122nd ASEE Annual Conference & Exposition
June 14 - 17, 2015
Seattle, WA
Making Value for Society
Paper ID #13623

Interactive Simulation for Introducing Industrial Engineering

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Abstract

This study represents a simulation-based Industrial Engineering (IE) challenge activity in an introduction-to-engineering course. The course is developed for incoming freshman students to raise their understanding of IE and three other engineering disciplines offered at Quinnipiac University. In the IE segment of the course students are introduced to the nature of the discipline and its wide applications through four introductory topics, two of which are Operations Research (OR) and Human Factors (HF). This is followed by an “IE Challenge” which incorporates techniques in OR and HF to make the students experience an example of a real-life problem requiring optimization and human-centered design. The students work in teams to create comfortable seating and an efficient route for an airplane given a revenue maximization goal. Upon completion the students become familiar with the Travelling Salesman Problem, Knapsack Problem, and working with anthropometric data for different genders and ethnic groups. The information about the students’ perception and attitude on IE is collected at the beginning and the end of the semester to investigate an increase of knowledge in IE as well as students’ preference in choosing it as their major.

1. Introduction

Simulations are widely used in engineering education as one of the most efficient and effective ways of teaching and learning engineering topics (Antao et al.)[1]. Simulation-based approaches are developed and used to provide an interactive, cooperative, and experimental learning environment where engineering students acquire practical experiences and master a specific skill. In addition, well-structured simulations encourage students to develop their computational, analytical, and teamwork skills. Students are also presented the opportunity to improve their professionalism and ethical values through these simulations. In Industrial Engineering (IE) teachings, where a variety of tools are used to design, improve, and manage integrated systems, simulation-based approaches become an important piece in the learning environment.

There are a number of publications in literature that analyze the impact of simulation-based teaching environments. A vast majority supports the experiential learning theory proposed by Kolb [2]. In Umble & Umble [3], researchers utilize in-class simulation exercises for supply chain and inventory management principles. These exercises provide opportunities for in-class student discussions that ensure the students’ understanding of inventory management problems. In Hartman et al.[4], a group of instructors use the Internet-based *Harvard Business School Press Project Management Simulation* in their courses to help students better understand the concepts of project management. The study shows that they are able to increase students’ understanding of project management through a role-playing simulation that requires students to apply main concepts in dynamic environments. Both of the aforementioned studies are aligned with Kolb & Kolb[5] which states learning to be a holistic process of adaptation to the world. Lastly, a five-phase design science methodology is suggested in Wu & Sankar[6] to develop an experiment in order to solve a real-world problem that improves students’ learning experience. They implement the method in an undergraduate classroom and have students interact with new technologies.

They conclude that similar projects have the potential to narrow the knowledge gap between academics and practitioners.

There is also an immense amount of research to compare simulation-based teaching environments and traditional tools in pedagogy. This research is especially present in laboratory components of engineering courses. Most of the researchers conclude that introducing simulation-based methods enhances the teaching environment and provides opportunities for students to improve their learning techniques. However, research also indicates that traditional methods should remain as the major part of teaching. In Weisner & Lan[7] student learning is compared in engineering laboratories on process control and monitoring. Computer-based simulation experiments are used as teaching tools for one group of students while another group uses tactile experiments. The study reveals that student learning is not adversely affected by computer-based experiments. A similar comparison study is reported in Olin et al. [8], where simulation-based laboratory components are introduced a group of electrical engineering students and their learning performances are assessed against a control group. The group that used simulation-based environments outperformed the control group. The study in Fraser et al. [9] also reports significant improvements in students' learning when the instructors use computer simulations in fluid mechanics.

With this theory in mind, we developed a spreadsheet-based simulation model as the IE challenge activity in an introduction-to-engineering course. The purpose of this user-friendly simulation tool was to raise students' understanding of IE and introduce a few common IE tools. This challenge allowed the students to directly apply the Operations Research and Human Factors concepts learned in the IE lessons of the course. The scenario behind the challenge was the realistic case of designing a commercial passenger airplane and scheduling its operations. Rather than a traditional test on the IE material presented during the three IE lessons, we evaluated the students based on their integrated knowledge and its application to a real-world scenario.

2. Project Overview

Quinnipiac University is a medium-sized private university in northeastern United States. Within the engineering program, a 3-credit hour Introduction to Engineering course is offered; it is required for all engineering freshman students. The goals of the course are twofold: (a) to explain the basic practice of engineering, impact on society, skills employed, and professional/ethical responsibilities; and (b) to summarize the knowledge bases, skills, problem types, and analysis techniques of the four engineering disciplines offered at the university. By raising students' understanding of engineering disciplines, the course enhances their ability to make an informed decision about pursuing an engineering major.

In the latest offering of the course, and in addition to the lessons focused on general topics (such as ethics, engineering design process, and entrepreneurship), there were four 75-minute lessons that provided additional knowledge in four engineering disciples, one being IE. A total of 72 students were introduced to the nature of IE and its wide applications as well as the topics of Operations Research (OR) and Human Factors (HF). The students then had a week to prepare for the "IE Challenge."

An activity incorporating both areas of OR and HF was designed to make the students aware of a real-life problem requiring the optimization of people, processes, and products by improving the current integrated systems. Complete details of the IE Challenge, including the scenario, the input data, and the interactive worksheet, is provided in the Appendix. The students worked in teams of four and were in charge of certain aspects of the design and operations of a commercial passenger airplane. The groups were given a revenue maximization goal that they had to work with during the challenge. In this exercise, the exterior dimensions of the airplane were set but the students were able to design the seats in as effective of a way as possible. This presented the first optimization decision. Given a fixed total width of the plane, it was clear that wide seats were good for passengers but bad for business and the reverse was true for narrow seats. There were penalties and rewards for the number of passengers loaded, passenger discomfort, seat manufacturing cost, and opportunity cost of space.

There were ten global destinations for the plane, each a certain distance away from the home base, and each with a certain reward. Global destinations introduced the concept of ethnic groups when considering anthropometric data for seat design. Given the limited fuel capacity of the plane, only a certain number of the cities could be visited, turning the Challenge into a combination of a Travelling Salesman Problem (TSP) and Knapsack Problem (KP), thus presenting the students with an optimization decision. The TSP is a fundamental combinatorial optimization problem with numerous applications in OR. It can be described as the problem of finding a minimum total distance of visiting *n* cities, starting and ending in the same city and visiting the other cities exactly once (Rego et al.)[10]. The classic KP consists of a set of items whose values and weights are deterministic; the objective is to find a subset of items to put in the knapsack in order to maximize the total values without incurring overflow (Chen and Ross)[11].

An interesting dilemma arose regarding strategy. Students could select the travel route to maximize rewards and design the seats according to the planned destinations and the characteristics of the associated ethnic groups. Alternatively, they could optimize the seat designs for the airplane interior and select the global destinations accordingly.

The project was designed with certain objectives in mind. Freshman students were exposed to IE for the very first time and it was imperative for them to learn about two key areas of the field: efficient operations and human-centered design. They got exposed to TSP and KP, as well as anthropometric data for genders and ethnic groups. In addition, students had to consider trade-offs in their decision making process in a real-world problem setting and became familiar with design and technical terms, as well as business concepts. In this week-long exercise they worked in teams and at the end of the challenge they had to make an oral presentation to describe their solution strategies, which improved their teamwork and communication skills. The students' performances were based on the highest revenue achieved as well as their presentation skills.

Two surveys were distributed to the students in order to validate the value of the IE challenge. The first survey was designed to measure the increase in students' perception on Industrial Engineering. Two questions are asked at the beginning and at the end of the semester:

(a) What does an Industrial Engineer do?
(b) How confident are you with your answer?

The first question was an open-ended question and it required a short sentence. We provided a five point Likert scale for the second question where 1 represents "Not confident at all" and 5 represents "Very confident." This measured the student's perceived knowledge. The students' actual knowledge was measured when we evaluated the answers of the first question and map them to a five point Likert scale where 1 represents "Not correct at all" and 5 represents "Completely correct". The results are displayed in Figure 1 where responses to the first and second questions are displayed on the X and Y axis, respectively. Each dot represents a single student's response. It is important to track the number of responses; therefore, points that would otherwise be overlaid are displayed closely alongside each other. At the start of the term, the majority of the students (84%) knew very little (1 or 2, out of 5) about what an IE does. At the end of the term, the majority of the students (91%) have acquired a true understanding of the engineering discipline (3 or above, out of 5). This improvement is clear graphically where the majority of the points fall in the upper right quadrant.

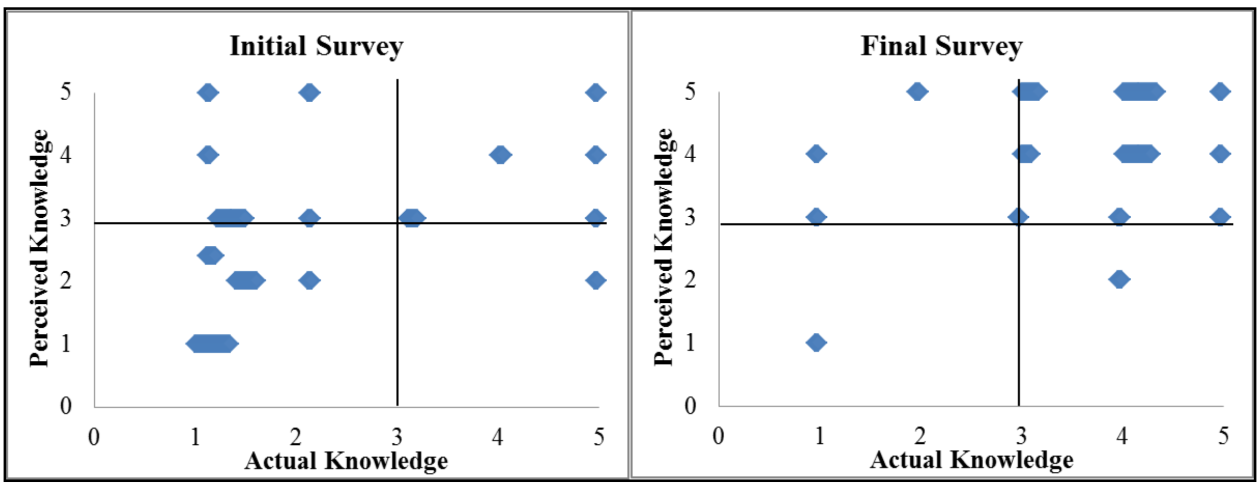

Figure 1: Students' perceived and actual knowledge about an IE career

The second survey was designed to receive feedback from students and identify any points that had to be improved. We asked the following five open-ended questions and categorized the answers:

(a) What do you think were the objectives of the IE Challenge?
(b) What were some INITIAL concerns you had with the project?
(c) What were some concerns you had AFTER completing the project?
(d) What were some outcomes/take-aways of the IE challenge for you?
(e) If there is something you would change about the IE challenge, what would it be?

3. Results

Student responses to the second survey are categorized; the results are displayed in Table 1. Unique responses that cannot be placed in existing categories are grouped as "other". There are many interpretations that can arise from the summary data. Overall, the majority of the students enjoyed the challenge and their feedback aligned with the initial expectations of the instructors at the design stage. Most of the students felt as though they had a much better understanding of the nature of IE after completing the IE Challenge. A few students felt that the challenge helped them apply what they learned prior to the challenge while others felt that they were not prepared with enough background information to finish the IE challenge effectively. Along with a better understanding of what IE's actually do, the students were also able to better appreciate the importance of presentation skills and teamwork after their experience. Team work and presentations skills are extremely important for professional engineers in any discipline (also included in ABET student outcomes a-k), so it is exciting to see that this exercise will prepare them for their future whether or not they choose the IE path.

Table 1: Tabulated survey results

What do you think were the objectives of the IE Challenge?	
To understand what IEs do and the challenges they face	51%
To understand IE business concepts (e.g. maximizing profit, problem solving, data analysis)	26%
To improve teamwork and communication skills	11%
Other	12%

What were some INITIAL concerns you had with the project?	
Concerns with finding the best solution strategy	33%
Concerns with the large amount on information and detail provided	23%
Concerns with teamwork and presentation skills	12%
Concerns with the amount of required work	6%
Concerns with the given time frame for completion	6%
Other/None	18%

What were some concerns you had AFTER completing the project?	
Concerns with achieving the best result	45%
Concerns with the chosen solution strategy	22%
Concerns with teamwork and presentation skills	18%
Other/None	15%

What were some outcomes/take-aways of the IE challenge for you?	
Better understood what an IE does and challenges they face	42%
Learned the value of teamwork and presentation skills	19%
Understood that there are different ways of thinking/developing strategies for engineering problems	15%
Used and optimized all factors to arrive at the best results	14%
Other	11%

If there is something you would change about the IE challenge, what would it be?	
No changes	45%
Make it more challenging	14%
Allow more solution options	12%
Provide more instructions/background information	6%
More guidance for the presentations	6%
Make it an individual project	3%
Other	14%

Overall, students were satisfied with how the IE Challenge turned out. Although the majority of them were intimidated at first, many of those students said that they would not change anything about the IE challenge. On the other hand, there are those who think the challenge should in fact be more challenging. It was pointed out that the Excel sheet, with built-in macros to perform the calculations for the students, made guesswork easy. Students could check different routes and seat sizes to come up with the best profit instead of applying what was learned in class. Other student suggestions included making the project an individual one, to create more destinations and seat design options, and creating several Excel sheets with altered information and/or requirements so that it will not be easy for students to copy answers from another group. Another interesting suggestion was to make the assignment more relevant by somehow applying the challenge to the students' personal lives. An example of this was figuring out a new system for the university inter-campus shuttle buses in order to improve the flow of students from one destination to another. While there are those who think the project was too easy and those who thought it was just right, there are students who still found it a bit too difficult. Overall, these students felt as though they needed more background information on how to handle the project as well as more instruction on what to include in the presentation. This group does not take up a large part of the overall student body, but it is still important to make sure all students have a good understanding on what is expected from them.

Various parts of the IE Challenge were received by students in different ways. While the majority of the student body felt that the objective was to get a sense of IE as a whole, some of them thought the objective was for them to learn to work in a team and others felt that it was finding the lowest cost of their decisions. This range could come from different causes because each student had their own experiences with the project. Working in a team was a large part of the challenge, and if a particular group decided to designate interior design of the plane to one person, flight path to another, and overall cost to a third, each one of those team members may have a different view on what the main objective is. In the end, no matter how the student interpreted their take-away points, they were all able to learn something, whether it be better communication skills or a general understanding of what IE is.

We can confidently make an inference from comparing the initial and final surveys that there was a lot learned about IE. At the start of the term, the strong majority of the students had very limited knowledge on what an industrial engineer does. They were cognizant of their unawareness. As a result, most of the data points fall in the bottom left quadrant of the Figure 1-Initial Survey. By the end of the term, after the students go through the IE lessons and apply the concepts in the IE Challenge, the strong majority have a reasonably good knowledge about an IE career. This is evident in the majority of the data points falling in the upper right quadrant of Figure 1-Final survey. Therefore, the IE Challenge, as a culmination of the IE lesson materials, has certainly achieved what it was designed to accomplish.

4. Conclusion

A hands-on, realistic project is used to illustrate the nature of Industrial Engineering in an introduction-to-engineering freshman-level course. Student teams are tasked with designing the seat widths of a passenger airplane as well as determining the travel route. Both IE subfields of

Human Factors and Operations Research have a role in this exercise. Seat design involves the usage of anthropometric data and the awareness of gender and ethnic differences. Selecting the optimal travel route, given a limited fuel capacity, demonstrates the concepts of the Travelling Salesman Problem as well the Knapsack Problem to the students.

Surveys taken after the activity demonstrate that most students think of the Industrial Engineering Challenge as a way to better understand what industrial engineers do as well as the challenges they face in the professional field. This project provides the students the experience to understand IE and, specifically, Operations Research and Human Factors. The multiple aspects of this project allow students to possibly find an area in IE that they will be interested in, whether it be operations research, human factors or another topic not explicitly present. The IE Challenge proves to be a great introductory way for students to see the complexity of everyday situations an IE experiences that students would not have ever noticed before.

References

1. Antao, B., Brodersen, A., Bourne, J., & Cantwell, J. (1992). Building Intelligent Tutorial Systems for Teaching Simulation in Engineering Education. *IEEE Transactions on Education*, *35*(1), 50-56.
2. Kolb, D.A. (1984). *Experiential Learning: Experience as the Source of Learning and Development.* New Jersey: Prentice-Hall.
3. Umble, E. and Umble, M. (2013). Utilizing a Simulation Exercise to Illustrate Critical Inventory Management Concepts. *Decision Science Journal of Innovative Education, 11*(1), 13-21
4. Hartman, N.S., Watts, C.A., and Trevelen, M.D. (2013). Appreciating the Complexity of Project Management Execution: Using Simulation in the Classroom. *Decision Sciences Journal of Innovative Education*, 323-334
5. Kolb, A. Y., & Kolb, D. A. (2005). Learning Styles and Learning Spaces: Enhancing Experiential Learning in Higher Education. *Academy of Management Learning & Education*, *4*(2), 193-212.
6. Wu, Y., and Sankar, C.S. (2013). Impact of Hands-On Research Experience on Students' Learning in an Introductory Management Information System Course. *Decision Sciences Journal of Innovative Education*, *11*(4), 335-358.
7. Wiesner, T.F., and Lan, W. (2004). Comparison of Student Learning in Physical and Simulated Unit Operations Experiments. *Journal of Engineering Education*, *93*(3), 195-204.
8. Olin, C., Bourne, J.R., Mosterman, P.J, and Brodersen, A.J. (2002). The Effectiveness of Learning Simulations for Electronic Laboratories. *Journal of Engineering Education*, *91*(1), 81-87.
9. Fraser, D.M., Pillay, R., Tjatindi, L. and Case, J.M. (2007). Enhancing the Learning of Fluid Mechanics Using Computer Simulations. *Journal of Engineering Education*, *96*(4), 381-388.
10. Rego, C., Gamboa, D., Glover, F., Osterman, C. (2011). Traveling Salesman Problem Heuristics: Leading Methods, Implementations and Latest Advances. *European Journal of Operational Research*, *211*, 427-441.
11. Chen, K., Ross, S.M. (2014). An Adaptive Stochastic Knapsack Problem. *European Journal of Operational Research*, *239*, 625-635.

Appendix: Project Document and Screenshots

<u>**QA Flight 110**</u>

You and three colleagues are a world-renowned team of industrial engineers. You have been tasked with the following: use your expertise in human factors and operations research to design the seats of an airplane and devise the flight schedule to optimally take passengers across several destinations.

Your flight originates in Berlin, Germany and must end there as well. There are nine possible destinations to visit and there are many eager passengers waiting to board Quinnipiac Airlines, flight 110 at each location. You may only visit each location once. Each destination has a reward associated with it upon your arrival. However, it is quite unlikely for the airplane to be able to make every destination due to the fuel limitations (6,000 miles). Your goal is to maximize the revenue for QA110.

The destinations have different distances from Berlin. You will use your expertise in operations research to make a trade-off between the associated rewards and costs. Table 1 displays the rewards (in Dollars) associated with each location and the distances (in 100s of miles) between them:

Table 1: Destination Rewards and Corresponding Distances

	reward	**Berlin**	**Vienna**	**Budapest**	**Zurich**	**Paris**	**Istanbul**	**Cairo**	**Beirut**	**Houston**	**Rio De Janeiro**
Berlin		0	3	4	5	6	7	8	9	10	11
Vienna	3,000		0	5	6	7	8	9	10	11	12
Budapest	3,000			0	7	8	9	10	11	12	13
Zurich	3,000				0	9	10	11	12	13	14
Paris	3,000					0	11	12	13	14	15
Istanbul	5,000						0	13	14	15	16
Cairo	5,000							0	15	16	17
Beirut	5,000								0	17	18
Houston	7,000									0	19
Rio De Janeiro	7,000										0

The external body of the airplane has been designed and completed. But the interior awaits your expertise. Use your knowledge in ergonomics to specify the seat widths. The interior has a total width of 430 cm. Given the fact that you will need at least one aisle (50 cm), you have 380 cm to place as many seats as you deem necessary. Be cognizant of the following as you design the cabin interior:

- The seat must have a minimum width of 38 cm and a maximum width of 65 cm,
- The seat widths can vary between the rows but not within the rows,
- Each seat has a fixed cost of $100,
- Each seat has a variable cost of $3/cm for any width larger than 38 cm,

- There is a penalty cost of $2/cm for any space unused in the allotted 380 cm,
- If the interior space is designed to be cramped, the passengers feel uncomfortable and this is bad for business. As a result, a penalty cost of $10/cm is associated with the seat's inadequacy.
- There is a $30 reward for every passenger comfortably seated,
- At each location, all passengers previously boarded on QA110 disembark; new passengers from that particular location board the plane,
- Given the minimum leg room and the total length of the airplane, the number of rows is fixed at 10.
- At each destination, there are 100 eager passengers waiting to board QA110. They are ready in the terminal, pre-arranged into 10 rows of ten people. They will be matched one-to-one between their pre-arranged location in the terminal and seat assignment on the plane. For example, the passenger waiting in position 9 in row 3 at the terminal will be assigned to seat 9 in row 3 on the plane. If no such seat exists due to your seat design, this person cannot board.
- Being unable to offer the passengers a seat is bad for reputation. Consequently, Quinnipiac Airlines is penalized $100 for each passenger unable to board,
- Anthropometric data for shoulder width of various populations are provided in Table 2.

Table 2: Shoulder width (in cm) of various populations

	Male			**Female**		
	5th percentile	**50th percentile**	**95th percentile**	**5th percentile**	**50th percentile**	**95th percentile**
German	42.0	46.2	49.9	39.1	43.2	46.9
Austrian	41.6	45.5	49.0	38.4	42.5	46.1
Hungarian	41.3	45.0	48.8	38.2	42.1	45.8
Swiss	41.5	45.2	48.9	38.2	42.2	45.8
French	41.4	45.1	48.8	38.1	42.1	45.7
Turkish	42.8	47.1	50.7	39.7	44.0	47.3
Egyptian	42.2	46.8	50.4	39.1	43.4	46.4
Lebanese	42.3	46.9	50.5	39.4	43.4	46.4
American	43.6	48.3	51.7	39.9	45.0	48.6
Brazilian	43.3	48.0	51.5	40.1	44.8	47.9

Total Interior Design Cost	$ (10,079.00)
Total Passenger Cost	$ (29,290.00)
Total Route Reward	$ 21,000.00
Total Cost	$ (18,369.00)

Notes:

•The interior has a total width of 430 cm.

•At least one aisle (50 cm); therefore, you have 380 cm to place seats.

•Seats must be minimum 38 cm and maximum 65 cm.

•Penalty cost of $2/cm for any space unused in the allotted 380 cm.

•Each seat has a fixed cost of $100 and variable cost of $3/cm for any width larger than 38 cm.

•The number of rows is fixed at 10.

•Seat widths can vary between the rows but not within the rows.

•Penalty cost of $10/cm associated with uncomfortable seats.

•Reward of $30 for every passenger comfortably seated.

•At each location, new passengers from that particular location board the plane.

•There are 100 eager passengers waiting to board pre-arranged into 10 rows of ten people.

• Airlines is penalized $100 for each passenger unable to board,

Solutions Interface (First Tab)

	Width of the Seats	Number of Seats per Row	Available Space Left	Total Seat Cost	Available Space Cost	Total Row Cost
Row #1	60	6	20	$ (996.00)	$ (40.00)	$ (1,036.00)
Row #2	62	6	8	$(1,032.00)	$ (16.00)	$ (1,048.00)
Row #3	30	12	20	$ (912.00)	$ (40.00)	$ (952.00)
Row #4	40	9	20	$ (954.00)	$ (40.00)	$ (994.00)
Row #5	38	10	0	$(1,000.00)	$ -	$ (1,000.00)
Row #6	39	9	29	$ (927.00)	$ (58.00)	$ (985.00)
Row #7	51	7	23	$ (973.00)	$ (46.00)	$ (1,019.00)
Row #8	59	6	26	$ (978.00)	$ (52.00)	$ (1,030.00)
Row #9	65	5	55	$ (905.00)	$ (110.00)	$ (1,015.00)
Row #10	38	10	0	$(1,000.00)	$ -	$ (1,000.00)
Total Number of Seats	80			$ (9,677.00)	$ (402.00)	$ (10,079.00)

Interior Design Calculations and Associated Cost Interface (Second Tab)

Distance Matrix (Miles)

		Berlin	Vienna	Budapest	Zurich	Paris	Istanbul	Cairo	Beirut	Houston	Rio De Janeiro
		1	2	3	4	5	6	7	8	9	10
Berlin	1	0	300	400	500	600	700	800	900	1000	1100
Vienna	2	300	0	500	600	700	800	900	1000	1100	1200
Budapest	3	400	500	0	700	800	900	1000	1100	1200	1300
Zurich	4	500	600	700	0	900	1000	1100	1200	1300	1400
Paris	5	600	700	800	900	0	1100	1200	1300	1400	1500
Istanbul	6	700	800	900	1000	1100	0	1300	1400	1500	1600
Cairo	7	800	900	1000	1100	1200	1300	0	1500	1600	1700
Beirut	8	900	1000	1100	1200	1300	1400	1500	0	1700	1800
Houston	9	1000	1100	1200	1300	1400	1500	1600	1700	0	1900
Rio De Janeiro	10	1100	1200	1300	1400	1500	1600	1700	1800	1900	0

START	Next	Next	Next	Next	Next	Next	Next	Next	Next	END	Total Distance	Total Route Reward
1	3	5	7	9	2					1	5400	$ 21,000.00

Airplane Routing Calculations and Associated Costs Interface (Third Tab)