Coffee Poptastic '03

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601.75 Design Methodology

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Contents

Initial Press Release

The Calgary Moon

Calgary's least read newspaper

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Summer 2003 Sees Calgary Hosting Poptastic '03

After unsuccessful bids to run for the 2010 Winter Olympics and the World Expo 2010, Calgary was in need for a spirit booster. This past week, Calgary got it. Calgary won the bid to host Poptastic '03, capturing 100% of the vote by the Poptastic committee. Factors in its success rate include the fact that Calgary was the only city running for the bid. Los Angeles had considered contending, but its mayor bailed out after considering the logistics of the event. "Calgary must be absolutely nuts to hold an event of this magnitude", said the L.A. mayor in a news conference earlier this morning.

Poptastic '03 is the world's premiere 3-day festival event. 4 Score and 10 of the biggest names in pop music will be headlining this monstrosity of an event. No less that 6 million, (yip folks, 6 millionarooney) pop-pickers in the same place at the same time - expecting a bomb (and not of the terrorist type). A musical boom bomb bam.

From outta nowhere an entire small town will erupt, a small town populated with the cream of North America's camping facilities.

Are you up to the task of providing the coffee-nectar for this event?

Project proposals

In order to develop project proposals, we utilized various techniques of lateral thinking. In certain cases the techniques were treated as they are intended: not as a rigid routine, but as methods of encouraging creativity and ideas or thoughts that may not generally be effected. Therefore some of the techniques were followed as taught and others were less formal although still very much a part of the process.

1. Cold Coffee

In the summer of the next year there will be a three-day pop-concert held near Calgary. No less then 6,000,000 people are expected to attend the concert and it is our task to organize the serving of coffee at the concert.

Let our reasoning begin with three important concepts: coffee, pop-concert, and summer.

We expect a young and trendy audience that will be dancing excessively during all three days of the event. We can expect high summer temperatures, which may make the dancing audience hot, thirsty and perhaps slightly dehydrated.

Let us now investigate coffee. Coffee is generally served hot. It is known as a source of revitalizing energy and people drink coffee when they take a break. The common aspects of coffee may not match the needs of our audience, but we have heard of a new kind of coffee that has been successfully introduced in Asia and Europe: X-press coffee, served ice-cold in cans.

This new kind of coffee combines the re-energizing aspect of traditional coffee with the refreshing aspect of a cold drink. It is a new trend and young people are eager to try it.

The logistics of the event when serving traditional coffee considers cups, water, coffee-powder, sugar, cream, sticks, heating, and preparation. X-press coffee reduces this list to only the ready-to-go cans and a method of cooling. The coffee is already prepared in advance; this will minimize queues and crowds in populated areas.

The logistic chain begins with the full cans. These cans must be distributed to the consumer who desires the coffee. After drinking the coffee, the consumer is left with empty cans. This chain has two important questions: how will the cans be distributed and what is happening to the empty cans?

We will distribute the cans by two different methods: buy them at a central booth or from vendors who walk around the concert area with (cooling-)backpacks.

The product is new to the Canadian market and as the event attracts six million people (almost one-fifth of the Canadian population!) plus a lot of media attention, X-press coffee is very interested in presenting their product at the concert. Therefore, we can

outsource the central coffee-booth to the company, which can host promotional events. This has the advantage in that it does not take any of our own manpower to run the booth. We will supply manpower for the walking-vendors.

The other question deals with the empty cans. We have several possibilities, which include: putting a deposit on the cans (that people should return); the usual garbage collection during and after the concert; or creation of a special incentive to return the cans. Possible incentives in this last case are digital pictures of each can-returner on the web or the creation of a huge can-sculpture in a central area. This involves every person who returns a can contributing to the sculpture. This can-sculpture can also be seen as a promotion event of the X-press coffee company.

2. Terrorist prevention scheme

Taking care of the health of six million people is very important. It would be a daunting task to deal with medical conditions among even one percentage of this population. From this viewpoint, the provision of coffee should take health considerations to heart.

The recent deaths caused by E. coli traces in the water supply of Walkerton, Ontario indicate the need to ensure safe drinking water. The water for the coffee will be purchased from a bottled water manufacturer and transported by tankers.

At the concert site, the water will be pumped into one of two large coffee-brewing tanks. The water will be brought to a boil for a minimum of 10 minutes to ensure elimination of bacteria, and then filtered through the coffee grinds within the closed-system of the tank. As we wish to reduce the risk of upset stomachs due to old coffee, the coffee must be freshly brewed every 30 minutes. While one tank holds the current coffee supply, the other tank will prepare the next batch of coffee. After 30 minutes, any remaining coffee in the first tank is dumped into a waste pool.

Threat of terrorist activity at a pop concert of this magnitude is very real, so every precaution must be taken that the coffee supply is not poisoned or tampered with. The coffee shall therefore be piped from the brewing tanks directly to vending booths, eliminating the need for humans to handle the coffee until it arrives at the dispensing tap. Guards shall be stationed at 100 m intervals along the piping. The transport of water and brewing of water will also be overseen by security officers.

Coffee (more particularly, the caffeine in the coffee) acts as a diuretic, therefore the drink itself poses some health risks. These risks will be dealt with using preventative measures and after-the-fact measures. In terms of prevention, only coffee that is decaffeinated or holds low caffeine concentrations will be served. The standard North American coffee-to-water ratio will be reduced from 3:64 (ie. 3 ounces coffee to 64 ounces water) to 3:56. Healthier additives such as brown sugar and low-fat cream (also known as “milk”) will be offered. Advertisements in the form of banners and pamphlets will warn people of the diuretic effects of coffee, especially during intense physical activity invoked by dancing

and cheering. Water stations will be set up throughout the concert grounds.

After-the-fact measures involve treatment of dehydrated individuals. Medical aides will be dispatched into the crowds to help such victims and bring them to medical stations. While people wait in line at coffee stands, soft background music will be played. This will help ease the emotional stress of waiting and therefore stabilize emotional health.

3. Envirocup

Six million people gathered together in one place for a long weekend sounds like great fun, but also implies that tons of refuse will need to be dealt with. It is possible that this refuse be treated in the normal way, that is, using landfills. However, this is not the image we wish to present. It is desirable that we, as a community, realize our responsibilities, and realize that these need not interfere with having fun.

Providing coffee for such a large group of people could be a logistical nightmare. Aside from the considerations of providing the coffee itself, milk, cream, sugar and cups are also necessary. The job of ensuring there is hot coffee to be served to those who wish it is important and requires deliberation.

As we have been informed, the situation with water has been taken care of and we can assume that there will be sufficient supplies. The coffee will be shipped in ready-ground to a main depot on the outskirts of the festival ground. From there, daily supplies will be delivered around the site by smaller vehicles capable of operating in such an environment. The supplies will be delivered daily in the wee hours, when there is less people traffic. The supplies of milk, cream and sugar will also be distributed in the same manner.

It is important that those who wish coffee (hot or frappe style) should have easy access to it. This means that portable vendors should roam the festival site, in particular the campsite in the morning and during the day. There will also be coffee stalls set up around the arena that will be designed for a high traffic flow and customer turnaround. The portable vendors will have filling stations also positioned around the site to ensure that each area has easy access to coffee.

In order not to produce too much waste in the form of cups and stirrers, we propose providing Swiss army coffee cups. Each ticket holder will receive a cup included in the price of their ticket, with cups also being available as memorabilia or gifts throughout the festival arena. The cup is fitted with a carrying loop, for ease of transportation when it is empty; a lid that has a no-loose strap; the handle has built in utensils, such as a plastic knife, fork and spoon set. Each cup issued with the entry wristband will also have a serial number engraved upon it; a raffle on the last day of the festival for meeting some of the stars will be drawn according to these serial numbers. Only the cups issued with the entry wristbands will have the serial numbers, as we wish to encourage people to keep their mug and re-use it. Obviously replacement mugs are available, but at a cost. Any

disposable cups available on site are to be made from paper and biodegradable in an acceptable amount of time.

We assume that there is no shortage of water for rinsing of cups and all other soft drinks are taken care of. We will compost the coffee waste for using on the grass that will no doubt be destroyed from three days of 6 million visitors walking on it.

4. Rich coffee

At a 3-day festival in the countryside, people often wish to rough-it, living the hippy lifestyle for a few days. However there are some home comforts that we consider necessities. We are not talking of a hot bath or shower. No. We are taking of your precious cup of coffee.

Many festival go-ers only wish for coffee in the morning-after-the-night-before; they will be catered to by other methods. However, for all coffee connoisseurs, we endeavor to provide the highest quality grinds in the industry. Not merely a Colombian and French roast, but the elite of quality blends and flavored coffees from all over the world in a variety of strengths and flavors.

Only French filtered mountain water will be used in the preparation and served to you in your choice of ceramic cup, bowl or mug, in a range of delightful colors. Your special coffee-shops will be situated at the most desirable locations in the festival arena. Away from drunken brawls and noisy children, we will provide an atmosphere of relaxation and calm as well as promoting your good feeling and enjoyment.

Nibbles in the form of home made muffins, cookies and scones will also be available. Our coffee will be brewed using a cafetiere fresh for your enjoyment. Special deliveries of fresh mountain water and coffee beans will be made every hour. The coffee will be ground on site, allowing the pleasure of that fresh ground taste and aroma.

Deciding on a scheme

After initial examination of the different proposals, we identified five criteria that are important in the decision making process. These are: simplicity; environment; health and safety; customer satisfaction; and profit.

Simplicity is concerned with the ease of implementing and carrying out the scheme. This considers staffing, transportation, etc. The impact on the surrounding, and larger, environment is also an important issue. Health and safety deal with matters such as the possibility that attendees may be injured or suffer as a result of any of our actions. Whereas customer satisfaction is self explanatory; we consider enjoyment of the beverage in terms of sales, availability, etc. Profit, last of all, is easily measured.

After careful examination of each of the proposals; they were ranked in accordance with the 5 criteria that have been identified as important. The most important criteria was scored with a value of 5, the least having a value of 1. Here are the ratings of the schemes (see Table 1)

	Anti-terror	Cold coffee	Envirocup	Rich coffee
Simplicity	2	5	2	1
Environment	2	3	5	2.5
Health & safety	5	3	3	2.5
Customer satisfaction	3	3	2	5
profit	2	3	2	3.5

Table 1: Valuation

After deciding on our ranking for the criteria and what we consider as important we built a priority matrix (Table 2) which examines the five criteria against pair wise and records decisions made dealing with which criteria we consider more important.

	Health & safety	Simplicity	Environmental	Customer satisfaction	Profit	∑
Health & safety	0	3	3	1	0	7.865
Simplicity	0.33	0	3	1,0.33	10	16.33
Environmental	0.33	0.33	0	0	3	5.667
Customer satisfaction	1	0.33	0	0	1	3.67
Profit	0	0.1	0.33	1	0	3.4

Table 2: Priority Matrix

When we examine the summation column of the priority matrix, we can rate the criteria in importance according to the summation values. From the table above we note that the order of importance is simplicity, health and safety, environmental, customer satisfaction and lastly profit.

Note that the providing of coffee at the concert is clearly not the cash cow. This explains why profit is the least important criteria. Even if the coffee is sold at a slight loss, the income generated from concert ticket sales will easily offset the coffee expenditures. As the time to develop the coffee branch of the concert is very short, we focus on finding a solution with a level of simplicity that reduces preparation and execution time. We distinguish between the customer satisfaction for the whole concert and the customer satisfaction for the coffee distribution (we call the latter one just customer satisfaction in this report). The health & safety aspect, the environmental aspect and the (coffee-) customer satisfaction clearly contribute to the customer satisfaction for the whole concert - this is why the need for effective coffee distribution originally arose.

We can use the initial table outlining the ratings of the criteria, according to each proposal to determine the most suitable scheme. In order to decide which of the schemes rated best in accordance with our priorities we used the *Gold Medal Method*. We are borrowing the method from the Olympics, where it is used for the country-medal rankings. In our case the priority ordering of the criteria simplicity, health & safety, environment, customer satisfaction and profit corresponds to the priority ordering of the gold, silver, bronze medal (plus 4^{th} and 5^{th} places).

Comparing the priority matrix and the ranking table using the Gold Medal method, we obtain results as shown in Table 3.

	Simplicity	Health & Safety	Environment	Customer satisfaction	profit	Award
Cold coffee		3	3	3	3	**Gold**
Anti-terror	2	5	2	3	2	**Silver**
Envirocup	2	3	5	2	2	**Bronze**
Rich coffee	1	2.5	2.5	5	4	**Tin**

Table 3: Results of Gold Medal Method

Table 3 shows that the method we have opted for is the Cold coffee idea. It is aimed at a young trendy audience and logistically is the most achievable and has the greatest chance of success.

With this decision taken the next step is to examine the architecture in more depth.

Development of the solution

Using the Cold-coffee method, which won our Gold medal, we created and populated a spreadsheet (as discussed in class) (Appendix). The first goal was to find numbers for the amount of coffee consumers in the audience, the average coffee consumption per person, and therefore the number of cans of coffee required (and also produced as garbage). This led to reasoning about the amount of cans sold per unit of time, which would be an important aspect of the calculations for the logistics of the solution.

We based the number of consumers on statistics that 60% of North Americans drink coffee. Of these 60%, we assumed that everyone would drink coffee above the age of 22 and no one would drink coffee below the age of 12 (we could call these youngsters "future coffee drinkers"). In calculating coffee consumption, we assumed two to three cups per day (about 0.5 L), and that people staying for breakfast would consume twice this amount.

Our original idea was to have one central booth and walking coffee sellers. The first assumption was that one can every ten seconds (per 1 meter of perimeter of the booth) could be sold. Using the spreadsheet to estimate a size of the central booth led very quickly to the insight that one central booth is not realistic. This is due to the monstrous dimensions of the booth that would be necessary to achieve this level of sales.

Therefore we identified that there is a need for a system consisting of several decentralized, or satellite, booths. Which means that the number of booths and their size became decision variables in the table.

The question about the maximum distance a person has to walk to the closest booth arose. To answer this, we had to get an idea about the dimensions of the festival arena. The initial guess was that for 6 million people we would require 1m² per person. Therefore the area must be at least 6 km². Considering that the area also contains stages, booths, and tents, we realized that 1m² is far too small. Calculations using the spreadsheet starting with a number of 50 booths showed us that each booth must sell about 8 cans per second to fulfill the demands of the audience. Therefore it was obvious that this estimate is still too small. Therefore we drew a plan and realistically tried to visualize the vastness of the space required to accommodate "no less than 6 million visitors". We finally settled on a festival surface area of 60 km^2.

At this point, we identified the need for a method of fast payment which would accelerate the process of selling cans of coffee and therefore improve consumer satisfaction (whilst increasing our profit). As the planning for the concert is already in a very advanced state, we assume that the need for a fast payment method arose earlier (it is not dependent on coffee sales alone) and therefore a fast payment method is available. The fast payment method involves charge cards that can be swiped for payment.

The speed of processing a purchase is now only limited by two factors: the client and the vendor. The speed of the client is not in our hands, but we can replace the vendor by a vending machine.

As our coffee is already delivered in cans by X-press company, no additional coffee preparation by a human vendor is required. There are various vending machines for cans available on the market which will allow us to deliver the coffee to the customers with as little complication or delay as possible. One concern was raised about using more electricity. However, a vending machine is nothing more than a glorified refrigerator with some additional technicalities, such as handling the payment and dispensing a can. We would require refrigerators at the sales booths so the vending machines would require no real extra electricity to operate. We assume that renting the vending machines will be cheaper than paying vendors to serve the coffee.

The manufacturer and distributors of the coffee are very keen to encourage the market and have some serious promotional events planned. They are providing several promotional outlets and staff. These are not included in our calculations.

The food vendors around the festival site have voiced an interest in quality, discount beverages. Therefore we allow them to sell a percentage of the total coffee, but the food vendors will be responsible for stocking and recycling their own supply of cans.

The vending machines themselves need careful consideration. We need to ensure that they will be well stocked, fully functional, and void of any danger or opportunity for mishaps or accidents.

Situating the vending machines at appropriate intervals around each stage and area of the festival site is important. This will ensure that everyone has access to liquid refreshment. We do not wish people to injure themselves or others by overturning, breaking into or climbing on the vending machines. We have therefore decided to locate the machines in clusters with false sloped roofs. The clusters will consist of several vending machines organized in a block so that they can be approached from all sides, whilst having their rears adjacent to each other. The size of the clusters (in terms of number of vending machines) is adapted as a decision variable in the spreadsheet.

The festival site hosts a certain number of different stages (experience relying on earlier events demonstrates that on average there is one stage for every 100,000 visitors). To make the logistics more manageable we divide the whole concert area into a number of subsidiary sublots (i.e. logistical subunits), which correspond to the different stages. Each sublot contains a warehouse for storing all the coffee cans that will be supplied to the sublot during the three-day concert. During the concert the vending machine clusters can be restocked from the nearest warehouse.

The vending machines themselves have to be large enough to hold sufficient cans so that they do not require restocking at an unreasonable, or unachievable rate. We will rent heavy duty, heavy demand vending machines that house 600 cans each. These machines are a great deal larger than conventional vending machines; however they provide stability and storage space whilst being energy efficient. In addition, a storage tower in the center of each vending machine cluster allows additional temporary storage of 20000

cans. Each vending machine is automatically refilled from the temporary storage via a feeding mechanism. Furthermore, the cans in temporary storage do not have to be refrigerated, saving energy costs. Only once the cans enter the vending machine are they refrigerated. The temporary storage tower together with the extra large vending machines enables us to minimize the number of restocks per day.

In order to refill a cluster, coffee cans need to be transported from the sublot warehouse. We will rent heavy duty battery-powered transport carts similar to golf carts, except with a chain of trailers for pulling the cans. Spare batteries are recharged at the warehouse, and swapped with drained batteries after several hours of driving. The transport carts are a clean alternative to trucks that require fuel, and eliminate the difficulty and safety risks of providing fuel stations throughout the concert grounds.

Because it is inefficient to restock the vending machines and storage tower one coffee can at a time, the storage mechanisms accept cans in packages of 50. We estimated it takes one person 45 seconds to unload a package from the transport cart and insert it into the vending machine or storage tower. Back at the warehouse, the transport carts are reloaded with the aid of a forklift in an estimated time of 5 minutes.

Spreadsheet Overview

The spreadsheet (Appendix) played a vital role in helping us to reach our final solution. During the design process, adding variables to the spreadsheet forced us to think of the problem in concrete terms, and often exposed areas that we had not considered. When we discussed the operation costs of a vending machine, we realized this would depend on the kilowatt-hour rating of the model, and in turn on the price per kilowatt-hour. These variables were not revealed in during our brainstorming sessions and casual discussion; they were revealed while fleshing out the spreadsheet. In the end, the spreadsheet also allowed us to adjust variables so as to achieve desirable values for our quality criteria. Our spreadsheet has been included in the Appendix (hint: if viewing this document via computer monitor, increase the page magnification to view the values in the spreadsheet in Appendix B).

The spreadsheet is partitioned into two areas, independent variables and dependent variables. The independent variables are further partitioned into context variables, decision variables, and temporarily independent variables. The context variables are those factors over which we have no control. For example, wholesale cost of a can of coffee is determined entirely by the X-Press company. The decision variables are those factors we can freely manipulate in order to influence the quality criteria found at the end of the dependent variable list. We have complete control over the retail cost of a can, for instance. The temporarily independent variables consist of those items that should really be dependent variables. For example, the average speed of the transport cart (which we set to 10 km/h) really depends on the crowd density and the load of the cart (ie. the number of staff and coffee cans the cart is carrying). Because of time constraints, we left several items as temporarily independent – in the future they should be expressed in terms of other variables.

For all of the dependent variables we calculated sensitivity values, displayed in the rightmost column. If we vary the values of an independent variable, the sensitivity values for each of the dependent variables expresses their sensitivity to the changes in the independent variable. In the spreadsheet, for example, we are varying the price of the retail cost of a can of coffee. Dependent variables such as number of refills required per cluster and staff wages display a relatively high sensitivity of 0.636, indicating that they rely heavily on the retail cost (the higher the price per can, the fewer the cans bought by consumers, and hence clusters don't need to be refilled as often and staff will have less work to do). The sensitivity values for the quality criteria were especially useful, as they indicated which independent variables played a great deal of influence. Profit has a sensitivity above 2, indicating that retail price should be very carefully considered when trying to adjust the profit.

In the spreadsheet we provided calculations for three control criteria: profit, customer satisfaction, and simplicity of solution. Due to time constraints, we did not calculate for environment and health/safety as this would have required identification of additional variables. The profit calculation is a simple "gains minus expenditures" calculation, involving variables such as money collected from vending machines and recycling, cost of wholesale cans, refrigeration costs, and staff wages. Satisfaction and simplicity are both calculated by averaging the sum of individual factors – each of these factors has a value from 0 to 1, so satisfaction and simplicity are also expressed as values from 0 (worst) to 1(best).

Satisfaction is based on factors such as:

- walking distance to nearest cluster (rating of 0 if distance is more than 1000 m)
- resale cost per can (rating of 0 is cost is more than $2)
- consumers per vending machine (rating of 0 if there are more than 10000 consumers per machine)

Simplicity is based on factors such as:

- period between servicing of clusters (rating of 1 if period is more than 24 hours)
- number of staff (less staff is better)
- number of carts (fewer carts is better)

In formulating the quality criteria we also considered the principle of "what goes up must come down." As we varied the resale cost of coffee cans, we noticed our profit was a monotonous function that kept increasing, so either we had created a money tree or our reasoning was wrong. We realized we had forgotten to consider the fact that consumers become turned off by high resale costs. Thus, we corrected our reasoning that as resale cost increases, the number of consumers decreases. Our profit function now has a peak value. In the spreadsheet insert, the satisfaction and simplicity quality controls do not display a peak. This is because we are currently varying only one independent variable – resale cost – which has a lower influence on satisfaction and simplicity.

Final Solution

After carefully adjusting our independent variables based on the sensitivity values of the quality criteria, we observed the effects on the quality control variables and chose a reasonable solution. Because generating a profit was the least of our concerns, and customer satisfaction and simplicity of the solution were considered more important, we considered the solutions in spreadsheet columns E through I as most viable. This way, we are maintaining a slight profit, while keeping relatively high satisfaction and simplicity ratings. Choosing column H as our final solution, our decision variables are set as follows:

- capacity of vending machine: 600
- number of vending machines: 2000
- number of sublots in the entire concert ground: 20
- number of vending machines in a cluster: 20
- number of excess cans held in a cluster's storage tower: 20000
- percentage of coffee sold by food vendors: 20 %
- number of transport carts per sublot: 6
- resale cost of a can of coffee: $1.20
- staff wage: $9 per hour

Values of the other independent and dependent variables can be obtained directly from the spreadsheet.

Observations

The problem formulation was very specific in stating that coffee had to be provided. But careful examination of the problem formulation identified areas where it could be interpreted in different ways, therefore generating alternative proposals with varying assumptions. For example, the problem formulation stated “provide coffee”, not “provide *enough* coffee”; this led us to consider situations where not enough coffee would be provided and also if the coffee were not in the form that consumers were used to, eg. hot. We examined the well known task of providing coffee and looked at some issues that may arise, asking each other questions and encouraging answers. Some of the questions dealt with methods of transporting, preparing and serving the coffee and its ingredients.

It was interesting with the different backgrounds of the group members and the complimentary sense of humour in the development of the project. A statement or assumption stated by one member would often invoke a seemingly bizarre response from another. We followed some of these through with a great deal of hilarity and found in certain cases that real assumptions, suggestions or situations cropped up. This meant that when we returned to the focus of the project we had generated ideas we may not otherwise have had.

In designing the proposals, we had to consider the context in which the coffee requirements were to take place. This led to some assumptions, for example the age and coffee consumption of the concert attendees, as well as the method of serving and details about the actual coffee itself. Abstraction of the ideas and concepts allowed us to examine different contexts and look at their respective dominant ideas and crucial factors. This was a multi-iteration process as many of the ideas are not necessarily related to one another, but orthogonal in nature. The technique of dialectics allowed us to identify some structures in our thoughts and ideas, and enable us to view them in a more focused manner. It was necessary to subdivide the larger task of providing coffee into its subtasks, for example the coffee, cups, heating elements, and ingredients such as water, coffee, sugar, etc.. In turn, these subtasks reminded us of all the additional transportation, storage, and propagation required.

It seemed, initially, obvious that the coffee should be traditional and served hot. This led us to invert what we were taking for granted and look at less traditional versions of coffee in terms of how to drink and serve it. The brainstorming sessions generated some interesting notes. Some of the ideas were hilarious, and although at first statement ludicrous, had a chance to become part of some fundamental ideas of how we could answer the project requirements.

Often using the analogy of the customers, or attendees, as a flock or swarm allowed us to think more about the movement and therefore situation and positioning in the various contexts we had concocted. It was often difficult to maintain a concentration on one aspect of the project. A certain amount of discipline was necessary at certain points to

constrain while attempting to allow free flow of ideas. Often a very random stimulus, for example part of a sentence overheard would produce some very unexpected results or new perspectives on the situation or contexts we were examining. A sense of humour is also an important factor as this encourages some innovative thinking and introduction of interesting ideas. We also found that the varying experience and background of the group brought a lot of perspectives together. This helped us question things we had taken for granted, due to our own understanding of a phrase, sentence or concept.

The design process was very different from those we are taught to endure in much of computer science. Laughter and absurdity was not just allowed but encouraged and in many cases brought about some very interesting results and considerations. Using various techniques when we felt we were repeating ourselves helped to break out of a pattern or chain of thought. The results we feel are by no means the most obvious, but are very interesting and in some cases quite innovative.

Appendix A – partial Spreadsheet (Screenshots)

	A	B	C	D	E	F	G
4		Relative increment	0	1	2	3	4
5	**Independent Variables**						
6	**context**						
7	number of attendees(*1,000,000)	0	6	6	6	6	6
8	fraction of attendees at breakfast	0	0,2	0,2	0,2	0,2	0,2
9	average age	0	24	24	24	24	24
10	consumption per person per day (L)	0	0,5	0,5	0,5	0,5	0,5
11	number of food vendors	0	3000	3000	3000	3000	3000
12	hours of operation per day (h)	0	16	16	16	16	16
13	surface area of concert ground (km^2)	0	60	60	60	60	60
14	size of cans (mL)	0	350	350	350	350	350
15	wholesale cost per can ($)	0	0,7	0,7	0,7	0,7	0,7
16	rental cost per vending machine ($)	0	300	300	300	300	300
17	rental cost per transport cart ($)	0	210	210	210	210	210
18	recycling rebate per can ($)	0	0,05	0,05	0,05	0,05	0,05
19	electricity cost ($ / kWh)	0	0,15	0,15	0,15	0,15	0,15
20	available staff	0	60000	60000	60000	60000	60000
21							
22	**decision**						
23	capacity of vending machines (# cans)	0	600	600	600	600	600
24	# of vending machines	0	2000	2000	2000	2000	2000
25	number of sublots	0	20	20	20	20	20
26	# vending machines per cluster	0	20	20	20	20	20
27	# excess cans stocked per cluster	0	20000	20000	20000	20000	20000
28	fraction of coffee sold by food vendors	0	0,2	0,2	0,2	0,2	0,2
29	number of transport carts per sublot	0	6	6	6	6	6
30	resale cost per can ($)	0	0,7	0,8	0,9	1	1,1
31	staff wage per hour ($)	0	9	9	9	9	9
32							
33	**temporarily independent**						
34	time to load 50-pack into v.m. (min)	0	0,75	0,75	0,75	0,75	0,75
35	time to reload transport cart (min)	0	5	5	5	5	5
36	average speed of transport cart (km/h)	0	15	15	15	15	15
37	driving costs for transport cart ($/km)	0	0,1	0,1	0,1	0,1	0,1
38	# staff per sublot	0	24	24	24	24	24
39	construction cost per cluster storage ($)	0	1000	1000	1000	1000	1000
40							

	A	B	C	D	E	F	G
40							
41	**Dependent Variables**						
42	coffee consumers (*1,000,000)		3,60	3,60	3,60	3,60	3,60
43	total consumption (*1000 L)		2160	2160	2160	2160	2160
44	demand at food courts (*1000 cans)		1234	1234	1234	1234	1234
45	demand at vending machines (*1000 cans)		4937	4937	4937	4937	4937
46	vending mch. demand per hour (*1000 cans)		308,6	308,57	308,6	308,6	308,6
47	# vending machine clusters		100	100	100	100	100
48	# clusters per sublot		5	5	5	5	5
49	# cans per cluster		32000	32000	32000	32000	32000
50	# staff per transport car		4	4	4	4	4
51	time to refill cluster, one person (min)		480,0	480,0	480,0	480,0	480,0
52	time to refill cluster, as team (min)		120,0	120,0	120,0	120,0	120,0
53	area served per cluster (km^2)		0,600	0,600	0,600	0,600	0,600
54	max walk distance to nearest cluster (m)		547,7	547,72	547,7	547,7	547,7
55	area per sublot (km^2)		3,00	3,00	3,00	3,00	3,00
56	avg drive distance to nearest cluster (m)		612,4	612,37	612,4	612,4	612,4
57	avg time to drive to cluster (min)		2,45	2,45	2,45	2,45	2,45
58	total time to service cluster, as team (min)		129,9	129,9	129,9	129,9	129,9
59	time to service all sublot clusters once (hrs)		1,804	1,8042	1,804	1,804	1,804
60	manhours to service all sublot clusters (hrs)		2858	2857,8	2858	2858	2858
61	manhours to service all clusters (hrs)		57156	57156	57156	57156	57156
62	work hours per person per day (hrs)		6,615	6,6152	6,615	6,615	6,615
63	consumers per cluster (*1000)		36	36	36	36	36
64	consumers per vending machine (*1000)		1,8	1,8	1,8	1,8	1,8
65	# cans sold per vending machine per hour		154,3	154,29	154,3	154,3	154,3
66	# cans sold per cluster per hour		3086	3085,7	3086	3086	3086
67	refill interval for one cluster (hours)		6,481	6,4815	6,481	6,481	6,481
68	# refills required for one cluster		11	11	11	11	11
69	spare time between servicing cluster (hrs)		4,677	4,6773	4,677	4,677	4,677
70	capacity of vending machine (L)		241,5	241,5	241,5	241,5	241,5
71	energy per vending machine (kWh / year)		158,1	158,13	158,1	158,1	158,1
72	energy per vending machine for 3 days (kWh)		1,3	1,2997	1,3	1,3	1,3
73	energy cost per vending machine ($)		0,195	0,195	0,195	0,195	0,195
74	refrigeration energy costs ($)		389,9	389,91	389,9	389,9	389,9
75	money from vending machines (* $1,000,000)		3,456	3,9497	4,443	4,937	5,431
76	total wholesale cost of cans (* $1,000,000)		3,456	3,456	3,456	3,456	3,456
77	recycling refund (* $1000)		308,6	308,57	308,6	308,6	308,6
78	total vending machine rental (* $1,000)		600	600	600	600	600
79	total transport cart rental (* $1,000)		25,2	25,2	25,2	25,2	25,2
80	total cluster construction cost (* $1000)		100	100	100	100	100
81	staff wages (* $1000)		514,4	514,4	514,4	514,4	514,4
82	profit (* $1,000,000)		-0,93	-0,438	0,056	0,55	1,043
83	satisfaction (0 = none, 1 = best)		0,701	0,684	0,667	0,651	0,634
84	simplicity (0 = none, 1 = best)		0,628	0,628	0,628	0,628	0,628
85							
86							

Appendix B – complete Spreadsheet (embedded in document)

	Relative increment	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Sensitivity
Independent Variables																							
context																							
number of attendees(*1,000,000)	0	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	
fraction of attendees at breakfast	0	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	
average age	0	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	
consumption per person per day (L)	0	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	
number of food vendors	0	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	
hours of operation per day (h)	0	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	
surface area of concert ground (km^2)	0	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	
size of cans (mL)	0	350	350	350	350	350	350	350	350	350	350	350	350	350	350	350	350	350	350	350	350	350	
wholesale cost per can ($)	0	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	
rental cost per vending machine ($)	0	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	
rental cost per transport cart ($)	0	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	210	
recycling rebate per can ($)	0	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	
electricity cost ($ / kWh)	0	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	
available staff	0	60000	60000	60000	60000	60000	60000	60000	60000	60000	60000	60000	60000	60000	60000	60000	60000	60000	60000	60000	60000	60000	
decision																							
capacity of vending machines (# cans)	0	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	
# of vending machines	0	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	
number of sublots	0	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	
# vending machines per cluster	0	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	
# excess cans stocked per cluster	0	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	
fraction of coffee sold by food vendors	0	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	
number of transport carts per sublot	0	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	
resale cost per can ($)	0.1	0.7	0.8	0.9	1	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2	2.1	2.2	2.3	2.4	2.5	2.6	2.7	
staff wage per hour ($)	0	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	
temporarily independent																							
time to load 50-pack into v.m. (min)	0	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	
time to reload transport cart (min)	0	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	
average speed of transport cart (km/h)	0	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	
driving costs for transport cart ($/km)	0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	
# staff per sublot	0	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	
construction cost per cluster storage ($)	0	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	
Dependent Variables																							
coffee consumers (*1,000,000)		3.60	3.60	3.60	3.60	3.60	3.60	3.51	3.33	3.15	2.97	2.79	2.61	2.43	2.25	2.07	1.89	1.71	1.53	1.35	1.17	0.99	0.175
total consumption (*1000 L)		2160	2160	2160	2160	2160	2160	2106	1998	1890	1782	1674	1566	1458	1350	1242	1134	1026	918	810	702	594	0.175
demand at food courts (*1000 cans)		1234	1234	1234	1234	1234	1234	1203	1142	1080	1018	957	895	833	771	710	648	586	525	463	401	339	0.175
demand at vending machines (*1000 cans)		4937	4937	4937	4937	4937	4937	4814	4567	4320	4073	3826	3579	3333	3086	2839	2592	2345	2098	1851	1605	1358	0.175
vending mch. demand per hour (*1000 cans)		308.6	308.6	308.6	308.6	308.6	308.6	300.9	285.4	270	254.6	239.1	223.7	208.3	192.9	177.4	162	146.6	131.1	115.7	100.3	84.86	0.175
# vending machine clusters		100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	0.000
# clusters per sublot		5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	0.000
# cans per cluster		32000	32000	32000	32000	32000	32000	32000	32000	32000	32000	32000	32000	32000	32000	32000	32000	32000	32000	32000	32000	32000	0.000
# staff per transport car		4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	0.000
time to refill cluster, one person (min)		480.0	480.0	480.0	480.0	480.0	480.0	480.0	480.0	480.0	480.0	480.0	480.0	480.0	480.0	480.0	480.0	480.0	480.0	480.0	480.0	480.0	0.000
time to refill cluster, as team (min)		120.0	120.0	120.0	120.0	120.0	120.0	120.0	120.0	120.0	120.0	120.0	120.0	120.0	120.0	120.0	120.0	120.0	120.0	120.0	120.0	120.0	0.000
area served per cluster (km^2)		0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.000
max walk distance to nearest cluster (m)		547.7	547.7	547.7	547.7	547.7	547.7	547.7	547.7	547.7	547.7	547.7	547.7	547.7	547.7	547.7	547.7	547.7	547.7	547.7	547.7	547.7	0.000
area per sublot (km^2)		3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	0.000
avg drive distance to nearest cluster (m)		612.4	612.4	612.4	612.4	612.4	612.4	612.4	612.4	612.4	612.4	612.4	612.4	612.4	612.4	612.4	612.4	612.4	612.4	612.4	612.4	612.4	0.000
avg time to drive to cluster (min)		2.45	2.45	2.45	2.45	2.45	2.45	2.45	2.45	2.45	2.45	2.45	2.45	2.45	2.45	2.45	2.45	2.45	2.45	2.45	2.45	2.45	0.000
total time to service cluster, as team (min)		129.9	129.9	129.9	129.9	129.9	129.9	129.9	129.9	129.9	129.9	129.9	129.9	129.9	129.9	129.9	129.9	129.9	129.9	129.9	129.9	129.9	0.000
time to service all sublot clusters once (hrs)		1.804	1.804	1.804	1.804	1.804	1.804	1.804	1.804	1.804	1.804	1.804	1.804	1.804	1.804	1.804	1.804	1.804	1.804	1.804	1.804	1.804	0.000
manhours to service all sublot clusters (hrs)		2858	2858	2858	2858	2858	2858	2598	2598	2338	2338	2078	2078	1819	1559	1559	1299	1299	1039	1039	779.4	779.4	0.636
manhours to service all clusters (hrs)		57156	57156	57156	57156	57156	57156	51960	51960	46764	46764	41568	41568	36372	31176	31176	25980	25980	20784	20784	15588	15588	0.636
work hours per person per day (hrs)		6.615	6.615	6.615	6.615	6.615	6.615	6.014	6.014	5.412	5.412	4.811	4.811	4.21	3.608	3.608	3.007	3.007	2.406	2.406	1.804	1.804	0.636
consumers per cluster (*1000)		36	36	36	36	36	36	35.1	33.3	31.5	29.7	27.9	26.1	24.3	22.5	20.7	18.9	17.1	15.3	13.5	11.7	9.9	0.175
consumers per vending machine (*1000)		1.8	1.8	1.8	1.8	1.8	1.8	1.755	1.665	1.575	1.485	1.395	1.305	1.215	1.125	1.035	0.945	0.855	0.765	0.675	0.585	0.495	0.175
# cans sold per vending machine per hour		154.3	154.3	154.3	154.3	154.3	154.3	150.4	142.7	135	127.3	119.6	111.9	104.1	96.43	88.71	81	73.29	65.57	57.86	50.14	42.43	0.175
# cans sold per cluster per hour		3086	3086	3086	3086	3086	3086	3009	2854	2700	2546	2391	2237	2083	1929	1774	1620	1466	1311	1157	1003	848.6	0.175
refill interval for one cluster (hours)		6.481	6.481	6.481	6.481	6.481	6.481	6.648	7.007	7.407	7.856	8.363	8.94	9.602	10.37	11.27	12.35	13.65	15.25	17.28	19.94	23.57	0.179
# refills required for one cluster		11	11	11	11	11	11	10	10	9	9	8	8	7	6	6	5	5	4	4	3	3	0.636
spare time between servicing cluster (hrs)		4.677	4.677	4.677	4.677	4.677	4.677	4.844	5.203	5.603	6.052	6.559	7.136	7.798	8.566	9.468	10.54	11.84	13.45	15.48	18.14	21.76	0.249
capacity of vending machine (L)		241.5	241.5	241.5	241.5	241.5	241.5	241.5	241.5	241.5	241.5	241.5	241.5	241.5	241.5	241.5	241.5	241.5	241.5	241.5	241.5	241.5	0.000
energy per vending machine (kWh / year)		158.1	158.1	158.1	158.1	158.1	158.1	158.1	158.1	158.1	158.1	158.1	158.1	158.1	158.1	158.1	158.1	158.1	158.1	158.1	158.1	158.1	0.000
energy per vending machine for 3 days (kWh)		1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	0.000
energy cost per vending machine ($)		0.195	0.195	0.195	0.195	0.195	0.195	0.195	0.195	0.195	0.195	0.195	0.195	0.195	0.195	0.195	0.195	0.195	0.195	0.195	0.195	0.195	0.000
refrigeration energy costs ($)		389.9	389.9	389.9	389.9	389.9	389.9	389.9	389.9	389.9	389.9	389.9	389.9	389.9	389.9	389.9	389.9	389.9	389.9	389.9	389.9	389.9	0.000
money from vending machines (* $1,000,000)		3.456	3.95	4.443	4.937	5.431	5.925	6.258	6.394	6.48	6.517	6.505	6.443	6.332	6.171	5.962	5.702	5.394	5.036	4.629	4.172	3.666	0.394
total wholesale cost of cans (* $1,000,000)		3.456	3.456	3.456	3.456	3.456	3.456	3.37	3.197	3.024	2.851	2.678	2.506	2.333	2.16	1.987	1.814	1.642	1.469	1.296	1.123	0.95	0.175
recycling refund (* $1000)		308.6	308.6	308.6	308.6	308.6	308.6	300.9	285.4	270	254.6	239.1	223.7	208.3	192.9	177.4	162	146.6	131.1	115.7	100.3	84.86	0.175
total vending machine rental (* $1,000)		600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	0.000
total transport cart rental (* $1,000)		25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	0.000
total cluster construction cost (* $1000)		100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	0.000
staff wages (* $1000)		514.4	514.4	514.4	514.4	514.4	514.4	467.6	467.6	420.9	420.9	374.1	374.1	327.3	280.6	280.6	233.8	233.8	187.1	187.1	140.3	140.3	0.636
profit (* $1,000,000)		-0.93	-0.44	0.056	0.55	1.043	1.537	1.996	2.289	2.58	2.774	2.966	3.061	3.154	3.198	3.146	3.091	2.939	2.786	2.536	2.283	1.934	2.089
satisfaction (0 = none, 1 = best)		0.701	0.684	0.667	0.651	0.634	0.617	0.601	0.584	0.567	0.551	0.534	0.517	0.501	0.484	0.484	0.484	0.484	0.484	0.484	0.484	0.484	0.189
simplicity (0 = none, 1 = best)		0.628	0.628	0.628	0.628	0.628	0.628	0.63	0.633	0.638	0.642	0.648	0.654	0.661	0.669	0.678	0.689	0.703	0.719	0.741	0.768	0.806	0.019