developed and implemented this project as part of a requirement for an Executive Decision Making class. DeWinde and Dutton used the tools and process learned in their studies and applied them to resolve a real-world decision making activity, which was (at DeWinde's suggestion) to determine the best resource allocation for the IBM Global Resources 2002 training curriculum.

# Project Plan

## Introduction and Overview

The IBM Global Services Company is located in Rochester, NY. Global Services is a small site comprised of four management and technical areas. These areas—or departments—include the following:

- Project Management
- Mainframe System Support
- Network System Support
- UNIX System Support

In February 2001, Global Services began a site-remodeling project that would include a new Education Room designed to—and intended for—hosting training courses for IBM Global Services employees. The remodeling project will complete in late 2001, thus the need to establish a training curriculum for 2002.

## Project Objective

The project objective was to determine the best allocation of resources (funding) for selecting the most appropriate and desired training courses for IBM Global Services employees. The significant constraint for this objective was the fixed, 2002 $200,000 training budget.

The courses selected for training options in 2002 had to provide IBM Global employees with their developmental and job-related skills. The project objective was then organized into sub-objectives to address this need, as described in the next paragraph.

### Project Sub-Objectives

Managers in all four of the IBM Global Services departments requested that employee training for 2002 focus on three main disciplines, as follows:

- Computer skills
- Project Management and Leadership Skills
- Soft skills (communications, presentations, etc.)

The initial list of potential courses was generated from suggested courses (alternatives) from each of the four department team leaders. Figure 1 shows the original list of potential courses with their associated costs.

| *Alternative* | *Costs* |
|---|---|
| Networking and Negotiating - Career Commincation Skills (ZRA0105C) | 2000 |
| Introduction to IBM Project Management Tool Suite (D2188) | 6000 |
| E-Business Intermediate (WHV7254C) | 6300 |
| Harzard Communcation (Right-to-Know) Training (XHV0932C) | 5450 |
| Authentic Leadership and Communication (ZBEV135C) | 7450 |
| Project Leadership: The Personal Side of Project Management (PE142) | 9535 |
| Presentation Skills (E5062) | 8650 |
| UNIX Advanced Topics (DN151) | 9000 |
| UNIX Intermediate Topics (WBT7023B) | 9000 |
| UNIX Fundamentals (WBT7022B) | 9000 |
| E-Business Fundamentals for Z-Series and OS/390 (WHV7253) | 10375 |
| Using OS/390 as your E-Business Server (ES76A) | 14950 |
| Introduction to OS/390 (ES050) | 5695 |
| Applied Management and Execution Using PM Tool Suite (21883) | 10700 |
| Network for OS/390 Implementation (CB695) | 13950 |
| Multinational Project Management (22105) | 13600 |
| Advanced Presentation Skills (PE164) | 14975 |
| E-Business Fundamentals (WHV7251C) | 18750 |
| Executing/Controlling & Closing Projects Using PCB and MS Project (21885B) | 14600 |
| UNIX Shell Programming (DN206) | 15000 |
| Applied Project Management in a Customer Environment (21802) | 27950 |
| Project Management Fundamentals (21788) | 23875 |
| Using Advanced Function Presentation (K2502) | 23785 |
| Project Management Certification Program (ZBEVPM1C) | 25000 |
| Fundamental System Skills in OS/390 (ES10A) | 20995 |
| OS/390 Facilities (ES150) | 18595 |
| OS/390 Installation (ES41A) | 23780 |

**Figure 1. Original List of Courses**

The initial list of 27 courses was selected from the IBM Global Campus web site located at Intranet URL: w3.education.ibm.com[1]. The cost of the course is the private price listed in the course description and is the IBM Global Campus cost for an IBM site to host a Global Campus course at their location. The course formats range from class sizes of a minimum of 12 students to a maximum of 20 students. The lecture times vary but range between 3 to 5 business days (course business day is an 8:00 a.m. lecture start and a 5:00 p.m. lecture completion).

[1] Web site w3.education.ibm.com is located on the IBM internal intranet network. This site is not accessible from the public Internet World Wide Web. Access is restricted to IBM employees only.

## General Approach to Project Implementation

After determining the project objective (goal) and sub-objectives (skills), the objectives and sub-objectives needed prioritizing. Prioritizing objectives and sub-objectives helps determine the benefit of each of the alternatives (courses), which in turn contributes to determining the best combination of alternatives.

A decision model called the Analytical Hierarchy Process and a software tool called Expert Choice were used to prioritize the objectives and sub-objectives, as discussed in the following paragraphs.

### Analytical Hierarchy Process

The Analytical Hierarchy Process (AHP) is a decision-modeling tool that allows a decision-maker to logically decompose the complexities of a decision and to evaluate the different components of the decision. As the name suggests, AHP uses a hierarchical approach to analyzing a decision. The decision goal is the top of the hierarchy, which is then segregated into objectives, sub-objectives and sub-sub-objectives (as required) descending in complexity. See Figure 2 for the hierarchy developed for the IBM Global Services course allocation process.

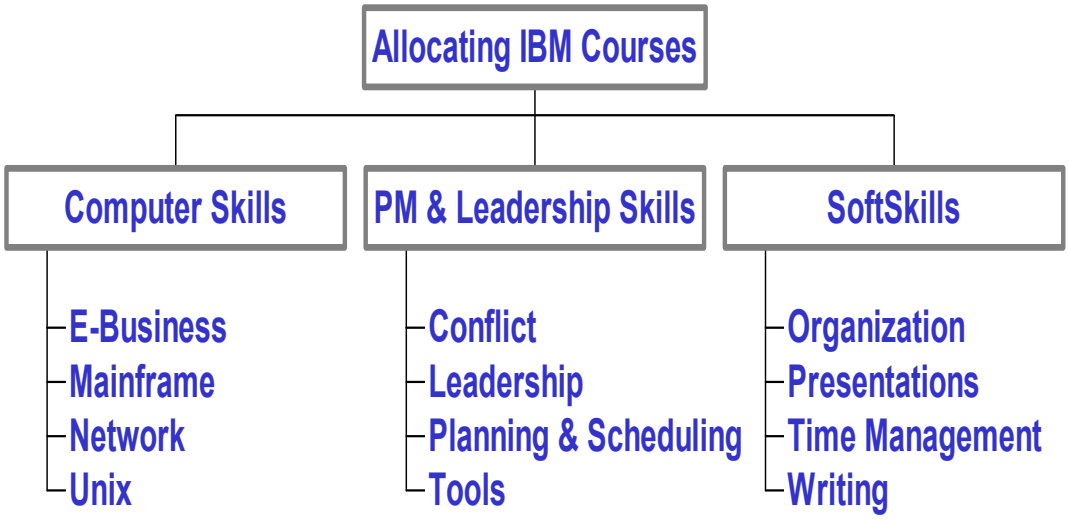



**Figure 2. Goal, Objectives, and Sub-Objectives Hierarchy**

### Expert Choice Software

The AHP is the foundation of the Expert Choice software, which is a decision modeling tool that aids decision-makers with synthesizing data and judgments required to make a good decision. The data from the hierarchy shown in Figure 2 was entered into Expert Choice and is shown in Figure 3.

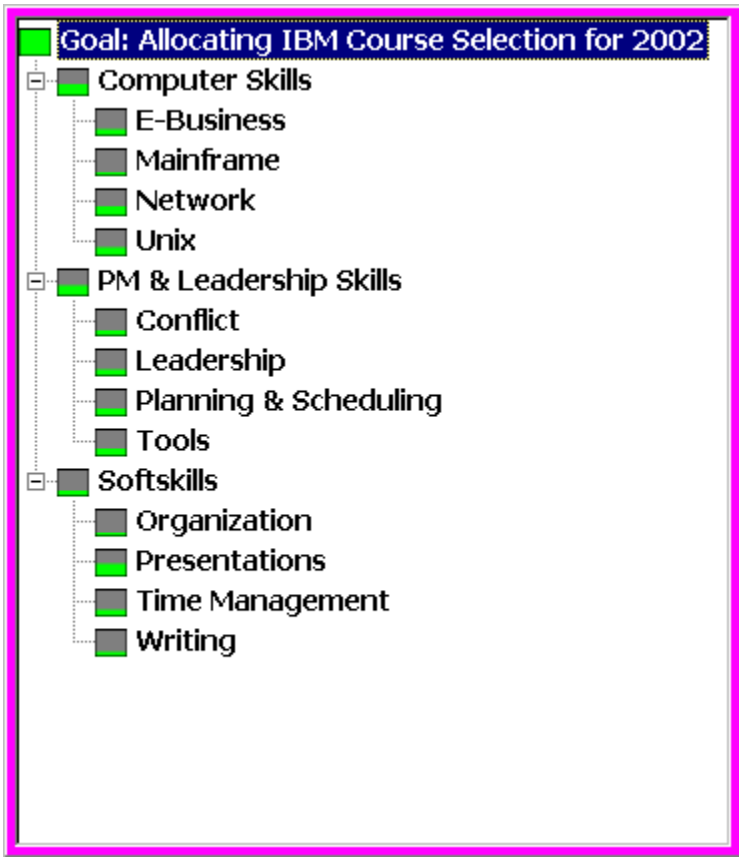



**Figure 3: Expert Choice Hierarchy**

### Bottom-Up Approach: Pair-wise Comparisons

To best understand which objectives best support the goal, each objective and sub-objective were evaluated using pair-wise comparisons. Pair-wise comparison is performed by evaluating each objective against another objective to derive its relative priority. This process is continued until each objective has been evaluated to each other objective then each sub-objective is evaluated against each other sub-objective until every pair of has been evaluated. In turn, the sub-objectives are evaluated as to how they contribute to their respective objectives (again using pair-wise comparisons). Finally, alternatives are assessed using intensity ratings to determine how much they contribute to their lowest, respective sub-objective. Pair-wise comparisons were not used for assessment of the alternatives because of the rather large number of individual pair comparisons required to perform this operation—a rating scale was used in stead and this scale was developed using pair-wise comparisons.

Using a group model, individual team leaders made their judgments. Their individual assessments would be then combined together. Starting with the

lowest sub-objectives, or the "bottom" of the hierarchy, the IBM Global Services four team leaders performed pair-wise comparisons on the sub-objectives and objectives to establish each element's contribution to the goal. Each team leader performed individual assessments, and this information was then entered into the Expert Choice model[2]. The data and judgments would later be combined into a single assessment. For example, as shown in Figure 4, the Computer Skills objective is compared to Project Management (PM) & Leadership Skills objective.

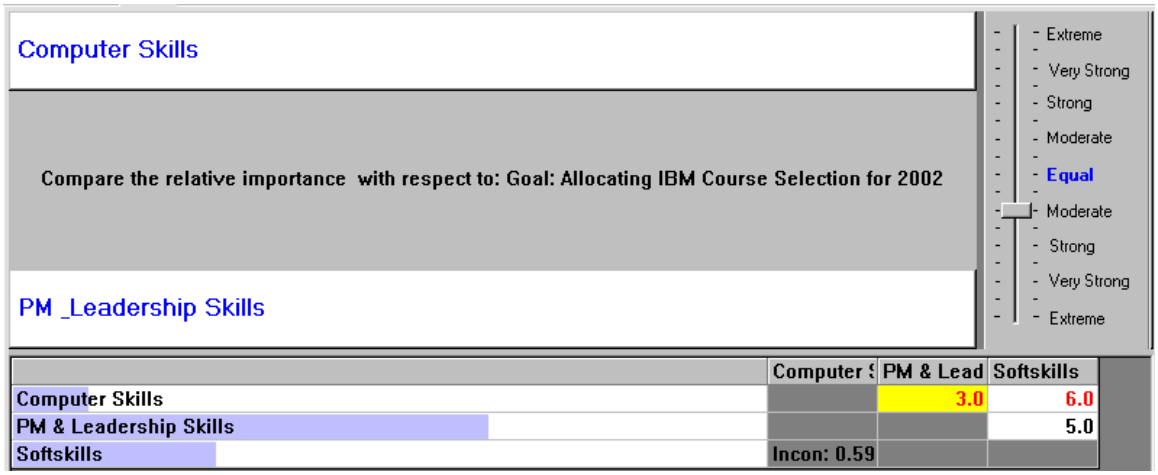



**Figure 4. Example of a Pair-wise Comparison of an Objective**

As a result of pair-wise comparisons, computer skills were evaluated as less important than PM and leadership skills. This methodology was repeated throughout the model until all objectives and sub-objectives were assessed.

### Data Synthesis

Once all of the pair-wise comparisons were completed, Expert Choice then calculated the priorities from the geometric average of the judgments made by the team leaders. The results, shown in Figure 5, clearly shows the computer skills objective as having the top priority, followed closely by PM and leadership skills. Soft skills were about half as important as computer and PM skills.

[2] The data and judgments were not entered directly into the Expect Choice software because the IBM team leaders did not have direct access to the software. The EC software and model resided on a personal home computer and not an IBM asset.

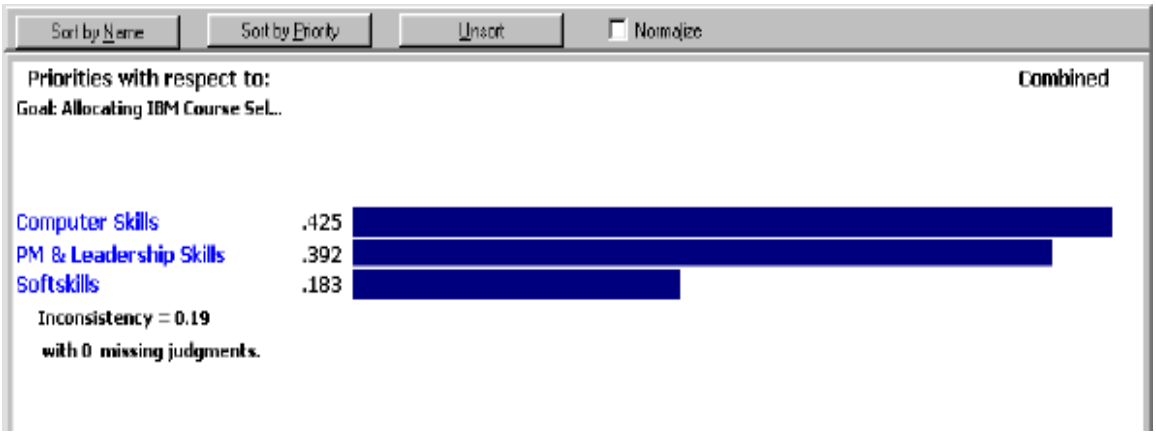



**Figure 5. Synthesized Data from Pair-wise Comparisons**

The ratio measures —.425 for Computer skills, .392 for PM & Leadership skills, and .183 for Softskills—show the actual percentage of each objective's importance to the goal. A graphical representation (green/gray boxes) of these numbers is also reflected on the Expert Choice hierarchy shown in Figure 3.

### Alternatives' Contributions

The contribution of each alternative with respect to each of the lowest level sub-objective was assessed using a rating scale shown in Figure 6. The ratio scale priorities of the ratings intensities were derived during a group meeting with the four team leaders (and not on an individual basis) using graphical pair-wise comparisons. The group setting ensured that each team leader understood that each alternative (course) was to be evaluated on its effectiveness on providing the required skill. The intensities would range from *Very Effective* to *Not Effective*. Figure 6 shows the six intensities and their numerical priorities used to evaluate the alternatives.

| ***Intensity Name*** | ***Priority*** |
|---|---|
| **Very Effective**: This course will be very effective in improving the employee skills | 1.000 |
| **Effective**: This course will be effective in improving the employees skills | 0.930 |
| **Moderately Effective**: This course will be moderately effective in improving the employees skills | 0.560 |
| **Somewhat Effective**: This course will be somewhat effective in improving the employees skills | 0.380 |
| **Not Very Effective**: This course will not be very effective in improving the employees skills | 0.050 |
| **Not Effective**: This course will not improve the employees skills | 0.000 |

**Figure 6. Intensities and Their Priorities for Assessing Alternatives**

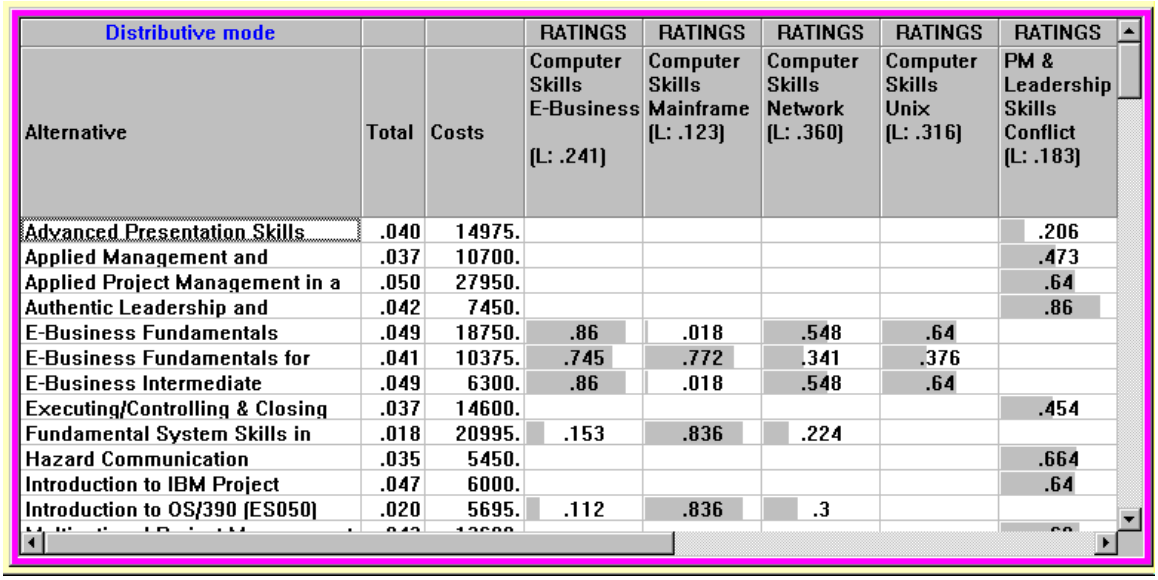
The team leads then performed privately (not in the group meeting) individual assessments of how well each course (alternative) would provide the required skills (sub-objective). Each team leader performed this function by filling out an individual questionnaire and rated each alternative using the rating scale. As shown Figure 7 the PM Team Leader reviewed each course and rated it using the intensities rating. As an example the alternative *Project Management Certification* course was rated *Moderately* to *Very Effective* in the PM & Leadership skills sub-objectives and rated *Not Very Effective* in the Softskills sub-objectives. The team leaders continued to rate each alternative using the intensity ratings.

| | RATINGS | RATINGS | RATINGS | RATINGS | RATINGS | RATINGS |
|---|---|---|---|---|---|---|
| Alternative | PM & Leadership Skills Conflict (L: .233) | PM & Leadership Skills Leadership (L: .572) | PM & Leadership Skills Planning & Scheduling (L: .124) | PM & Leadership Skills Tools (L: .071) | Softskills Organizatio (L: .069) | Softskills Presentatio (L: .563) |
| Multinational Project Management | Effective: | Moderately | Effective: | Moderately | Not Very | Somewhat |
| Network for OS/390 Implementation | Not | Not | Not | Not | Not | Not |
| Networking and Negotiating - Career | Very | Effective: | Not Very | Not Very | Somewhat | Somewhat |
| OS/390 Facilities (ES150) | Not | Not | Not | Not | Not | Not |
| OS/390 Installation (ES41A) | Not | Not | Not | Not | Not | Not |
| Presentation Skills (E5062) | Somewhat | Somewhat | Somewhat | Somewhat | Somewhat | Very |
| Project Leadership: The Personal Side | Very | Very | Moderately | Moderately | Somewhat | Somewhat |
| Project Management Certification | Moderately | Effective: | Moderately | Moderately | Not Very | Not Very |
| Project Management Fundamentals | Effective: | Effective: | Very | Moderately | Not Very | Not Very |
| UNIX Advanced Topics (DN151) | Not | Not | Not | Not | Not | Not |
| UNIX Fundamentals (WBT7022B) | Not | Not | Not | Not | Not | Not |
| UNIX Intermediate Topics (WBT7023B) | Not | Not | Not | Not | Not | Not |

**Figure 7: Individual Assessment of Contribution**

Once each alternative was rated (by completion of the individual questionnaire), the information was entered into Expert Choice[3], where the priorities were synthesized (combined together) to establish their contributions to the sub-objectives, as shown in the data grid in Figure 8.

[3] Again, the data and judgments were not entered directly into the Expect Choice software because the IBM team leaders did not have direct access to the software. The EC software and model resided on a personal home computer and not an IBM asset.



| Distributive mode | | | RATINGS | RATINGS | RATINGS | RATINGS | RATINGS |
|---|---|---|---|---|---|---|---|
| Alternative | Total | Costs | Computer Skills E-Business (L: .241) | Computer Skills Mainframe (L: .123) | Computer Skills Network (L: .360) | Computer Skills Unix (L: .316) | PM & Leadership Skills Conflict (L: .183) |
| Advanced Presentation Skills | .040 | 14975. | | | | | .206 |
| Applied Management and | .037 | 10700. | | | | | .473 |
| Applied Project Management in a | .050 | 27950. | | | | | .64 |
| Authentic Leadership and | .042 | 7450. | | | | | .86 |
| E-Business Fundamentals | .049 | 18750. | .86 | .018 | .548 | .64 | |
| E-Business Fundamentals for | .041 | 10375. | .745 | .772 | .341 | .376 | |
| E-Business Intermediate | .049 | 6300. | .86 | .018 | .548 | .64 | |
| Executing/Controlling & Closing | .037 | 14600. | | | | | .454 |
| Fundamental System Skills in | .018 | 20995. | .153 | .836 | .224 | | |
| Hazard Communication | .035 | 5450. | | | | | .664 |
| Introduction to IBM Project | .047 | 6000. | | | | | .64 |
| Introduction to OS/390 (ES050) | .020 | 5695. | .112 | .836 | .3 | | |

**Figure 8. Data Grid**

The entries within the columns represent the objectives (or skills) and are a numerical average of the intensities provided by the team leaders. The value in the Total columns represents a ratio scale measurement of how much each course is expected to contribute toward the overall goal. Therefore, for each alternative, the Total column can be attributed as being the amount of total benefit that can be realized for selecting this course. The Cost column is dollar expense associated with selecting this alternative. This cost is the private price listed in the course description and is the expense for an IBM site to host this Global Campus course at their location. The next step was to determine a way of allocating which combination of courses is best.

Three different approaches were used to solve the allocation of the courses to both maximize the overall benefit and adhere to the imposed and fixed budget. The relative ease of solving the resource allocation project using the three different methods would lend credence to the one solution as being the most effective. The first method is based on Max-Benefit, the second method is based on Benefit/Cost ratios, and the final method is a feature of the Microsoft Excel (setup by Expert Choice software) called *Solver*.

## Max-Benefit

In Figure 9, the alternatives have been sorted based on their benefit (Benefit column—shown in descending order from highest benefit). A Max-Benefit for course selection is determined by selecting courses with the highest benefit and then continuing until the $200,000 budget is depleted.

| *Alternative* | *Benefits* | *Costs* | *Cum Benefit* | *Cum Cost* |
|---|---|---|---|---|
| Using OS/390 as your E-Business Server (ES76A) | 0.053 | 14950 | 0.053 | 14950 |
| Applied Project Management in a Customer Environment (21802) | 0.050 | 27950 | 0.103 | 42900 |
| E-Business Fundamentals (WHV7251C) | 0.049 | 18750 | 0.152 | 61650 |
| E-Business Intermediate (WHV7254C) | 0.049 | 6300 | 0.201 | 67950 |
| Project Leadership: The Personal Side of Project Management (PE142) | 0.049 | 9535 | 0.250 | 77485 |
| Introduction to IBM Project Management Tool Suite (D2188) | 0.047 | 6000 | 0.297 | 83485 |
| Network for OS/390 Implementation (CB695) | 0.045 | 13950 | 0.342 | 97435 |
| Multinational Project Management (22105) | 0.043 | 13600 | 0.385 | 111035 |
| Authentic Leadership and Communication (ZBEV135C) | 0.042 | 7450 | 0.427 | 118485 |
| Presentation Skills (E5062) | 0.042 | 8650 | 0.469 | 127135 |
| E-Business Fundamentals for Z-Series and OS/390 (WHV7253) | 0.041 | 10375 | 0.510 | 137510 |
| Project Management Fundamentals (21788) | 0.041 | 23875 | 0.551 | 161385 |
| Advanced Presentation Skills (PE164) | 0.040 | 14975 | 0.591 | 176360 |
| Networking and Negotiating – Career Communication Skills (ZRA0105C) | 0.040 | 2000 | 0.631 | 178360 |
| UNIX Advanced Topics (DN151) | 0.038 | 9000 | 0.669 | 187360 |
| UNIX Intermediate Topics (WBT7023B) | 0.038 | 9000 | **0.707** | **196360** |
| Using Advanced Function Presentation (K2502) | 0.038 | 23785 | 0.745 | 220145 |
| Applied Management and Execution Using PM Tool Suite (21883) | 0.037 | 10700 | 0.782 | 230845 |
| Executing/Controlling & Closing Projects Using PCB and MS Project (21885B) | 0.037 | 14600 | 0.819 | 245445 |
| UNIX Fundamentals (WBT7022B) | 0.036 | 9000 | 0.855 | 254445 |
| Hazard Communication (Right-to-Know) Training (XHV0932C) | 0.035 | 5450 | 0.890 | 259895 |
| Project Management Certification Program (ZBEVPM1C) | 0.034 | 25000 | 0.924 | 284895 |
| UNIX Shell Programming (DN206) | 0.030 | 15000 | 0.954 | 299895 |
| Introduction to OS/390 (ES050) | 0.020 | 5695 | 0.974 | 305590 |
| Fundamental System Skills in OS/390 (ES10A) | 0.018 | 20995 | 0.992 | 326585 |
| OS/390 Facilities (ES150) | 0.013 | 18595 | 1.005 | 345180 |
| OS/390 Installation (ES41A) | 0.012 | 23780 | 1.017 | 368960 |

**Figure 9. Max-Benefit Combination of Alternatives**

This method produced a course selection of 16 classes (show in yellow in Figure 9) at a total expense of $196,360 and a cumulative benefit of 0.707. The next section reviews the course selection using the Benefit/Cost ratio method.

## Benefit/Cost Ratio

In Figure 10, the alternatives are sorted based on a normalized Benefit/Cost ratio (B/C column—the benefit divided by cost and scaled up by 100,000 for ease of comparison. The B/C column is in descending order for each alternative). The maximum Benefit/Cost ratio for the courses is determined by selecting courses with the highest B/C ratio and again continuing to select courses until the $200,000 budget is depleted.

| *Alternative* | *Benefits* | *Costs* | *B/C* | *Cum Benefit* | *Cum Cost* |
|---|---|---|---|---|---|
| Networking and Negotiating – Career Communication Skills (ZRA0105C) | 0.040 | 2000 | 2.000 | 0.040 | 2000 |
| Introduction to IBM Project Management Tool Suite (D2188) | 0.047 | 6000 | 0.783 | 0.087 | 8000 |
| E-Business Intermediate (WHV7254C) | 0.049 | 6300 | 0.778 | 0.136 | 14300 |
| Hazard Communication (Right-to-Know) Training (XHV0932C) | 0.035 | 5450 | 0.642 | 0.171 | 19750 |
| Authentic Leadership and Communication (ZBEV135C) | 0.042 | 7450 | 0.564 | 0.213 | 27200 |
| Project Leadership: The Personal Side of Project Management (PE142) | 0.049 | 9535 | 0.514 | 0.262 | 36735 |
| Presentation Skills (E5062) | 0.042 | 8650 | 0.486 | 0.304 | 45385 |
| UNIX Advanced Topics (DN151) | 0.038 | 9000 | 0.422 | 0.342 | 54385 |
| UNIX Intermediate Topics (WBT7023B) | 0.038 | 9000 | 0.422 | 0.380 | 63385 |
| UNIX Fundamentals (WBT7022B) | 0.036 | 9000 | 0.400 | 0.416 | 72385 |
| E-Business Fundamentals for Z-Series and OS/390 (WHV7253) | 0.041 | 10375 | 0.395 | 0.457 | 82760 |
| Using OS/390 as your E-Business Server (ES76A) | 0.053 | 14950 | 0.355 | 0.510 | 97710 |
| Introduction to OS/390 (ES050) | 0.020 | 5695 | 0.351 | 0.530 | 103405 |
| Applied Management and Execution Using PM Tool Suite (21883) | 0.037 | 10700 | 0.346 | 0.567 | 114105 |
| Network for OS/390 Implementation (CB695) | 0.045 | 13950 | 0.323 | 0.612 | 128055 |
| Multinational Project Management (22105) | 0.043 | 13600 | 0.316 | 0.655 | 141655 |
| Advanced Presentation Skills (PE164) | 0.040 | 14975 | 0.267 | 0.695 | 156630 |
| E-Business Fundamentals (WHV7251C) | 0.049 | 18750 | 0.261 | 0.744 | 175380 |
| Executing/Controlling & Closing Projects Using PCB and MS Project (21885B) | 0.037 | 14600 | 0.253 | **0.781** | **189980** |
| UNIX Shell Programming (DN206) | 0.030 | 15000 | 0.200 | 0.811 | 204980 |
| Applied Project Management in a Customer Environment (21802) | 0.050 | 27950 | 0.179 | 0.861 | 232930 |
| Project Management Fundamentals (21788) | 0.041 | 23875 | 0.172 | 0.902 | 256805 |
| Using Advanced Function Presentation (K2502) | 0.038 | 23785 | 0.160 | 0.940 | 280590 |
| Project Management Certification Program (ZBEVPM1C) | 0.034 | 25000 | 0.136 | 0.974 | 305590 |
| Fundamental System Skills in OS/390 (ES10A) | 0.018 | 20995 | 0.086 | 0.992 | 326585 |
| OS/390 Facilities (ES150) | 0.013 | 18595 | 0.070 | 1.005 | 345180 |
| OS/390 Installation (ES41A) | 0.012 | 23780 | 0.050 | 1.017 | 368960 |

**Figure 10. Benefit/Cost Combination of Alternatives**

This method produced a course selection of 19 classes (show in yellow in Figure 10) at a total expense of $189,980 and a cumulative benefit of 0.781. This is an improvement in the number of courses selected by 15.7 percent (or 3 courses) but the budget is not as fully utilized as with the Max-Benefit method and the cumulative benefit has improved. For Max-Benefit, only $3,640 of the budget remains, but with Benefit/Cost $10,020 of the budget remains, an increase of under-utilized budget of 180 percent. The third course selection method, which uses *Solver*, is covered in the next section.

## Solver

*Solver* is an integer optimization method that determines the combination of alternatives that maximizes the total benefits while not exceeding the total constrained budget. Alternatives will be funded in whole, and cannot be partially or negativity funded. The DVS column shows which alternatives have been selected; a value of 1 indicates the alternative has been selected and a value of 0 indicates that the alternative has not been selected. If an alternative is selected (DVS column equal to 1) the funded benefit (F. Benefit column) and funded cost (F. Costs column) are displayed. The funded benefit column represents the sum of the benefit amounts for each funded alternative while the funded cost column represents the sum of the cost amounts for each funded alternative.

Additional constraints can be added, such as *musts* (alternative needs to be included) and *must nots* (alternative need not be included). However, discussions with the team leaders concluded that these constraints were not required and therefore not included within the model. Once the budget constraint of $200,000 was incorporated, *Solver* produced a final allocation, as shown in Figure 11.

| *Alternative* | *Benefits* | *Costs* | *DVS* | *F. Benefits* | *F. Costs* | *B/C* |
|---|---|---|---|---|---|---|
| Advanced Presentation Skills (PE164) | 0.040 | 14975 | 1 | 0.040 | 14975.0 | 0.26711 |
| Applied Management and Execution Using PM Tool Suite (21883) | 0.037 | 10700 | 1 | 0.037 | 10700.0 | 0.34579 |
| Applied Project Management in a Customer Environment (21802) | 0.050 | 27950 | 0 | 0.000 | 0.0 | 0.17889 |
| Authentic Leadership and Communication (ZBEV135C) | 0.042 | 7450 | 1 | 0.042 | 7450.0 | 0.56376 |
| E-Business Fundamentals (WHV7251C) | 0.049 | 18750 | 1 | 0.049 | 18750.0 | 0.26133 |
| E-Business Fundamentals for Z-Series and OS/390 (WHV7253) | 0.041 | 10375 | 1 | 0.041 | 10375.0 | 0.39518 |
| E-Business Intermediate (WHV7254C) | 0.049 | 6300 | 1 | 0.049 | 6300.0 | 0.77778 |
| Executing/Controlling & Closing Projects Using PCB and MS Project (21885B) | 0.037 | 14600 | 1 | 0.037 | 14600.0 | 0.25342 |
| Fundamental System Skills in OS/390 (ES10A) | 0.018 | 20995 | 0 | 0.000 | 0.0 | 0.08573 |
| Hazard Communication (Right-to-Know) Training (XHV0932C) | 0.035 | 5450 | 1 | 0.035 | 5450.0 | 0.64220 |
| Introduction to IBM Project Management Tool Suite (D2188) | 0.047 | 6000 | 1 | 0.047 | 6000.0 | 0.78333 |
| Introduction to OS/390 (ES050) | 0.020 | 5695 | 0 | 0.000 | 0.0 | 0.35119 |
| Multinational Project Management (22105) | 0.043 | 13600 | 1 | 0.043 | 13600.0 | 0.31618 |
| Network for OS/390 Implementation (CB695) | 0.045 | 13950 | 1 | 0.045 | 13950.0 | 0.32258 |
| Networking and Negotiating – Career Communication Skills (ZRA0105C) | 0.040 | 2000 | 1 | 0.040 | 2000.0 | 2.00000 |
| OS/390 Facilities (ES150) | 0.013 | 18595 | 0 | 0.000 | 0.0 | 0.06991 |
| OS/390 Installation (ES41A) | 0.012 | 23780 | 0 | 0.000 | 0.0 | 0.05046 |
| Presentation Skills (E5062) | 0.042 | 8650 | 1 | 0.042 | 8650.0 | 0.48555 |
| Project Leadership: The Personal Side of Project Management (PE142) | 0.049 | 9535 | 1 | 0.049 | 9535.0 | 0.51390 |
| Project Management Certification Program (ZBEVPM1C) | 0.034 | 25000 | 0 | 0.000 | 0.0 | 0.13600 |
| Project Management Fundamentals (21788) | 0.041 | 23875 | 0 | 0.000 | 0.0 | 0.17173 |
| UNIX Advanced Topics (DN151) | 0.038 | 9000 | 1 | 0.038 | 9000.0 | 0.42222 |
| UNIX Fundamentals (WBT7022B) | 0.036 | 9000 | 1 | 0.036 | 9000.0 | 0.40000 |
| UNIX Intermediate Topics (WBT7023B) | 0.038 | 9000 | 1 | 0.038 | 9000.0 | 0.42222 |
| UNIX Shell Programming (DN206) | 0.030 | 15000 | 1 | 0.030 | 15000.0 | 0.20000 |
| Using Advanced Function Presentation (K2502) | 0.038 | 23785 | 0 | 0.000 | 0.0 | 0.15976 |
| Using OS/390 as your E-Business Server (ES76A) | 0.053 | 14950 | 1 | 0.053 | 14950.0 | 0.35452 |
| | | | | 0.791 | 199285.0 | |
| | | | | | 200000.0 | |

**Figure 11. Solver Budget/Alternative Allocation**

The best selection of alternatives (courses) is highlighted in yellow. The red box shows the budget ($200,000) and the gray box shows the total funds used ($199,285) and the green box shows the cumulative benefit (0.791). The *Solver* method produced a course selection of 19 classes and at a total expense of $199,285 and cumulative benefit of 0.791. These results are an improvement over both the Max-Benefit and Benefit/Cost ratio methods. For *Solver,* only $715 of the budget remains—an improvement over both the Max-Benefit and Benefit/Cost ratio methods. In addition for *Solver* cumulative benefit is optimal at 0.791—an improvement of 110 percent over Max-Benefit and 101 percent over Benefit/Cost ratio method.

Although the IBM course allocation budget has been constrained to only $200,000 for the 2002 year, another feature within *Solver* is Optimize for Increasing Budgets. This feature produces a listing of courses, which provide the maximum benefit at various levels of funding up to the total amount necessary to

fund all courses. The Optimize feature produced the results found in Table 1 and Table 2 (see Appendix A). The budgets ranged from $2,000 (where only one course is funded) to $369,250 where all courses were funded. The *F* within the rows for an alternative means that this course was funded at this level of budget (the column). The table also contains the cumulative total benefit (Funded Benefit), which is the total benefit that can be realized for this particular level of funding. As the level of funding increased, the Funded Benefit also increased but not at the same rate until the maximum total benefit (1.017) and maximum budget ($369,250) are achieved when all courses have been selected.

As is shown in Figure 12, when the budget is constrained to $200,000 (the red line) the benefit realized (0.791) is 77.78% of the maximum total benefit (1.017). If the budget were to be increased (the blue line) by $169,250 (about 84.6 percent) to the maximum budget ($369,250) this results in an improvement of only 22.22 percent for the funded benefit, which is not a fair trade for the amount spent. If the budget was reduced to only $100,000 (the green line) or by 50 percent, the funded benefit realized would be (0.514) 50.54 percent of the maximum total benefit and is a decrease of 27.24 percent (from 77.78 percent — benefit realized at the budget of $200,000).

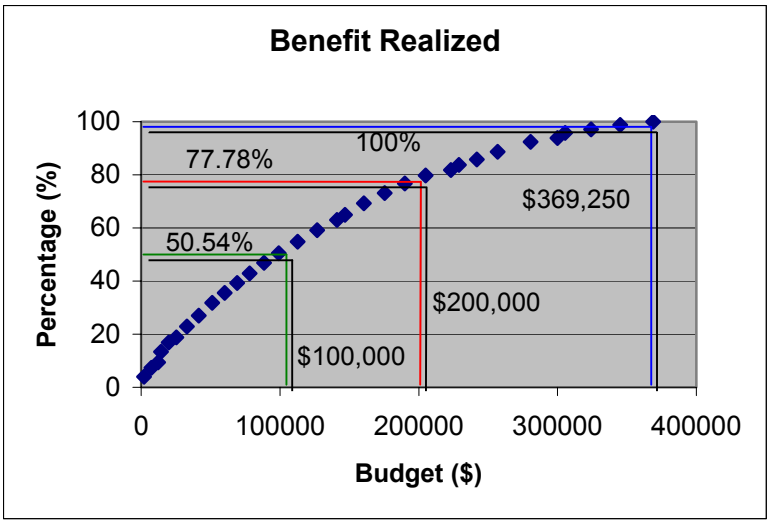



**Figure 12. Benefit Realized with Respect to Budget**

Therefore, increasing or decreasing the budget by some percentage does not guarantee the same increase or decrease within the benefit realized. A budget needs to be determined that provides the best allocation of resources resulting in the best possible benefit realized.

## Recommendation and Conclusion

DeWinde and Dutton recommend that IBM Global Services elect to offer the courses listed in Figure 11 (resulting from the *Solver* method*)*. These courses allow IBM Global Services to make the best use of its education funds that also meet the company's expected and desired course curriculum. The Max-Benefit and Benefit/Cost ratio did provide a good selection of courses and did provide to the team a better understanding of how resource allocations can be performed, but the optimal solution for maximization of benefit and costs were produced from the *Solver* method.

## Reaction

A meeting was held with the team leaders to review and discuss the recommendation for the IBM Global Campus course allocation. The team leaders were impressed with how this decision was modeled and then synthesized. The team leaders never considered that this type of decision-making could undergo a formal process such as AHP, and one commented that he thought the selection would occur by each team leader choosing a course and continuing round robin until the budget was used up. The team leaders reviewed the three methods used (Max-Benefit, Benefit/Cost ratio, and *Solver*) and have determined to use the results provided by the *Solver* method. Additional constraints (such as *musts* and *musts nots*) were not determined to be required because each team leader appeared to be satisfied that the allocation of courses achieved the stated objectives and appeared to have something for everyone. The budget constraint of $200,000 was discussed and understood that increases to this budget would only result in minimal increasing the total possible benefit. A presentation to the management team is scheduled for the Monthly Manager meeting in May (2001).

## Bibliography

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## Appendix A. Solver Optimization of Increasing Budget

| Alternatives/Budget | $2,000 | $7,450 | $13,145 | $15,145 | $20,595 | $26,290 | $33,740 | $42,390 | $51,390 | $60,390 | $69,390 | $78,390 | $88,765 | $99,465 | $113,065 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Advanced Presentation Skills (PE164) | | | | | | | | | | | | | | | |
| Applied Management and Execution Using PM Tool Suite (21883) | | | | | | | | | | | | | | F | F |
| Applied Project Management in a Customer Environment (21802) | | | | | | | | | | | | | | | |
| Authentic Leadership and Communication (ZBEV135C) | | F | | | | | F | F | F | F | F | F | F | F | F |
| E-Business Fundamentals (WHV7251C) | | | | | | | | | | | | | | | |
| E-Business Fundamentals for Z-Series and OS/390 (WHV7253) | | | | | | | | | | | | | F | F | F |
| E-Business Intermediate (WHV7254C) | | | F | F | F | F | F | F | F | F | F | F | F | F | F |
| Executing/Controlling & Closing Projects Using PCB and MS Project (21885B) | | | | | | | | | | | | | | | |
| Fundamental System Skills in OS/390 (ES10A) | | | | | | | | | | | | | | | |
| Hazard Communication (Right-to-Know) Training (XHV0932C) | | F | | | F | F | F | F | F | F | F | F | F | F | F |
| Introduction to IBM Project Management Tool Suite (D2188) | | | F | F | F | F | F | F | F | F | F | F | F | F | F |
| Introduction to OS/390 (ES050) | | | | | | F | F | F | F | F | F | F | F | F | F |
| Multinational Project Management (22105) | | | | | | | | | | | | | | | F |
| Network for OS/390 Implementation (CB695) | | | | | | | | | | | | | | | |
| Networking and Negotiating - Career Communication Skills (ZRA0105C) | F | F | | F | F | F | F | F | F | F | F | F | F | F | F |
| OS/390 Facilities (ES150) | | | | | | | | | | | | | | | |
| OS/390 Installation (ES41A) | | | | | | | | | | | | | | | |
| Presentation Skills (E5062) | | | | | | | | F | F | F | F | F | F | F | F |
| Project Leadership: The Personal Side of Project Management (PE142) | | | | | | | | | F | F | F | F | F | F | F |
| Project Management Certification Program (ZBEVPM1C) | | | | | | | | | | | | | | | |
| Project Management Fundamentals (21788) | | | | | | | | | | | | | | | |
| UNIX Advanced Topics (DN151) | | | | | | | | | | | F | F | F | F | F |
| UNIX Fundamentals (WBT7022B) | | | | | | | | | | | | F | F | F | F |
| UNIX Intermediate Topics (WBT7023B) | | | | | | | | | | F | F | F | F | F | F |
| UNIX Shell Programming (DN206) | | | | | | | | | | | | | | | |
| Using Advanced Function Presentation (K2502) | | | | | | | | | | | | | | | |
| Using OS/390 as your E-Business Server (ES76A) | | | | | | | | | | | | | | | |
| Fund Benefit | 0.04 | 0.075 | 0.096 | 0.136 | 0.171 | 0.191 | 0.233 | 0.275 | 0.324 | 0.362 | 0.4 | 0.436 | 0.477 | 0.514 | 0.557 |

## Table 1. Course Allocation for Increasing Budget Amounts (Part 1)

| Alternatives/Budget | $127,015 | $141,615 | $147,310 | $160,910 | $175,510 | $190,110 | $205,110 | $223,705 | $229,400 | $247,995 | $262,995 | $281,590 | $300,185 | $305,880 | $324,475 | $345,470 | $369,250 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Advanced Presentation Skills (PE164) | | | | | F | F | F | F | F | F | F | F | F | F | F | F | F |
| Applied Management and Execution Using PM Tool Suite (21883) | F | F | F | F | F | F | F | F | F | F | F | F | F | F | F | F | F |
| Applied Project Management in a Customer Environment (21802) | | | | | | | | | | F | F | F | F | F | F | F | F |
| Authentic Leadership and Communication (ZBEV135C) | F | F | F | F | F | F | F | F | F | F | F | F | F | F | F | F | F |
| E-Business Fundamentals (WHV7251C) | | F | F | F | F | F | F | F | F | F | F | F | F | F | F | F | F |
| E-Business Fundamentals for Z-Series and OS/390 (WHV7253) | F | F | F | F | F | F | F | F | F | F | F | F | F | F | F | F | F |
| E-Business Intermediate (WHV7254C) | F | F | F | F | F | F | F | F | F | F | F | F | F | F | F | F | F |
| Executing/Controlling & Closing Projects Using PCB and MS Project (21885B) | | | | | | F | F | F | F | F | F | F | F | F | F | F | F |
| Fundamental System Skills in OS/390 (ES10A) | | | | | | | | | | | | | | | | F | F |
| Hazard Communication (Right-to-Know) Training (XHV0932C) | F | F | F | F | F | F | F | F | F | F | F | F | F | F | F | F | F |
| Introduction to IBM Project Management Tool Suite (D2188) | F | F | F | F | F | F | F | F | F | F | F | F | F | F | F | F | F |
| Introduction to OS/390 (ES050) | F | | F | F | F | F | F | | F | F | F | F | | F | F | F | F |
| Multinational Project Management (22105) | F | | | F | F | F | F | F | F | F | F | F | F | F | F | F | F |
| Network for OS/390 Implementation (CB695) | F | F | F | F | F | F | F | F | F | F | F | F | F | F | F | F | F |
| Networking and Negotiating - Career Communication Skills (ZRA0105C) | F | F | F | F | F | F | F | F | F | F | F | F | F | F | F | F | F |
| OS/390 Facilities (ES150) | | | | | | | | | | | | | | | F | F | F |
| OS/390 Installation (ES41A) | | | | | | | | | | | | | | | | | F |
| Presentation Skills (E5062) | F | F | F | F | F | F | F | F | F | F | F | F | F | F | F | F | F |
| Project Leadership: The Personal Side of Project Management (PE142) | F | F | F | F | F | F | F | F | F | F | F | F | F | F | F | F | F |
| Project Management Certification Program (ZBEVPM1C) | | | | | | | | | | | | | F | F | F | F | F |
| Project Management Fundamentals (21788) | | | | | | | | F | F | F | F | F | F | F | F | F | F |
| UNIX Advanced Topics (DN151) | F | F | F | F | F | F | F | F | F | F | F | F | F | F | F | F | F |
| UNIX Fundamentals (WBT7022B) | F | F | F | F | F | F | F | F | F | F | F | F | F | F | F | F | F |
| UNIX Intermediate Topics (WBT7023B) | F | F | F | F | F | F | F | F | F | F | F | F | F | F | F | F | F |
| UNIX Shell Programming (DN206) | | | | | | | F | F | F | | F | F | F | F | F | F | F |
| Using Advanced Function Presentation (K2502) | | | | | | | | | | | | F | F | F | F | F | F |
| Using OS/390 as your E-Business Server (ES76A) | | F | F | F | F | F | F | F | F | F | F | F | F | F | F | F | F |
| Funded Benefit | 0.602 | 0.641 | 0.661 | 0.704 | 0.744 | 0.781 | 0.811 | 0.832 | 0.852 | 0.872 | 0.902 | 0.94 | 0.954 | 0.974 | 0.987 | 1.005 | 1.017 |

**Table 2. Course Allocation for Increasing Budget Amounts (Part 2)**