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Qualitative versus quantitative data tools for sustainable package design at Eastman Kodak company

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Qualitative versus Quantitative Data Tools for Sustainable Package Design at Eastman Kodak Company

By

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M. S. DEGREE THESIS

The M. S. degree thesis of

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Dedication

To my grandmother, who taught me how to be proactive, responsible and above all, always stay positive. Who at 85 finds it in her heart to encourage me and pushes me to do and be my best.

Thank you for always being here for me, not matter how far you are.

Qualitative versus Quantitative Data Tools for Sustainable Package Design at Eastman Kodak Company

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Abstract

Due to the increased sustainability trends in the packaging industry during the last decade and a push from major retailers, in conjunction with the dire economic climate and internal reorganizations within the company, a need for an official design tool was born; a tool that would simplify, unify and improve the design process within the company. Following the creation of the original tool, the Packaging Development and Optimization Tool (PDOT), a critique arose that suggested an addition of LCA data, creating a more quantitatively based tool. A modified design process followed, the Sustainable Packaging Design Tool (SPDT), which utilized LCA data in addition to all other package specifications to recommend a design option with a minimal impact.

This study compares the two different packaging design tools. It assumes that a quantitatively based design tool is superior to a qualitatively based tool. It suggests that a quantitative tool can reduce decision-making time, improve satisfaction with design decision and create consistency of results. The research was based on the study and survey of packaging engineers in the company.

Table of Contents

List of Figures

List of Diagrams

List of Graphs

Glossary of Terms

BU – Business Unit

CDG – Consumer Digital Group

COMPASS – Comparative Packaging Assessment. An online software tool that is used as the basis for the LCI information for the Sustainable Packaging Design Tool. (https://www.design-compass.org/)

FPEG – Film Paper and Entertainment Group

GCG – Graphic Communications Group

HSE – Health Safety and Environment

PAE – Packaging Analysis and Engineering

PDOT – Packaging Development Optimization Tool, also referred to as the Qualitative Design Tool or the Original tool.

SPDT – Sustainable Packaging Design Tool, also referred to as the Quantitative Design Tool, or the New tool.

SPG – Strategic Product Group

Introduction

"Take only memories, leave nothing but foot prints"

- Chief Seattle

Chief Seattle's view was noble, yet it is more of an idealistic idea, and less a realistic concept, when the analogy is drawn to the field of packaging. Package manufacturing, use and disposal are some of the largest offenders when it comes to waste and emissions, both during the pre consumer (recovery, manufacturing and transportation) and post consumer (use and disposal) stages of the packaging process. According to the USEPA, "packaging constitutes as much as one-third of the non-industrial solid waste stream" (EPA [Packaging], 2008). Additionally, the European Environmental Agency generated a report that shows that as much as 28 percent of the municipal packaging waste, goes to landfill, as can be seen in the figure below.

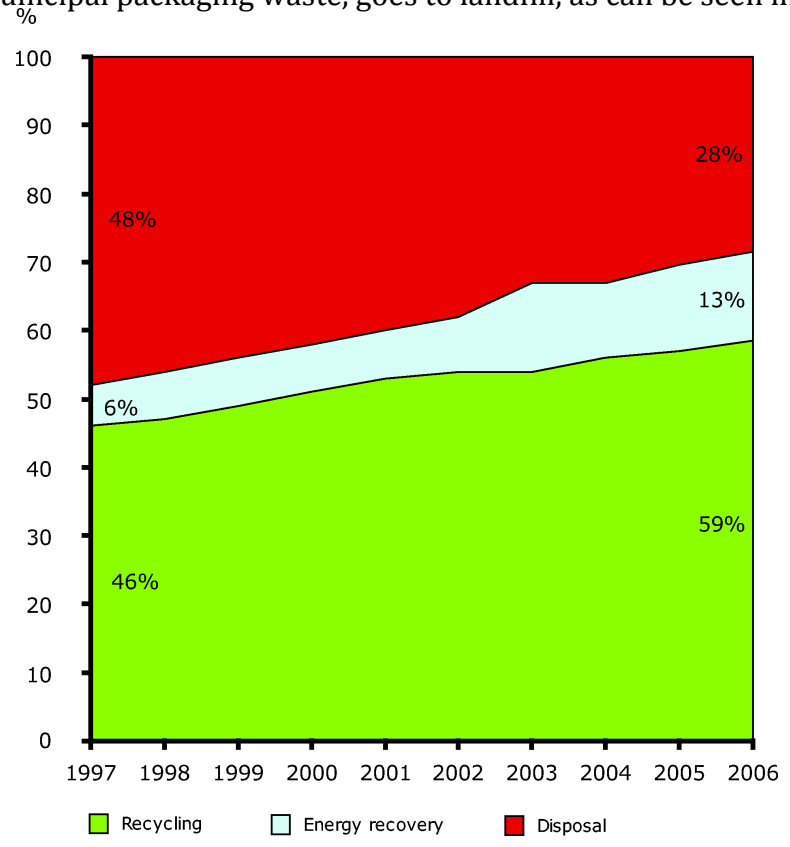


Figure 1 - Treatment of Packaging Waste [Kg/person] (Erol, 2009)

As a result of this data, it is becoming increasingly evident that Europe, the world leader in waste management and recycling efforts (EIONET, 2009) (European

Commission, 2009), has a significant improvement opportunity. The United States, a follower on the issues of emissions, waste and recycling, has a much greater window of opportunity.

More over, throughout the packaging life cycle there are negative implications, not only at the end of pipe, but also at the beginning and throughout the process. Air and water emissions in manufacturing and distribution are only few of the many effects that add to environmental and societal harm. Changing those processes and reducing those impacts will reduce the ramifications not only to the environment and society, but also reduce costs.

One might claim that packaging is an unnecessary evil. However, it is obvious that without packaging, products can neither arrive safely at their destination nor be promoted on the shelves. Most importantly, they can not fulfill their function of informing the consumer of any harmful affects of a product (i.e. for a hazardous cleaning agent).

Chief Seattle's quote is a goal, possibly far-reaching and maybe even unattainable, yet it is something to strive for. As long as there are tangible products there will be packaging, but the quantity and format of packaging is something that can be altered. Sustainable design is an idea that has been around for a few decades; however, the packaging community has started taking serious notice only during the past few years.

The first steps of sustainable package design had become increasingly evident with the development and implementation of the Wal-Mart scorecard in 2006. The scorecard forced each of Wal-Mart's and Sam's Club's suppliers in the United States to complete a series of questions about the packaging and distribution of each stock keeping unit (SKU) that is sold to those retailers. Some of those questions required emissions data that was never consistently collected or tracked in the industry, a fact that created great frustration within the supplier community. This frustration resonated in two distinctly opposite manners. Some started looking at the idea of sustainability as a nuisance and inconvenience that should be ignored and avoided at all cost, hoping that as previous trends, this too shall pass. Which subsequently meant finishing the scorecard project and never touching the subject

again. Others looked at the idea of sustainability and sustainable design as an innovative and economically sound opportunity.

Kraft Foods, as an example, assigned a former packaging engineer to be their VP of Sustainability, and increasingly started looking for process improvements. A prominent example could be seen in their underground storage facility, where they converted an empty limestone mine into their largest refrigerated distribution facility in the United States. This facility uses 65% less energy, compared to above ground facilities. (Kraft Foods, 2008)

Puma, the sports apparel manufacturer, was able to look at the global sustainability trends and create new packaging processes and designs with a significant impact (Casey, 2010). As an example, the company designed the "Clever little bag", essentially eliminating the shoebox and its accompanying carrying bag. With the launch of the new design, the company expects to save tremendously through out multiple stages of the manufacturing process.

> … approximately 8,500 …, 20 million Megajoules of electricity saved, 1 million litres of fuel oil used and 1 million litres of water saved. During transport 500,000 litres of diesel is saved and lastly, due to the replacement of traditional shopping bags with the lighter built-in bag the difference in weight can save up to 275 tons of plastic. (PUMA, 2010)

Wal-Mart triggered a large push for many large companies to work on their own sustainability goals. They recognized the potential savings that could arise from sustainability initiatives - many have decreased their material waste through light weighting, reducing package size, changing materials and looking into bio polymers. However, longer and more in-depth research of sustainability opportunities has not been done and is probably forthcoming, potentially adding sustainable package design to their bottom lines. Further more, with the financial crisis unraveling in 2008-2009, many companies have started to realize that the way they used to do business is no longer enough, and that they are behind their competition in the market. There are a few reasons, alone or in combination, why a company might be lagging:

a. Old processes - Not designed for the high speeds of the global market and economy.
b. Rises and falls in commodity pricing – unpredictability of the market and faulty budgeting can create serious financial problems.
c. Media push for green and sustainable packaging – a company's inability to quickly change with market demands.
d. Consumer's understanding of the impacts that non-sustainable products have on the world – consumers accept the idea of green and their purchase decisions are in accordance.

Obviously loss of market share is not a direct function of being unsustainable, but shareholders are more likely to invest in a company that is known for being good for the community and the environment, as well as being financially stable (Mohr, 2001).

Another company that found it timely to implement sustainability considerations is Eastman Kodak Company. The decline of the Kodak stock in recent years in conjunction with the recession had impacted the company significantly. Having the business divided between commercial (printing presses), traditional (Film, paper, etc.) and luxury goods (Digital camera's, digital frames, etc.) created a situation in which the consumers could forgo their purchases of Kodak products, as they are not a necessity. (Ait-Sahalia, Parker, & Yogo, 2004)

Packaging design and engineering had been a part of Eastman Kodak for many years. While Wal-Mart hired their first university educated packaging engineer in 2005, Kodak had a packaging designated test facility since 1947 and had college educated packaging professionals working on staff for decades.

As an asset to the company, the package design and testing have been in place for a very long time as a separate division of the product commercialization process. On the other hand, those procedures are very hard to alter, and old habits are very hard to break. As a result, any execution of minor changes become very difficult to implement.

Therefore, an addition of the package development optimization tool (PDOT), one that is the basis for this study (Appendix I), was not lightly accepted by the

community of packaging professionals. As a result, it was implemented as part of the regulatory process and not as part of a packaging design process, which was the original intention. If there was an official package design process, the PDOT could have been an essential part of it, which would have contributed to better-informed decision-making.

Problem Statement

The Package Development Optimization Tool (PDOT) that was created in 2008 at Kodak lacks external, objective quantitative data while leaving the decisions, which are qualitative and subjective, inconsistent from engineer-to-engineer.

In this day and age package design should have sustainability as table stakes. Kodak's Health Safety and Environment (HSE) with the help of the corporate Package Analysis and Engineering department (PAE) started the development of the PDOT to implement a sustainable framework to the design process. This design evaluation tool provides the packaging engineers with the ability to compare and contrast up to four packaging options based on material and format selection. The PDOT was based on material matrix, and serves as a comparison tool.

Previous research (Parra, 2008) had shown that materials selected in the package design process have a key role in sustainable packaging design. Additionally, the format of the packaging design also plays a roll in the life cycle of the system, as reusability and recyclability directly affect the environmental impact of the packaging system.

Hypothesis

I hypothesize that a quantitative packaging design tool that is based on material life cycle assessment data will –

a. Decrease decision-making time.
b. Add to the engineers' satisfaction in the final design decision.
c. Provide consistency of decision making between various engineers.

The results of the study will attempt to show that by adding the quantitative data to the existing tool, the package design process will provide for objectivity and consistency of results across different business units.

Background

Package Design

Industry wide, the packaging design process is usually a subjective process for each engineer or designer. As such, it is reasonable that the engineers at Kodak do not use an official design process. Due to the subjectivity of the process, there is no consistency of results and different individuals have different material and format preferences for their designs, based on previous knowledge, experiences and perceptions.

In 2008, the Health Safety and Environment group in Kodak worked on revamping various standards. One of the projects included the elimination of package regulation redundancies and creation of the PDOT with the help of the Package Analysis and Engineering group (PAE).

Through observations over a nine-month co-op, from March through December 2008, it became evident that there is a lack of procedural consistency in the design process, as well as a lack of enthusiasm about sustainable design. Part of the co-op responsibilities included the creation of the PDOT, which was a project that was developed with the help of several packaging engineers in the company. In May 2008, a series of interviews were conducted with the packaging engineers to determine the design process and their understanding of the process within the whole supply chain. The questions were as follows-

Interview Questions

1. What is your connection to the HSE representative?
2. If we were to represent you to HSE what would you like us to say?
3. How can the product standards be a better tool for the packaging community?
4. Do you have knowledge of the supply chain to assess optimization? How accessible are you to the entire supply chain?
5. What is the current design process for packaging optimization, if in existence?
6. How much of consideration is given to all aspects that would impact optimization (Space utilization, robustness of product, material choice, etc) Not only space utilization but also challenging product design in order to save money on packaging, i.e. Material quantity on space utilization.
7. What are your packaging priorities, in terms of change, that you are seeing? Do you have any goals from the SPG, about materials that you need to eliminate, reduce packaging, in regards to the design or the material?
8. What are your sustainability goals from the Business Units?

The interview responses indicated that the engineers were not aware of a corporate definition of sustainability, nor did they know how it would pertain to packaging. They did not know of any optimization or sustainability goals driven by the Strategic Product Groups (SPG) or the Business Units (BU).
Additionally, the engineers did not feel there was a person in Health Safety and Environment (HSE) they could turn to with any questions about the topic of sustainability. They also stated that there is a lack of instruction in the design process, and a design standard created through HSE will not be implemented and used unless it is supported and endorsed by corporate management.

Moreover, the interviews highlighted two main issues:

a. The product commercialization does not include packaging as an official step, and most engineers enter too late in the process. In Kodak, the commercialization process, also known as KMCP, consists of eight passage points that are called gates, as seen below: (in bold are the most commonly used)

- **G0 Project Inception - Product is brought up from idea stage to commercialization**
- G1 Project Assessment
- **G2 Project Commitment - Agreement of plan, where and how the product will be sold**
- G3 Design Readiness
- **G4 Project Verification - Manufacturing ready, post testing**
- G5 Launch Readiness
- **G6 Manufacturing Readiness - to be produced and sold**
- G7 Marketing and Manufacturing Re-review
- **G8 Post Mortem – Taken out of production**

The figure below shows the time in the commercialization process where the packaging design process begins, superimposed on the product life cycle.

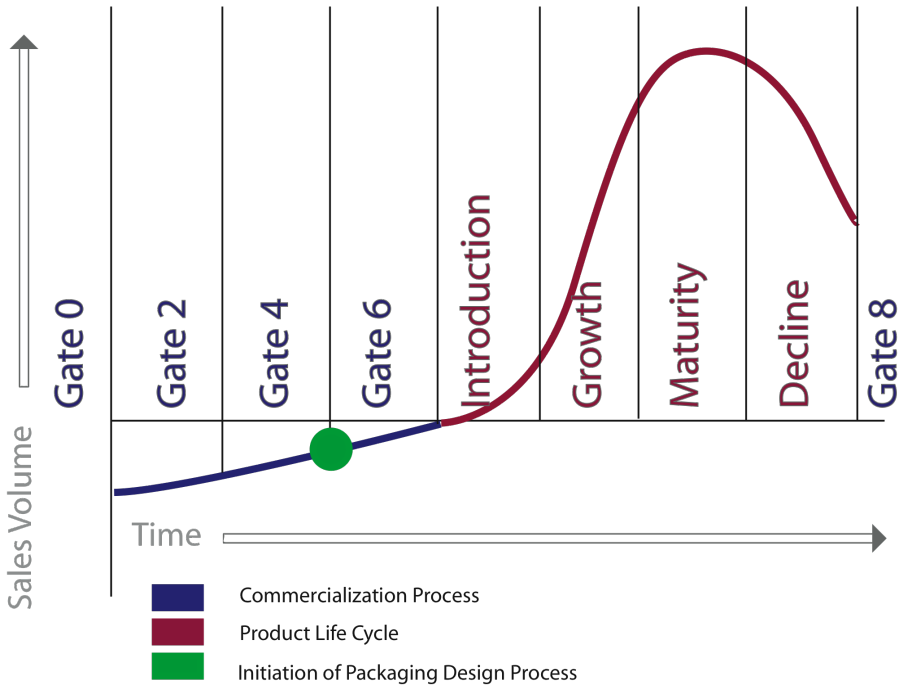


Figure 2 – Kodak's commercialization process superimposed on the Product Life Cycle

b. An official optimization process does not exist; all related redesign efforts are driven by the following factors:

- Retail Push – New requirements from large retailers.

- Damage Problems – Customer complaints and losses during transportation.
- Marketing – Market trends and promotion of brand image
- Cost Savings

Any existing optimization efforts were centered on the low hanging fruit, which often solved one problem but created others. At times, the engineers used recyclable and returnable materials, while on other occasions they used stock items and optimized formats by reducing the variety of packaging (single format fits multiple products), instead of customizing the packaging system, and optimizing on materials and space.

To further understand the design process at Eastman Kodak, a group of packaging engineers at the company were surveyed. As they are the group that is officially responsible for the package design, it was important to understand their process. It is essential to state that the sample is extremely small (ten individuals), and full participation was not achieved (5 participants answered the survey), hence creating a very limited understanding of the process.

After analyzing the results from the brief survey (see Appendix II), it became evident that although there is no official company process, most engineers follow the same overall steps. The design process consists of multiple steps during which the engineers identify the product requirements through contact with the relevant departments, followed by the creation of a concept, designing and prototyping the package, ship testing according to the necessary requirements and specifying the packaging for manufacturing, as shown in Diagram 1 below.

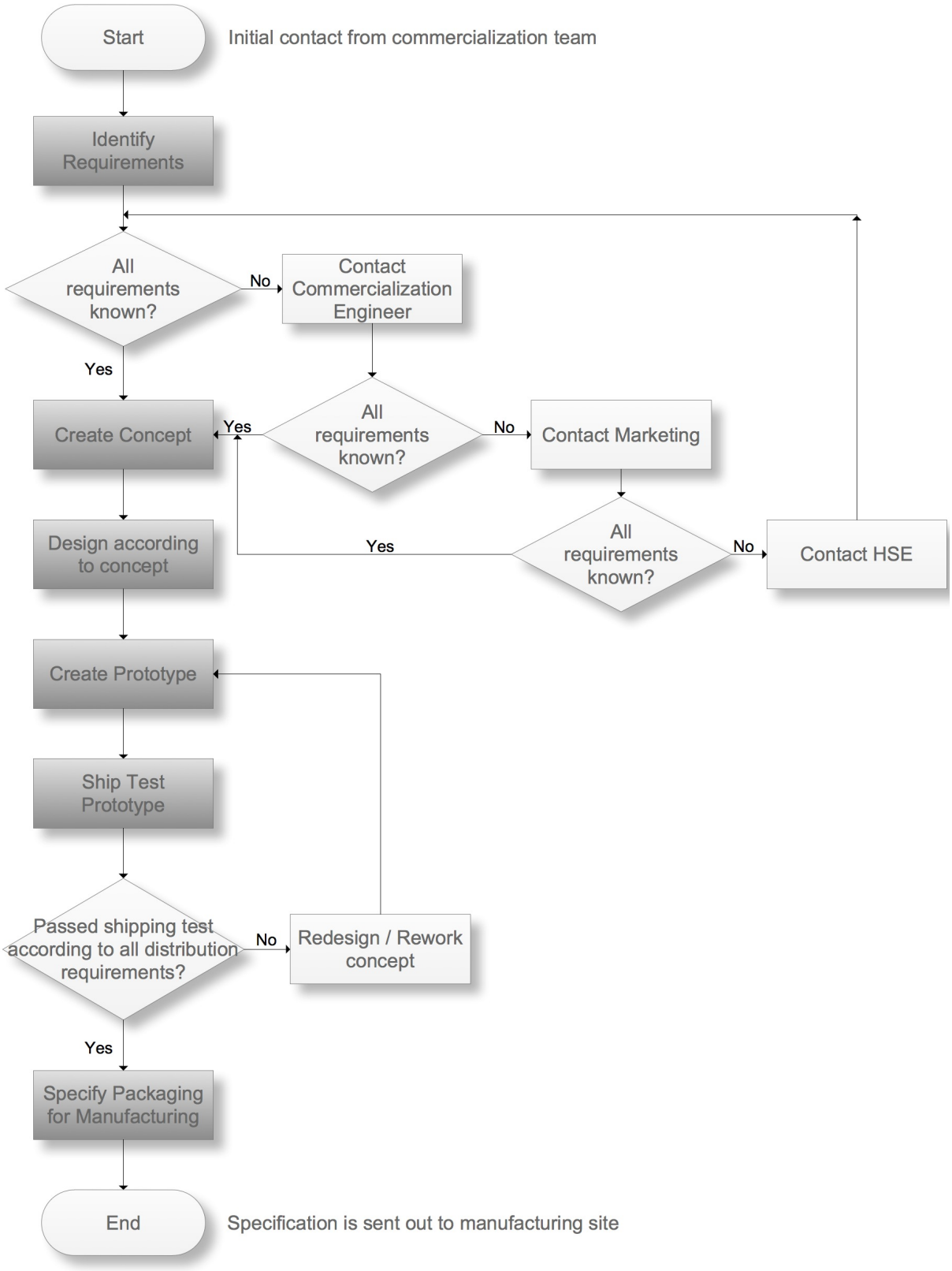
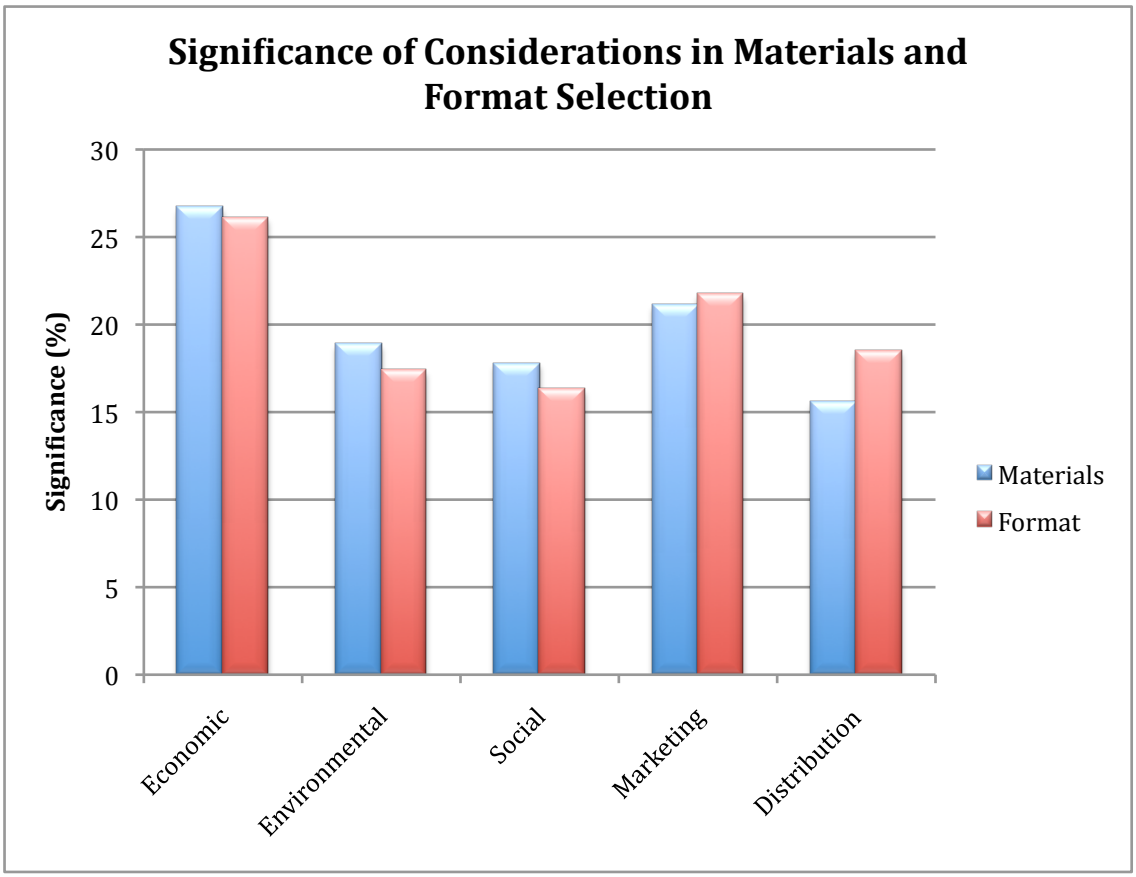


Diagram 1 – Unofficial Packaging Design Process (Main steps are highlighted in grey)

Another point of interest was the engineers' reaction to sustainability trends and willingness to design accordingly. To do that an additional question was added to the survey, which asked to rate the five given design considerations in order of importance for the material and format choices. Results shown in Graph 1.



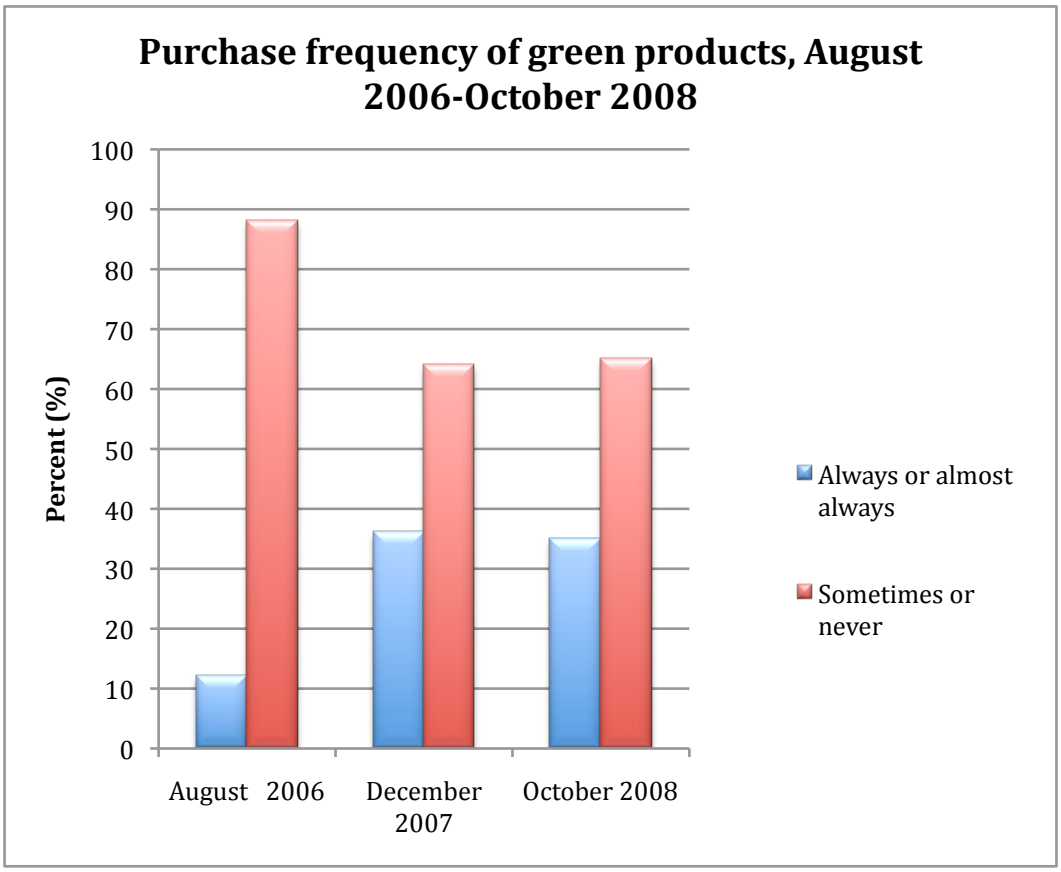
Graph 1 – Eastman Kodak Design Process Survey (Feb 2009)

This showed that the environmental and social concerns are not at the top two for either one of the topics covered in the question, thus showing that despite the sustainability push from the industry in general and within the company in particular, the design considerations have not changed at all. It is possible to assess that they will not change unless the design process becomes a regulatory obligation that will require a paper trail. Alternatively, the packaging engineers were not sure what the environmental or social concerns implied. The survey was given after the implementation of the Package Development Optimization Tool, and even with that

push, the participants did not feel an overall need to change their considerations for design.

"Green" Packaging

It is becoming evident to many companies, as well as consumers, that there are many sustainability claims in the marketplace. It is also clear that consumers are interested and willing to buy products that claim sustainable/green/environmental improvement, or reduced impact. Market research group, Mintel, found that between 2006, 2007 and 2008 the amount of consumers that regularly buy "green"[1] products increased by 300%. In addition, by 2009, 1/3 of all consumers always or almost always purchase "green" products, as shown in graph 2.



Graph 2 – Packaging Trends in Food and Drink – US (Mintel, 2009)

[1] Green products according to Mintel: "'green' products in general (such as organic or locally produced food, recycled paper, natural cleaning products, cars with high MPGs, or appliances with Energy Star ratings)"

Additionally, Mintel also found that the amount of products launched to claim a greener approach had grown exponentially since 2002, where only five products fell under that category, compared to 2007 where "there were 328 new products, representing a 200 percent increase since 2006"(Crowley, 2008).

However, packaging is still the largest component of the solid waste stream (Min & Galle, 1997), which becomes a place for environmental and social concerns, providing for improvement opportunities. Many companies have positioned themselves as being "green" or sustainable and market their products or brands as having addressed environmental initiatives. Having design processes that can provide proof of the validity of the packaging through better choices or a paper trail can provide an advantage to a company and minimize any commercial risks.

Sustainable Package Design

Sustainable package design considers all aspects of a holistic approach. It works to minimize the negative environmental, social and economic impacts, and maximize positive outcomes (i.e. seed impregnated corrugated box that can grow a plant once planted and watered) (Thompson, 2007).

Sustainable packaging looks at material choices and formats as the keys to a favorable design. It considers the following aspects (Parra, 2008):

- Minimizes package weight
- Optimizes cube utilization
- Looks for materials that satisfy multiple packaging functions (protect, contain, promote – i.e. barrier properties, labeling, printability)
- Strives for a closed loop reusable system
- Use of materials that can be recycled in the target markets
- Provide for alternative uses to the consumer if can not be recycled in the recycling stream
- Use recycled content materials when appropriate
- Considers compostable materials or biodegradable in land fills
- Avoid complex and mixed materials
- Avoid multiple materials in same packaging systems

- Avoid unnecessary packaging components

Ultimately sustainable design in packaging should strive to create a system that considers all the steps above, while trying to prevent a negative, long-term impact.

The Purpose

The purpose of the study is to determine the validity of a new quantitative design tool—Sustainable Packaging Design Tool (SPDT)—by comparison to the Package Development Optimization Tool (PDOT) through the removal of the material matrix and the addition of the COMPASS^{SM} web based software. The new tool will provide an assessment of the environmental impacts of the designs, and provide for a data driven decision-making process.

Nature of Study (Methodology)

Prior research of the design process at Kodak lead to the creation of the PDOT, and although found to be problematic in its use it was implemented in January 2009. The new tool, SPDT, incorporates COMPASS^{SM} with parts of the PDOT to provide for a material LCA data- based design tool.

The quantitative, SPDT tool is evaluated against the original optimization tool, PDOT, through the opinions and views of the packaging engineers to provide a better understanding of the value of the two tools.

COMPASS^{SM}

> COMPASS^{SM} (Comparative Packaging Assessment) is an online software tool for packaging designers and engineers to assess the human and environmental impacts of up to four package designs side-by-side… COMPASS is intended as a design phase tool that helps designers consider the environmental impact of a package's entire life cycle - from manufacture to end of life… (Sustainable Packaging Coaliton, 2008)

Procedure

Subjects

Eastman Kodak Company is comprised of three overarching business units: GCG, CDG and FPEG. Each unit has its own internal structure, but certain sections in the company are considered corporate. This in turn means that they report directly to the corporate management and not the business units alone, and serve all three-business units at once. Kodak's business structure is unconventional as it relates to the packaging group. The packaging professionals are familiar with each other, as the original organizational structure was a centralized packaging group that

supported all businesses, as shown in Figure 3.

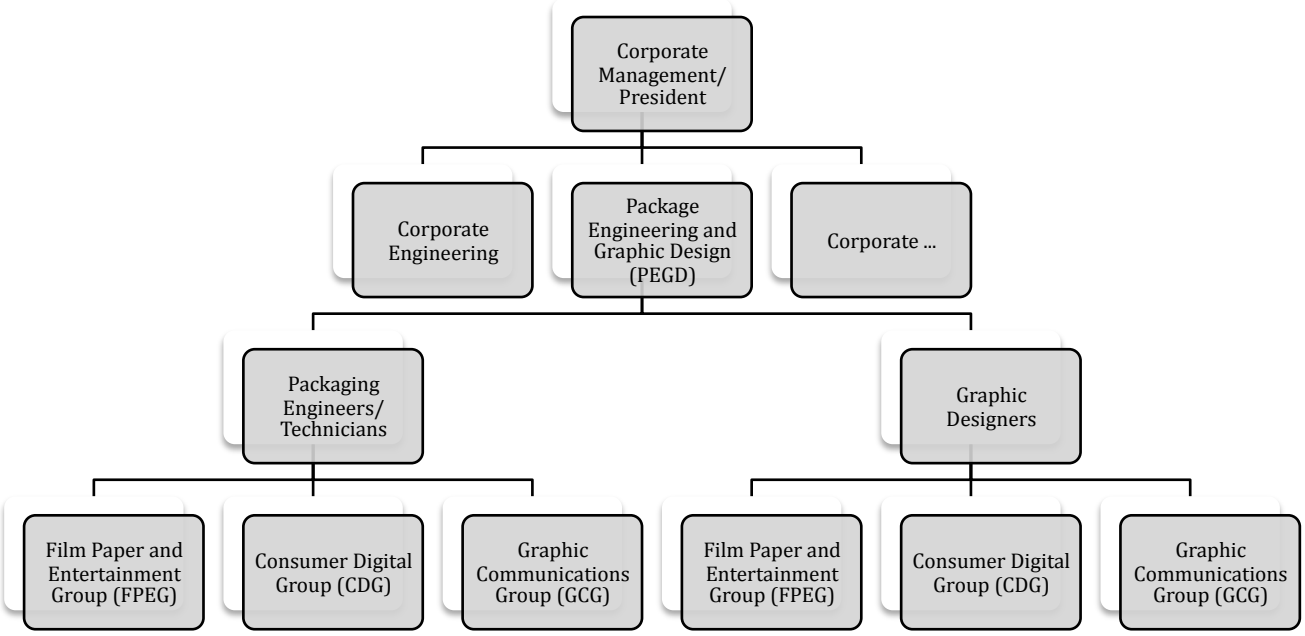
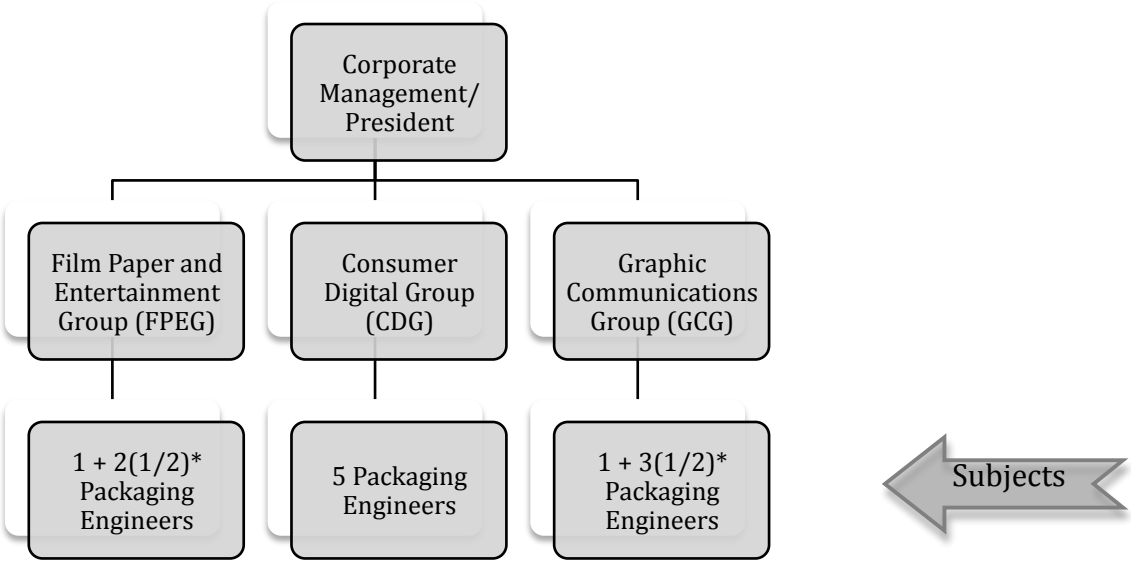


Figure 3 – Eastman Kodak Company; Original Organizational Structure

A restructuring created an alternative composition. The new structure (Figure 4) potentially affects the interaction between the individuals and the sharing of tacit knowledge that impedes consistency of design decisions.



* Some packaging engineers are assigned to more than one business unit through the corporate engineering's PAE group.

Figure 4 – Eastman Kodak Company, New Organizational Structure

In this study, the subjects are the nine active packaging engineers, a packaging technician and two packaging managers. Their opinions will determine the results of the study. Due to the small group size, the sample and the total population are one and the same.

Data-gathering

The subjects will be asked to use the original Package Development Optimization Tool and the Sustainable Packaging Design Tool for the design of packaging for the same product. They will then be instructed to fill out a survey (Appendix IV) that will ask them to determine the length of time until the decision is made, consistency of results and satisfaction with the final design decision while comparing the two tools.

Variables

Independent Variable: Sustainable/quantitative Packaging Design Tool (SPDT) (See Appendix III) .The environmental impact data is partially provided by entry of results from COMPASS^{SM}. The engineer is expected to input all data entries into COMPASS^{SM} which includes the following information: (SPC, 2008)

Add Primary Package

- Name – Input of name of primary package
- Description – Description of package or product
- Capacity – Input of capacity (numerical)
- Data Set – Choice of US, EU or CA data sets

Add New Component

- Name – Input of name of primary package
- Description – Description of package or product
- Data Set – Choice of US, EU or CA data sets
- Material – Choice of packaging material
- Amount – Amount of material used in package, in grams

- % PCR – Post consumer recycled content
- % Certified – FSC (Forest stewardship council), or any other dependent on material.
- Conversion – Choice of Conversion process based on material choice
- Packaging Type - Choice of Packaging Type based on material choice

Once finished filling in the data in COMPASS[SM], the engineer is then expected to look at the bar graphs that are presented in COMPASS[SM] and copy that data into the Microsoft® Excel spreadsheet (Appendix III), along with the financial data (provided by the commercialization team, marketing, purchasing or suppliers), to receive a recommendation of which of the design options had the minimal or maximal overall impact.

Dependent Variables:

a. *Decision Making Process: Time – change in efficiency*

   A measure based on the personal experiences of the subjects, as reported by them through an anonymous survey.

b. *Satisfaction in the Final Design Decision*

   A measure based on the personal experiences of the subjects, as reported by them through an anonymous survey.

c. *Consistency of decision making among subjects*

   The subjects engagement and interest in providing an objective solution through the use of the SPDT could create consistent and reproducible results when using the SPDT.

Confounding Factors:

a. *Personal knowledge of subjects*

   Investigators personal knowledge of the subjects can affect the objectivity of results. To minimize subjectivity, minimal discussion will be held about the topic prior to the study.

b. *Subjects' biases towards supplier choices*

Subjects' material preferences can be affected by a long-standing business relationship with suppliers.

c. *Subjects' predetermined material preferences*

Subjects' material preferences can be affected by previous experience with similar projects, products or perception of certain materials.

d. *Unwillingness to fill out an additional document*

There is an inherent resistance to an additional form of paperwork, as the size of the company already generates numerous processes that require excessive documentation.

e. *Workload – lack of time*

Due to the increased workload of the subjects, the attention that is needed to provide viable, truthful results to the study might be lacking.

Control: Package Development Optimization Tool

The tool's main objective is ultimately striving to minimize resource use.

> Package size, number of components and material choice are the main factors that affect the minimization of environmental impact of a packaging system. Use this tool to ensure that the minimum amount of material is being utilized to protect the product and that the material choices are aligned with the material strategy matrix included in this tool. (Package Development Optimization Tool, Eastman Kodak, 2009)

Currently, this tool is a set of questions meant to prompt packaging professionals to use best practices in their decision making process when designing new packaging systems.

In the process, the engineer chooses the type of package and materials involved in the design of the existing package, or a revision of an existing design, as well as two options for new design ideas. He or she is then required to answer the following questions by entering a number or definition, for each of the options:

- Space Utilization: Determines the percentage space utilized in a full container. (up to 100%)
- Materials Weight: Packaging materials weight of all materials involved in the

system. (Weight in g or Oz)

- Number of Components: Total number of components utilized in the design. (Entering number 1-10)
- Complexity of Materials: Determines whether complex format materials are used. (i.e. multi layer: tri- layer films, laminated paperboard)
- Reusable Format: Determines whether some or all of the system can be reused in the same function.
- Complexity of Format: Specifies the number of different materials included in the design.
- Cost: Enter baseline cost of the packaging system.

Excluding the first option, space utilization, under each of the main questions outlined above, the tool also asks additional questions to direct the designer/engineer to think further about reduction, elimination or change for each of the sections. The questions are as follows:

- Materials Weight: Can you reduce weight?
- Number of Components: Can packaging components be eliminated?
- Complexity of Materials: Can less complex materials be used?
- Reusable Format: Can other materials be reused?
- Complexity of Format: Can you reduce the number of dissimilar materials used?

For this tool, the only data that is provided by the tool comes in the form of the materials matrix (see Figure 5/Appendix I) that separates materials based on their "intended purpose." The five columns, *Restrict, Minimize, Neutral, Promote and Watch*, direct the designer to use the materials in the Promote or Neutral columns, while avoiding the ones in the Minimize and Restrict columns. The Watch column is set for materials that are under scrutiny due to being very new, or have a negative reputation, but not restricted in any regulations. (Chart says observe but text says watch. Need to match.)

	Restrict	Minimize	Neutral	Promote	Observe
Paper		SBS		Kraft - RC	
		Bleached		Molded Pulp - RC	
				Paperboard - RC	
Plastic	PVC	Mixed Resin	HDPE - Virgin Resin	HDPE - RC	PLA
		PS - Expended	LDPE - Virgin Resin	LDPE - RC	Bioplastics
			PET	RPET	
			Polyurethane		
			PS - Injection molded		
			PP		
			Nylon		
Metal			Galvaneal Steel		
			Coated Tin Free Steel		
			Zinc Coated Steel (fasteners)		
			Aluminum		
Wood	Methyle Bromide Treated		Solid Lumber	Manufactured Lumber	
Glass		All grades			
Other	HM Ink		Inks		Soy Based Ink
		Laminated Films	Cold set latex adhesive	Reusable Format Containers	Biodegradable
			Coatings (labels, cartons, flexibles, wood containers)		

RC - Recycled Content

Figure 5 - Packaging Optimization Tool; Material Matrix

The selection of materials was based on the interviews that were initially conducted to determine the materials used in the company. The materials matrix was populated by Carol Herring (Manager, PAE) and the author, with input from a representative from each of the strategic project groups (SPG) and the counterpart in HSE who provided the group with effective regulatory restrictions. The population of the materials within the respective columns is based solely on the input from the individuals involved, and is not found in any research or literature.

The tool's interface is an Adobe PDF form that was created by the author. The form allows the designer to fill out the name of the Packaging Engineer, Date, Catalog # of the product, Product Name and Name of the SPG. It then directs the user to look at the material matrix and fill out all of the materials used and answer the questions mentioned above, eventually prompting to choose his/hers preferred option between those entered.

The form does not provide for any data or any numbers outside the ones entered by the engineer. It presents a side-by-side comparison of the materials and

numbers for different packaging system designs, but does not recommend any of the options as preferred.

Data Analysis

The results of the survey will be used to determine whether the new LCA based tool (SPDT) can be better utilized and provide usable data for sustainable package design. The data gathered through the survey will be based on the experiences and opinions of the packaging engineers that are usually responsible for package design.

All the answers will be analyzed in accordance with the questions and the dependent variables.

Scope and Limitation

Scope

This study focuses on the addition of material life cycle assessment information to a packaging design tool with the help of the COMPASS^{SM} online software, and to understand its effect on the design process and consequently the community, i.e. packaging engineers.

The conceptual framework of the study creates a major change in the original design tool to effectively track the effects of that change on the design processes and, subsequently, the subjects of the study. A quantification of the material choices will provide for an in depth view of the design alternatives and potentially change the design decision and reduce negative impacts.

COMPASS^{SM} provides multiple life cycle inventory matrices, but for the purpose of the study we will concentrate on the following: (SPC, Life Cycle Matrics, 2009)

a. Fossil Fuel Consumption (MJ – eq)

   A measure of the total quantity of fossil fuel consumed throughout the life cycle to produce the primary, secondary or packaging system reported as in megajoules equivalents per gram of packaging material. This metric assumes the impacts of different fossil fuel types as being the same (i.e. 1 MJ of coal is the same as 1 MJ of crude oil or 1 MJ of natural gas).

b. GHG Emissions (kg CO2 – eq)

   A measure of the total quantity of greenhouse gases (GHG) emitted during the production of the materials used in the primary, secondary or packaging system in kilogram of CO2 equivalents per gram of packaging material. Global warming potentials (GWP) from the Intergovernmental Panel on Climate Change's (IPCC) 2007 are used for GHG calculations.

c. Eutrophication (kg PO4-eq)

   A measure of the quantity of environmental emissions generated during the production of the materials used in package design which contribute to Eutrophication; reported in kilogram of phosphate (PO4) equivalents per gram of packaging material. Eutrophication is the increase in chemical nutrients, typically compounds containing nitrogen or phosphorus, in an ecosystem. This results in an increase of the ecosystem productivity – excessive plant growth and decay.

d. Human Impacts (DALY)

A measure of the quantity of environmental emissions resulting in particulate, cancer & toxic non-cancer impacts to humans released during the production of the materials used in the package design. The metric reports the three measurements in Disability Adjusted Life Year (DALY) per kilogram of packaging material. This metric is an aggregation of the USEtox method developed by the UNEP/SETAC Life Cycle Initiative and assessment method for particulate emissions from the Harvard School of Public Health.

e. Material Health (SPC, Attributes and Material Health, 2009)

The material health table represents a listing or tally of chemicals used during the last unit process (step) of primary packaging material manufacturing. In the U.S., these chemicals are referenced from the California Proposition 65 List of Chemicals Known to the State of California to Cause Cancer or Reproductive Toxicity and U.S. EPA's List of priority Chemicals, which includes persistent, bioaccumulative, and toxic substances. In Europe, these chemicals are referenced from similar lists released by the REACH laws of 2007 (Registration, Evaluation, Authorization and Restriction of Chemical substances).
Each entry provides a "story line" for the chemical input, which tells the designer what happens to the input during the manufacture process. The intention is that over time, designers may be able to seek out alternative materials with reduced hazardous inputs and, perhaps design out such chemicals.

Limitations

a. The COMPASS℠ Software and the data provided is not company specific. The

Company license agreement states the following:

COMPASS environmental profiles represent a simplification of the actual interactions between a package design and the environment, and are based on industry average, third-party verified data that are subject to considerable uncertainty. In addition, the data in COMPASS are limited to a certain number of materials, cover only three life-cycle phases (manufacturing, conversion and end-of-life) and do not address performance or cost considerations for a material. For these reasons, COMPASS is intended to and should be only one source of information used to make package design decisions. Your access to and use of COMPASS is conditioned upon your payment of any required license fee to GreenBlue and your adherence to the terms of this agreement with GreenBlue, the owner of COMPASS, and all intellectual property rights associated with COMPASS. (SPC, License Agreement, 2008)

b. Due to the nature of the data, SPC also refrains from offering the COMPASS[SM] data as marketing claims, and states in the restriction section: "COMPASS and the data generated by COMPASS cannot be used in any marketing or advertising claims for any product, service or company" (SPC, License Agreement, 2008).
c. Sample size: Due to the small packaging engineers group (12) in Kodak, the sample size is limited in its ability to provide for a better representation.
d. Active participation: It is likely that not all subjects will participate in the survey, thus reducing the amount of raw data even further.
e. Resistance to change: Subjects might be resistant to an additional tool, and might claim that they already have enough workload and assistance tools.
f. Subject – Investigator relationship: The investigator's previous work with many of the individuals and the interpersonal relationships created might skew the results or the willingness/ability to provide objective answers.
g. Lack of Diversity: The participants of the survey work at the same company and industry, mainly have the same education and background, and as such their design and engineering views might be limited to the same set of experiences.

Note: Alternatively, having multiple engineers from different companies and different industries could have created a much more diverse sample with different results.

Significance

The study provides for a value analysis of an LCA based design tool. The updated tool encompasses environmental impacts of the material, and subsequently, the format decisions that are made by the package designers/engineers.

As the need for sustainable package design increases, the engineers' understanding of the long-term affects of their design will become imperative for a superior choice. The design choice may only be value based, but ultimately it might be subject to regulatory or marketing scrutiny. The use of the tool and the ability to

retain the alternatives as well as the final choice, and an ability to explain and defend it, might be used as a conviction in case of audits or reviews of the design solution.

Without referencing LCA data in the design choices, the decisions are inherently lacking, as they do not have the quantitative and objective information needed to make the best possible decision for all parties involved (company, nature, community). The impact that the materials and formats of the packaging have on society and environment are at times misunderstood, both from a professionals' standpoint, as well as consumers' standpoint.

If the SPDT is proven to be more effective, the use of the tool will allow packaging engineers to have more reproducible and objective results, and the ability to understand and think in terms of sustainability oriented design, which goes hand in hand with the goals of the company's businesses and society as a whole.

Long Range Consequences

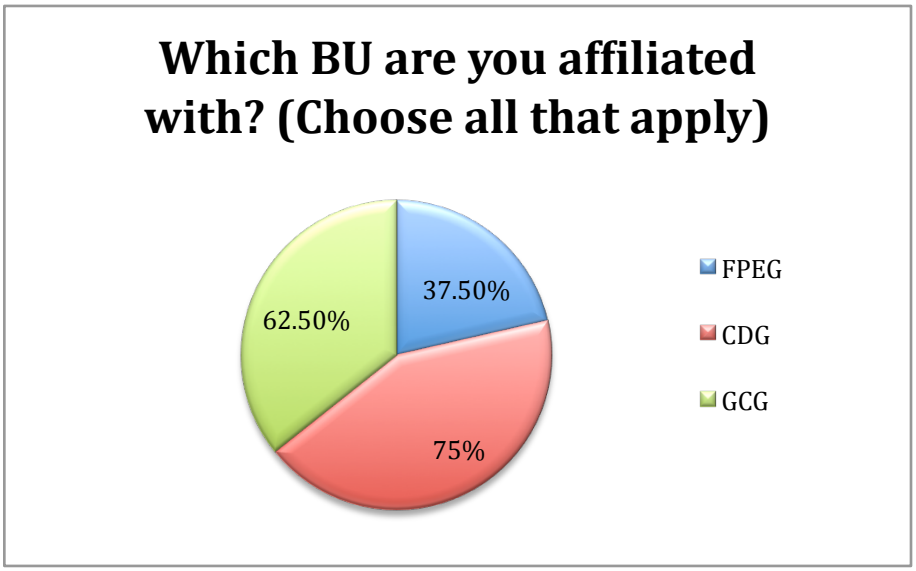
The knowledge provided by this study will help packaging engineers and designers understand the tools that are needed for sustainable package design. This tool will provide information in regards to the quantitative vs. qualitative design options and whether one is preferred over the other, which in turn can save companies money either by eliminating the need for unused data, or by providing for tools for a smarter design.

Results

The results of the survey refer to the initial hypothesis that states that there is a direct and positive relationship between the additions of the LCA data via COMPASS[SM] software to the design tool, and an increase in overall design process efficiency (through reduction in decision making time, increase in satisfaction and consistency of results).

Due to the low number of packaging engineers in Kodak, twelve individuals were invited to participate in the surveys. Out of them, ten were in attendance and eight completed the survey in full. Seven surveys were submitted by participating packaging engineers and the additional survey was filled by a technician who often servers as a packaging designer on projects.

Results presented here represent the summary to the survey answers, as shown in Appendix V.

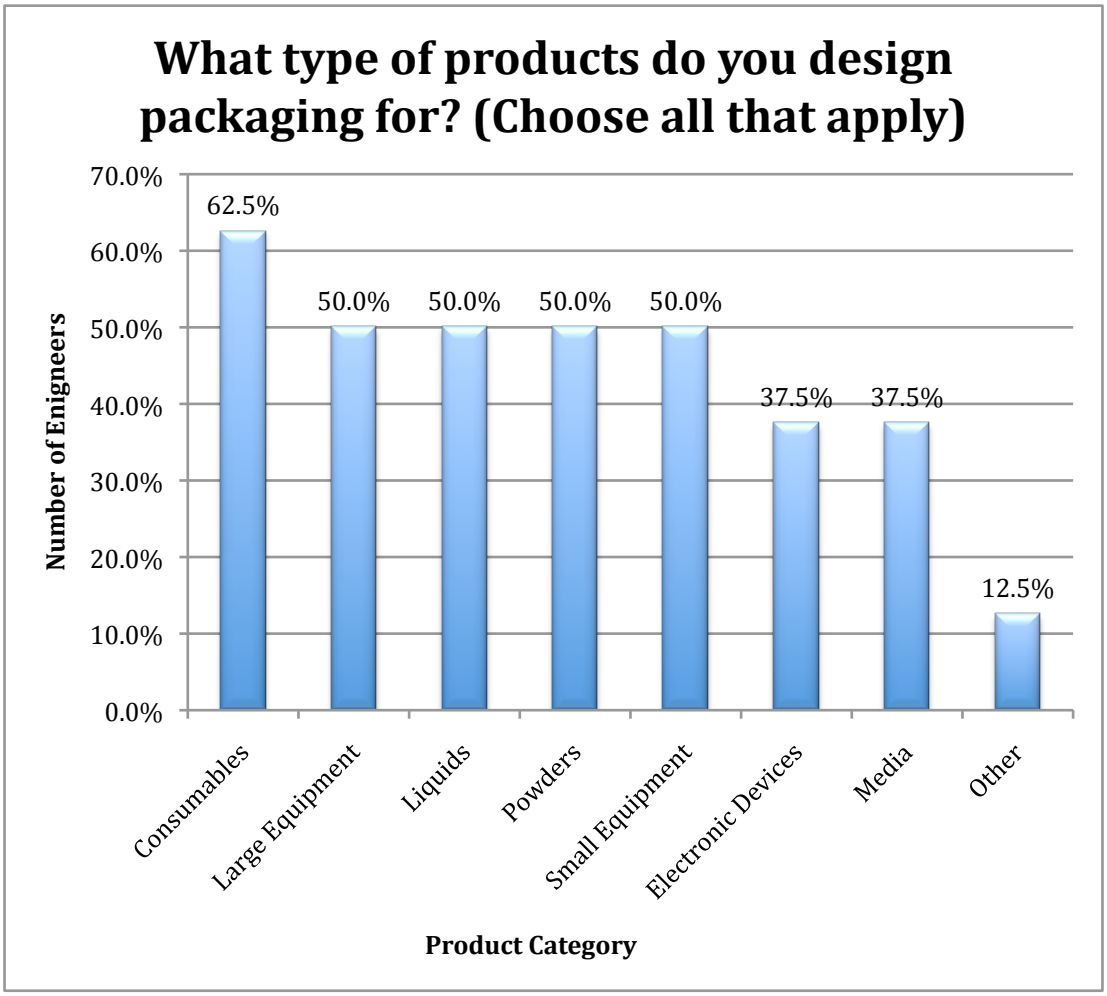


Note: The pie's values exceed 100% due to the fact that some engineers divide their time between two or three of the Business Units (BU's).

Graph 3 – Resource Allocation by Business Unit

The graph above shows that most of the engineering resources (75%) are allocated towards the CDG (Consumer Digital Group) business. As much of the work that is done in CDG is private consumer driven (cameras, frames, batteries, etc). As such, there is a very intense push from both marketing and purchasing to drive the

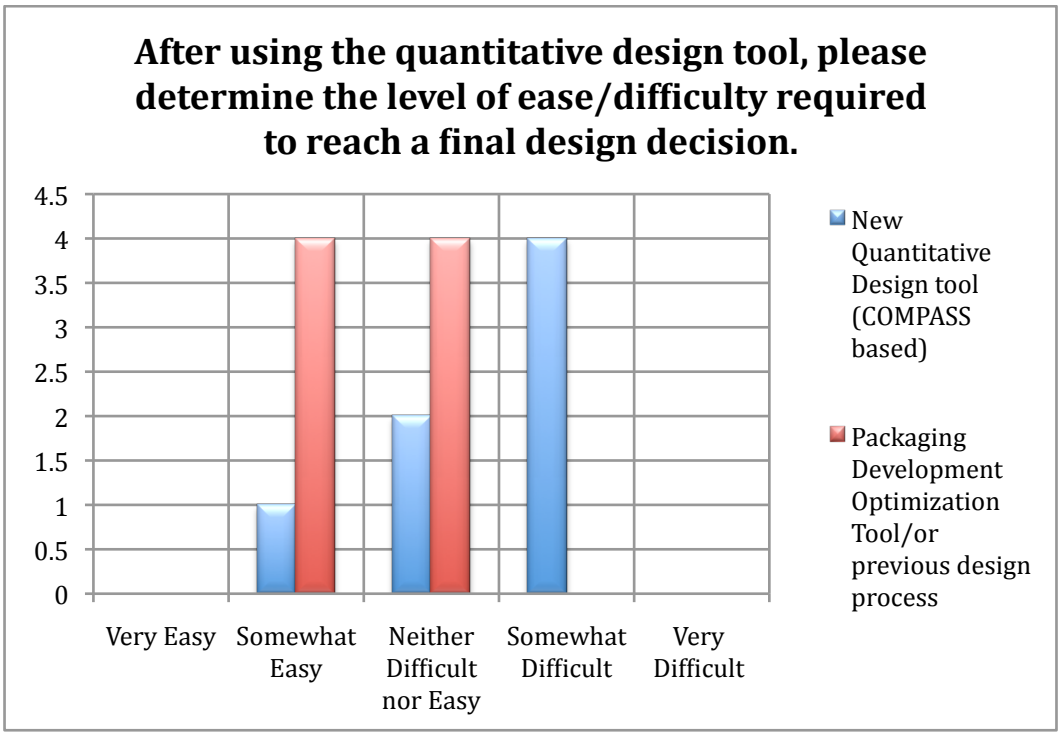
consumer to the package, yet at the same time contribute to savings and promote sustainability. GCG (Graphic Communications Group) follows with 62.5% of the engineers' time allocation, and as much of that is being allocated towards commercial printing projects where much of the work is being done on shipping and logistics optimization. The FPEG (Film Paper and Entertainment Group) business requires about half the allocation of GCG. As the principal and most established part of Eastman Kodak it has had the most attention throughout the years, and as such the most developed packaging supply chain. In addition, its stable decline over the past decade has required a reduction in work force resource allocation.



Graph 4 – Allocation of Resources by Product Type

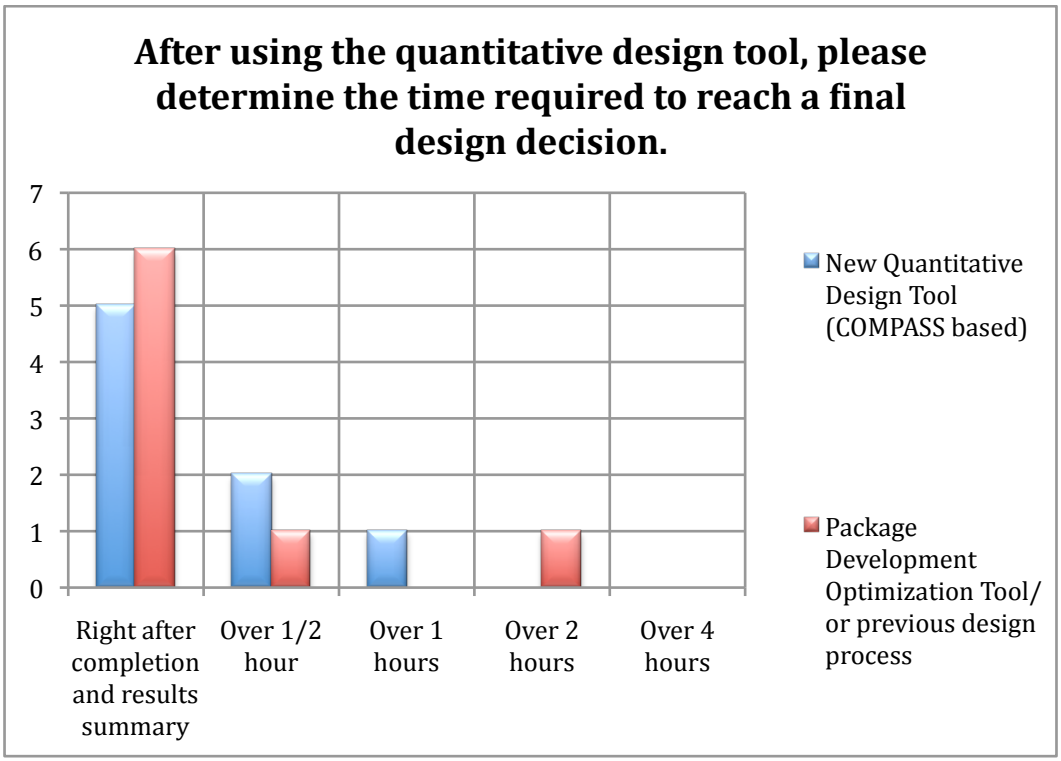
The categories above were divided per product categories, as follows:
Consumables – Traditional Film, One-Time-Use-Cameras (OTUC), Consumer Ink, Motion Picture Film, CD's
Large Equipment – Commercial Printers, Printing Presses, Picture Kiosks
Liquids – Photo Chemicals
Powders – Photo Chemicals
Small Equipments – Parts, All-In-One Printers, Document Imaging Printers
Electronic Devices – Digital Cameras, Digital Frames, Batteries, Devices
Media – Traditional Paper, Thermal Media
Other – Paper, Ink, Toner

Graph 4 shows that most of the participants work with the *Consumable*s category that includes products from both the traditional business, as well as the newer businesses.
50% of the participants claim to design packaging for *Large Equipment, Liquids, Powders* and *Small Equipment*.
37.5 % of the participants assert to designing packaging for *Electronic Devices* and *Media*.
The *Other* category was intended to include any and all other products that were not mentioned in the options above, and as such only one participant found the other category more suitable for his product, rather that the options given in the question.



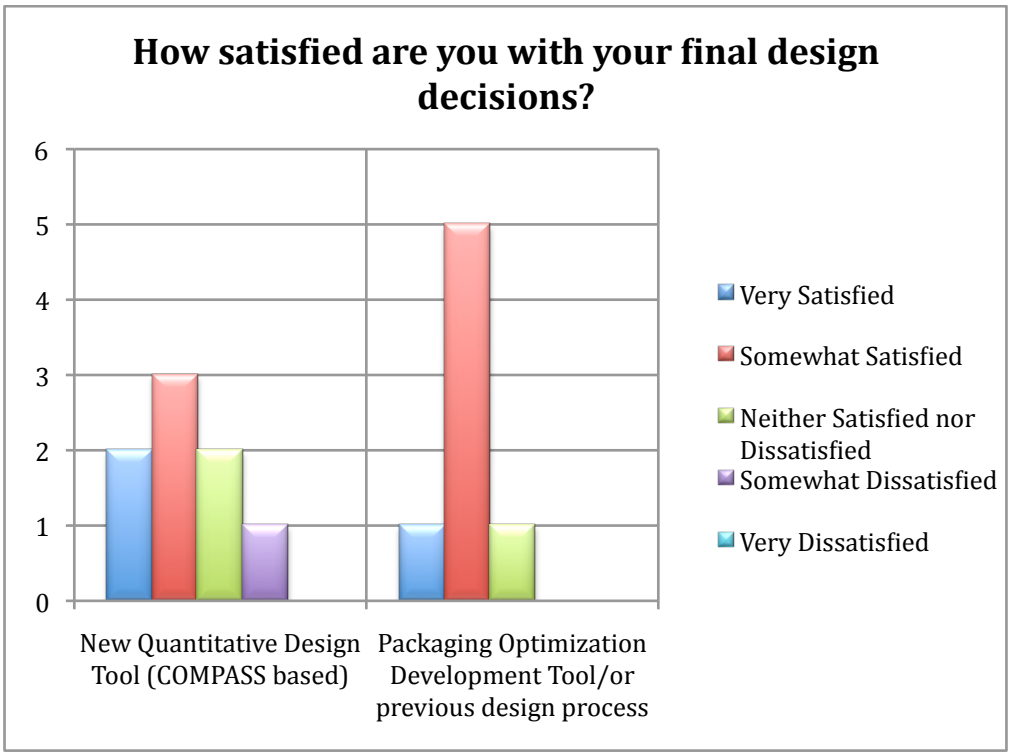
Graph 5 - Difficulty in Using the Different Design Tools

Graph 5 shows that the subjects felt that completion of the packaging optimization development tool is *somewhat easy* to *neither difficult nor easy* while the new quantitative design tool is on the harder side with *somewhat difficult* as the result for most responses.



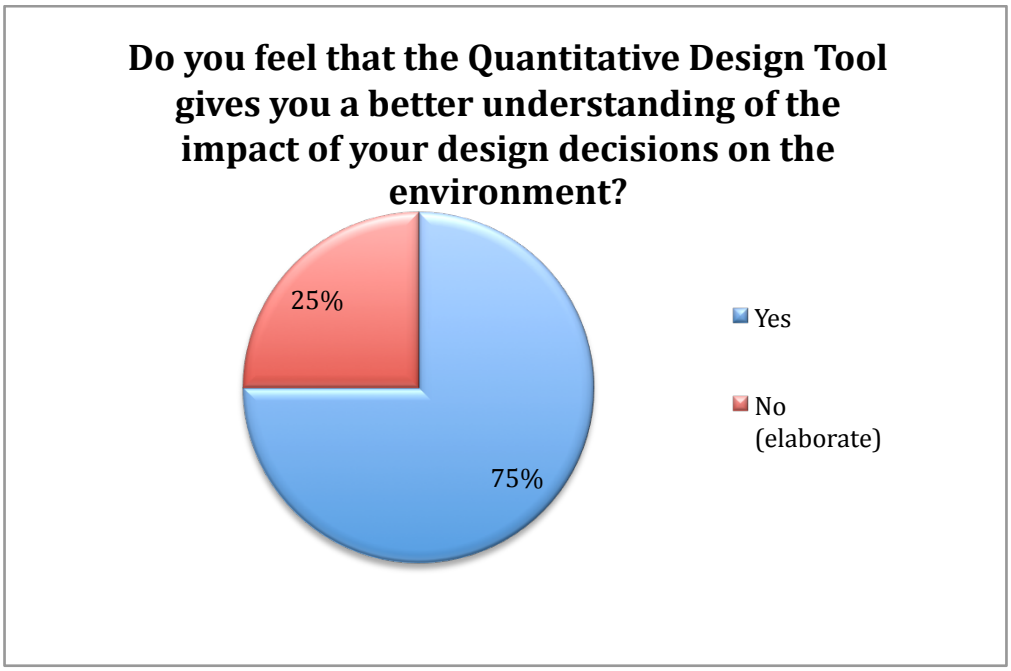
Graph 6 – Time Required to Reach a Design Decision

Graph 6 shows that although the new tool is harder to complete, as shown in the previous question, the decision making time is almost the same with the majority of the subjects, indicating an immediate completion time. The remainder of the subjects indicated that they required between half an hour and two hours to make a decision based on the new Quantitative Design Tool, and between half an hour to over two hours based on the Packaging Optimization Development Tool.



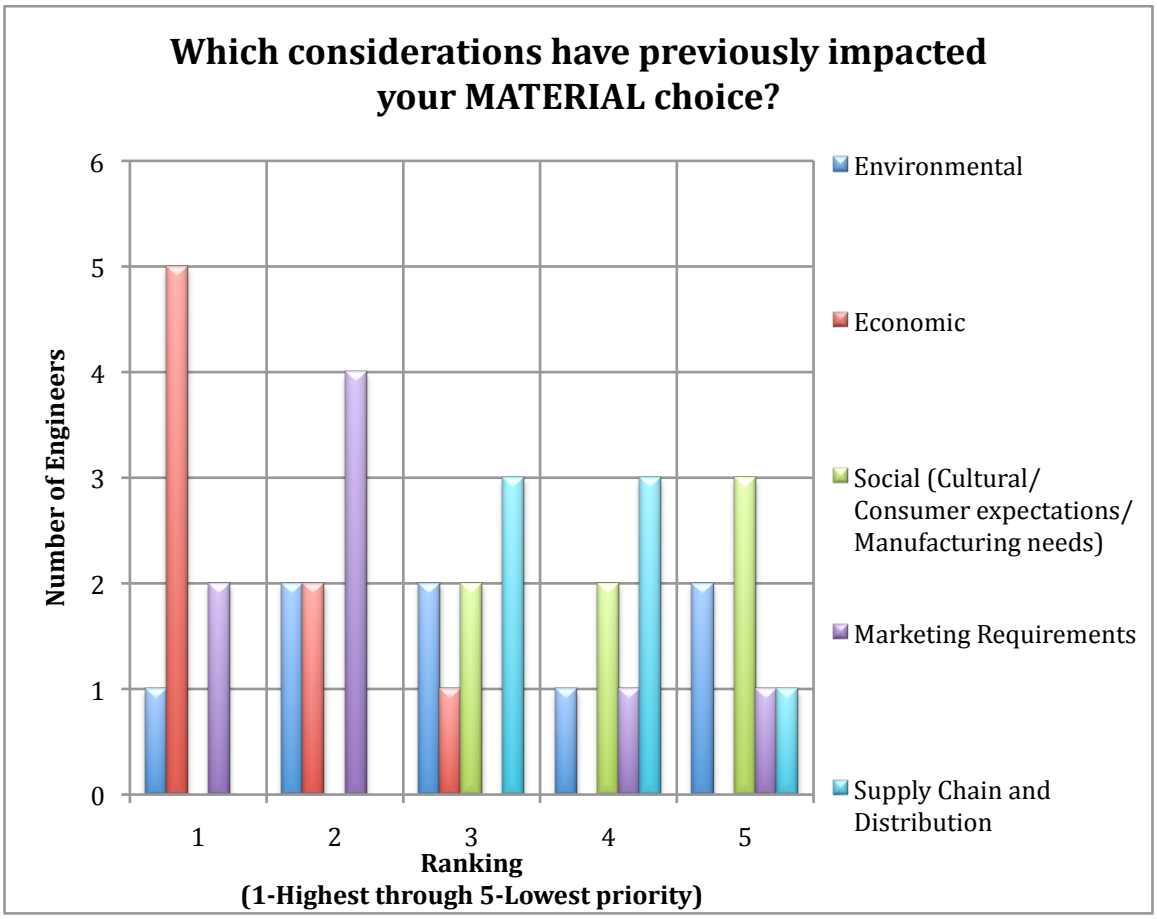
Graph 7 – Satisfaction with the Final Design Decision

The graph above shows that where as most subjects (86%) were satisfied with their design decisions using the Package Development Optimization Tool, they didn't find the Sustainable Packaging Design Tool to be as useful for them. 62% were satisfied with their design decisions, yet 25% were ambivalent about their decision and 13% were dissatisfied with their decision.



Graph 8 – Understanding of Impact on the Environment

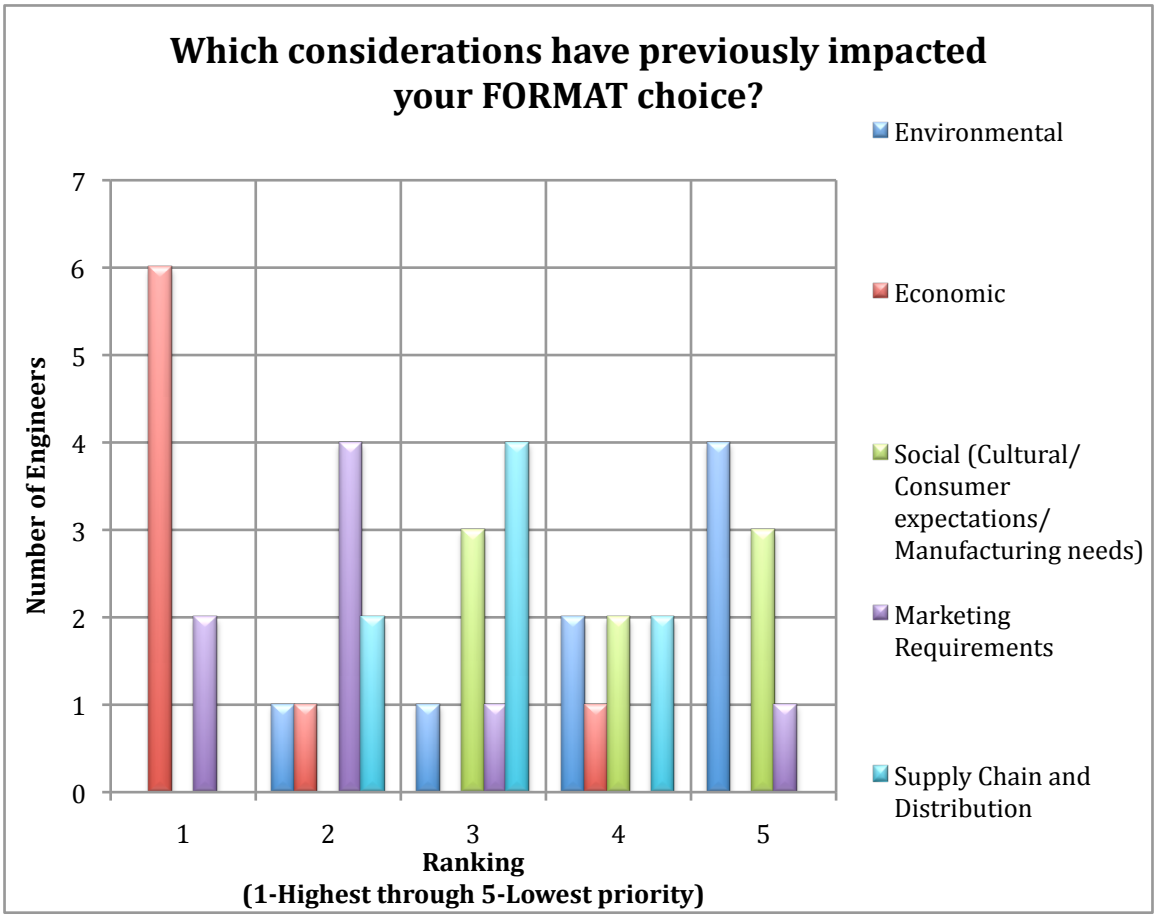
75% of the respondents found the information provided through the Quantitative Design Tool to give better understanding of impact of the design on the environment. The remaining 25% indicated the reason for the 'misunderstanding' was due to the fact that "the program is rather difficult as the steps progress," as well as, "I feel that this tool just reinforces my qualitative assessment. I feel that the fact that it doesn't include distribution life cycle is a major deficiency."
It is important to note that the subjects didn't have much time to use the tools prior to the survey.



Graph 9 –Ranked Material Choice Consideration (Previous)

The graph above shows very clearly the highest and lowest priorities as it pertains to material choices. 100% of the participants placed Economic considerations in the top three rankings, with 63% choosing this category as a first priority. 25% chose it as second priority and the remainder at a third priority. The Marketing Requirements came in second with 75% choosing it in the top two rankings, with 25% as first priority and 50% as second priority. However, the remaining 25% of the participants chose it as a forth or fifth ranking. Interestingly, the Environmental consideration is the only one that appeared in all rankings prioritizing from 1 through 5, with 38% in both the two highest and two lowest priorities. Supply Chain and Distribution ranked forth in the overall importance category with 100% ranking in the bottom three priorities, 43% in both the third and forth priority, and the remaining 14% in the fifth priority. Consequentially, Social Considerations ranked last, also with 100% of the rankings in the bottom three priorities, yet 72% considered those to be

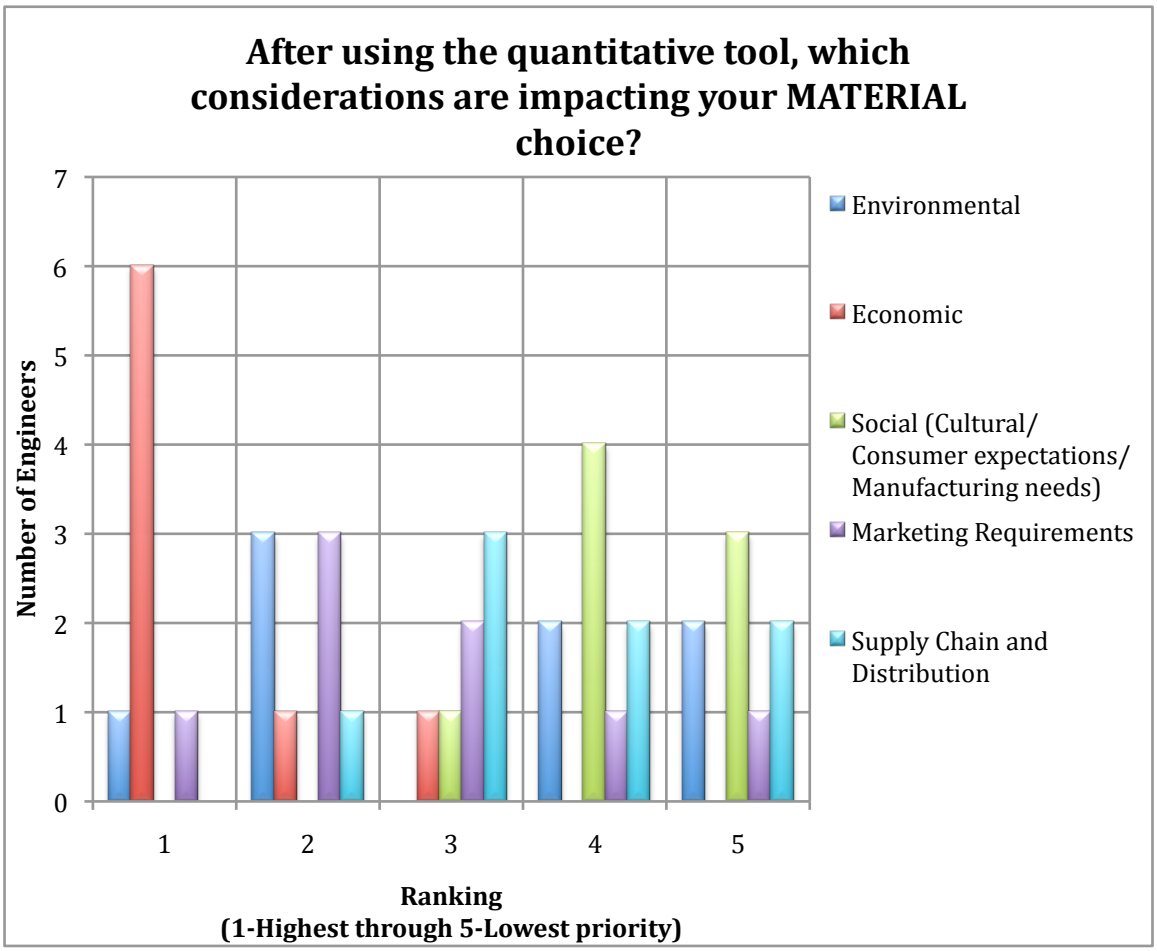
priority four or five.



Graph 10 –Ranked Format Choice Consideration (Previous)

The graph above shows that the Economic Consideration takes priority above all else with 75% choosing it at highest priority, and 12% as second highest priority.

Again, as with the material priorities, Marketing Requirements take on a high priority with 88% ranking it in the top three priorities. However, the difference comes in with Supply Chain and Distribution becoming the third consideration, with 75% at the second and third considerations and 25% at the fourth. Also interestingly, the Social Considerations move up one spot to become a fourth consideration, with 50% at the second and third priority and 50% at the fourth and fifth. In the format choice, Environmental Considerations move down two spots to become the lowest priority, with 57% choosing it as a fifth ranking.

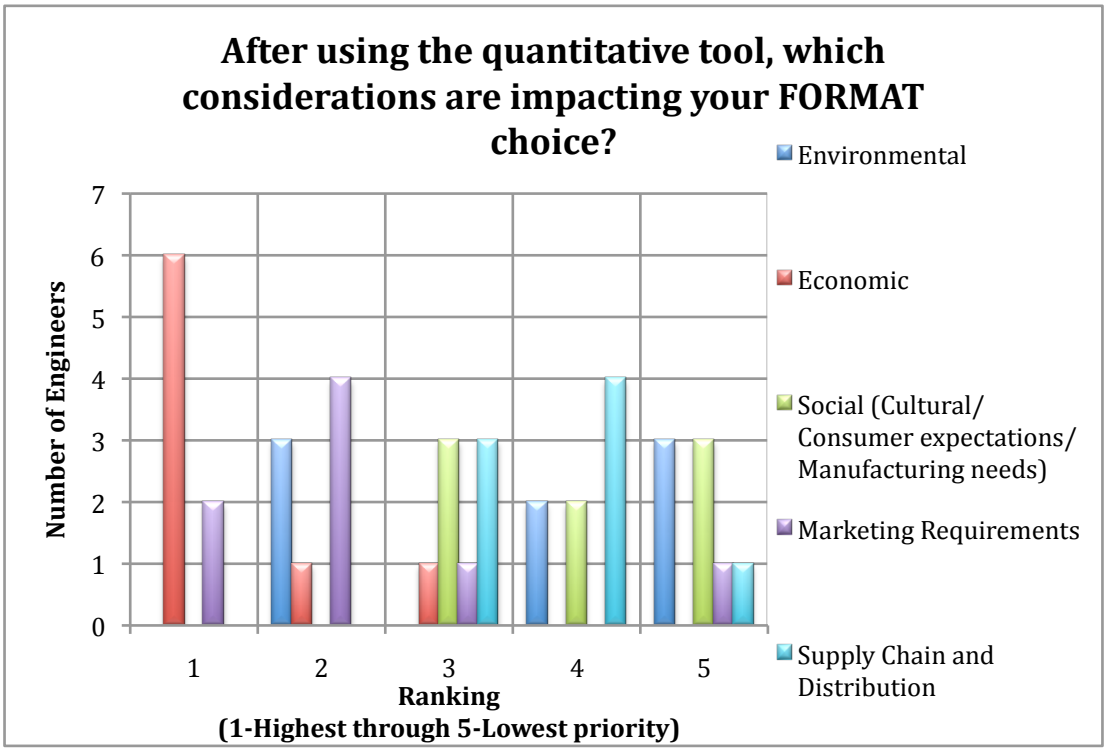


Graph 11 – Ranked Material Choice Consideration (SPDT)

Similar to the results in Graph 9, the graph above indicates that the primary consideration is Economic, followed by Marketing Requirements, Environmental, Supply Chain and Distribution and lastly Social Considerations.

75% of the subjects have indicated that Economic considerations are at a first priority, and 12.5% each for a second and third priority. Marketing Requirements priorities are dispersed among all of the five rankings yet the majority is still between the first and third priority (75%). 37.5% of the subjects chose the Environmental Consideration at the second priority,, ultimately indicating 50% at the first and second priorities, combined. Yet the other 50% were chosen as a forth and fifth priority.

12.5% of the subjects chose Supply Chain and Distribution considerations as a second priority, while 37.5% chose it as a third. The remaining 50% chose it as a fourth and fifth priority, inevitably suggesting that Social considerations are not a priority when it comes to material selection. 12.5% chose is as a third priority, 50% chose it as a forth priority and the remaining 37.5% chose it as a fifth priority.

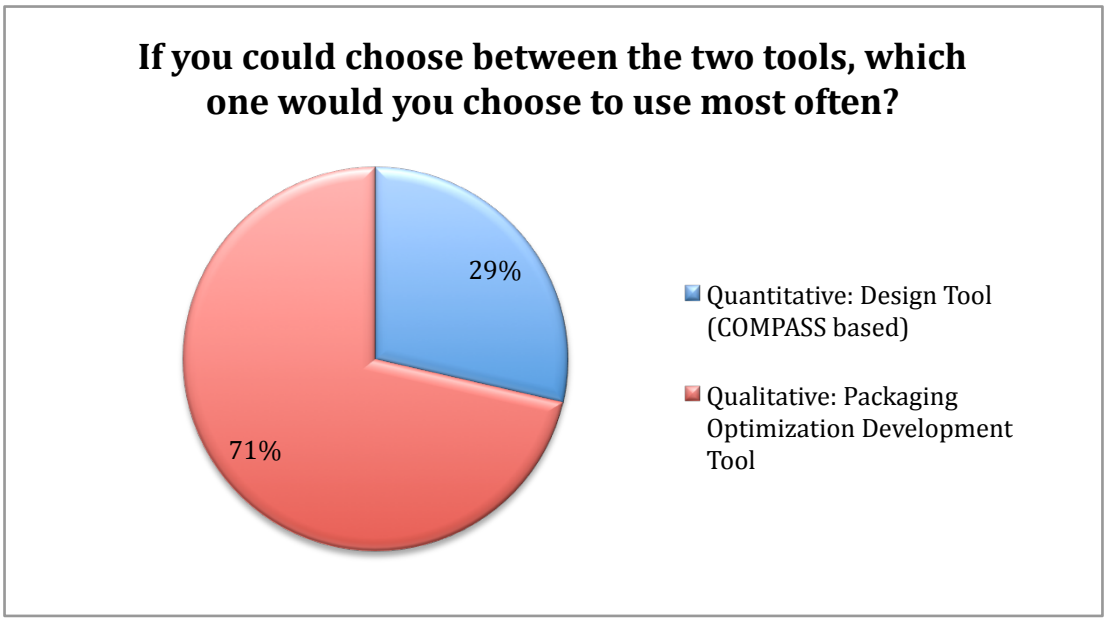


Graph 12 – Ranked Format Choice Consideration (SPDT)

The graph above indicates a very similar distribution to Graph 11, yet different from Graph 10, to which the comparison is made. The overall rankings are as follows, highest to lowest.: Economic, Marketing Requirements, Environmental, Supply Chain and Distribution followed by Social Considerations. The Economic Consideration was chosen as a first priority by 75% of the subjects, and as second and third priority by the remaining 25%. Marketing Requirements were chosen by 25% of the respondents as a first priority and as a second priority by 50% of the people. The remainder has chosen it as a third and fifth priority at 12.5% each.

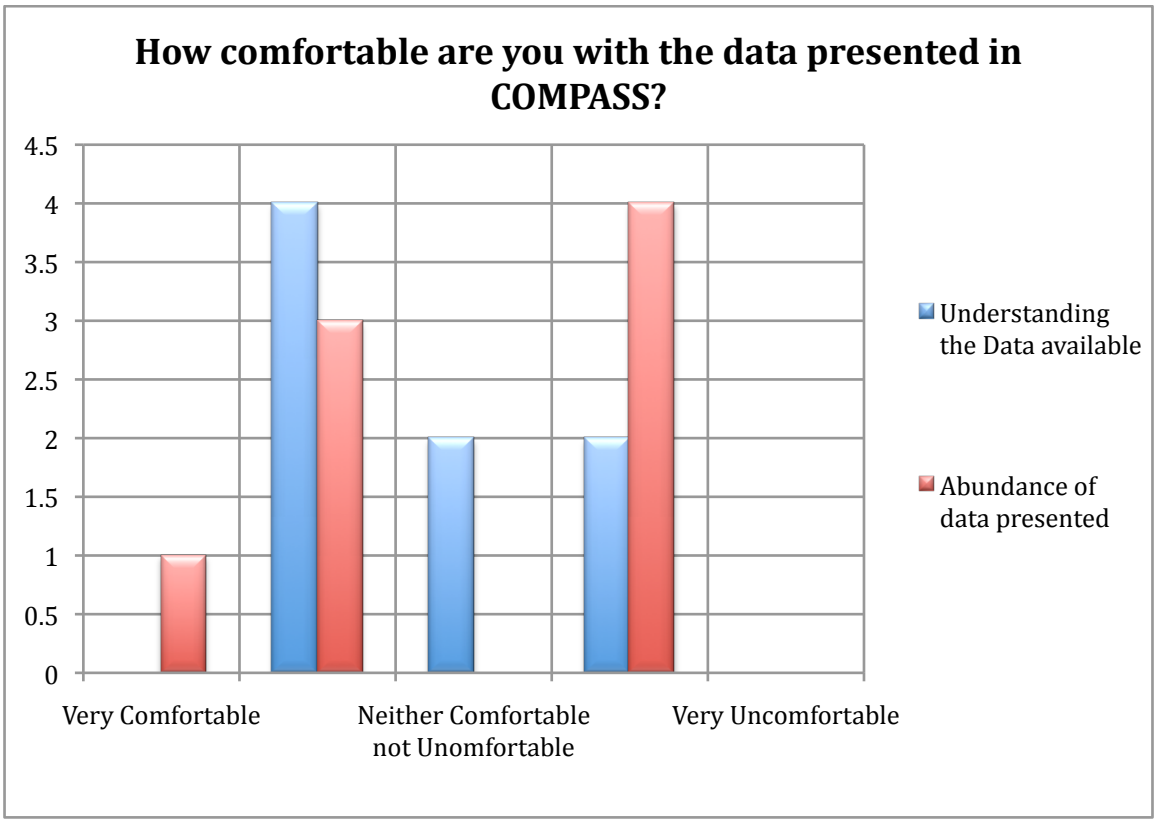
37.5% and 25% chose Environmental considerations as a second priority, and forth priority, respectively, with the remainder chosen as a fifth priority.

Supply Chain and Distribution was chosen in the third, forth and fifth priorities with 37.5%, 50% and 12.5% respectively, indicating a low interest in the topic with regards to Format choices. The lowest ranked consideration, was chosen by 37.5% as a third priority and 25% as a forth priority, leaving the rest as a fifth. As such, the Social Consideration, although were at the forth place on graph 4, have moved to the last spot, showing a disinterest by the subjects.



Graph 13 – Design Tool Preference

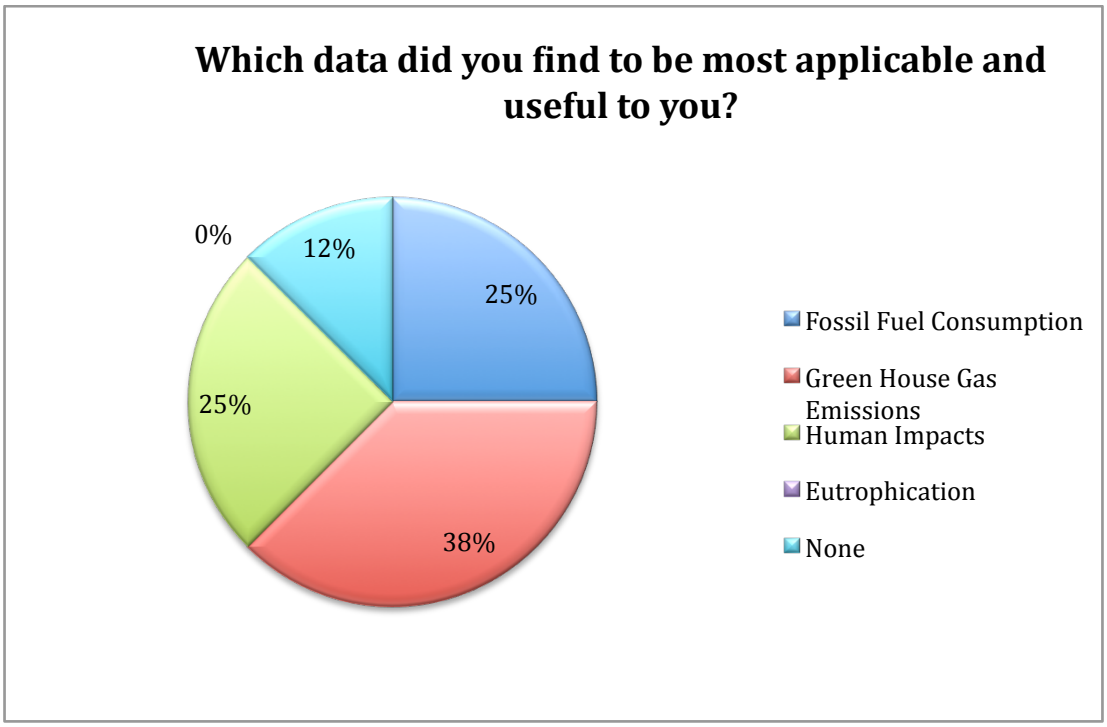
The Graph above clearly identifies the subjects' dislike towards the newer tool, and their affinity towards the original design tool with 71% choosing it, over the 29% who chose the Quantitative option.



Graph 14 – COMPASS℠ Data

50% of the subjects surveyed feel *Somewhat Comfortable* with the data available in COMPASS℠, while 25% feel *Somewhat Uncomfortable* with the data available. The remainder feel *Comfortable nor Uncomfortable*.

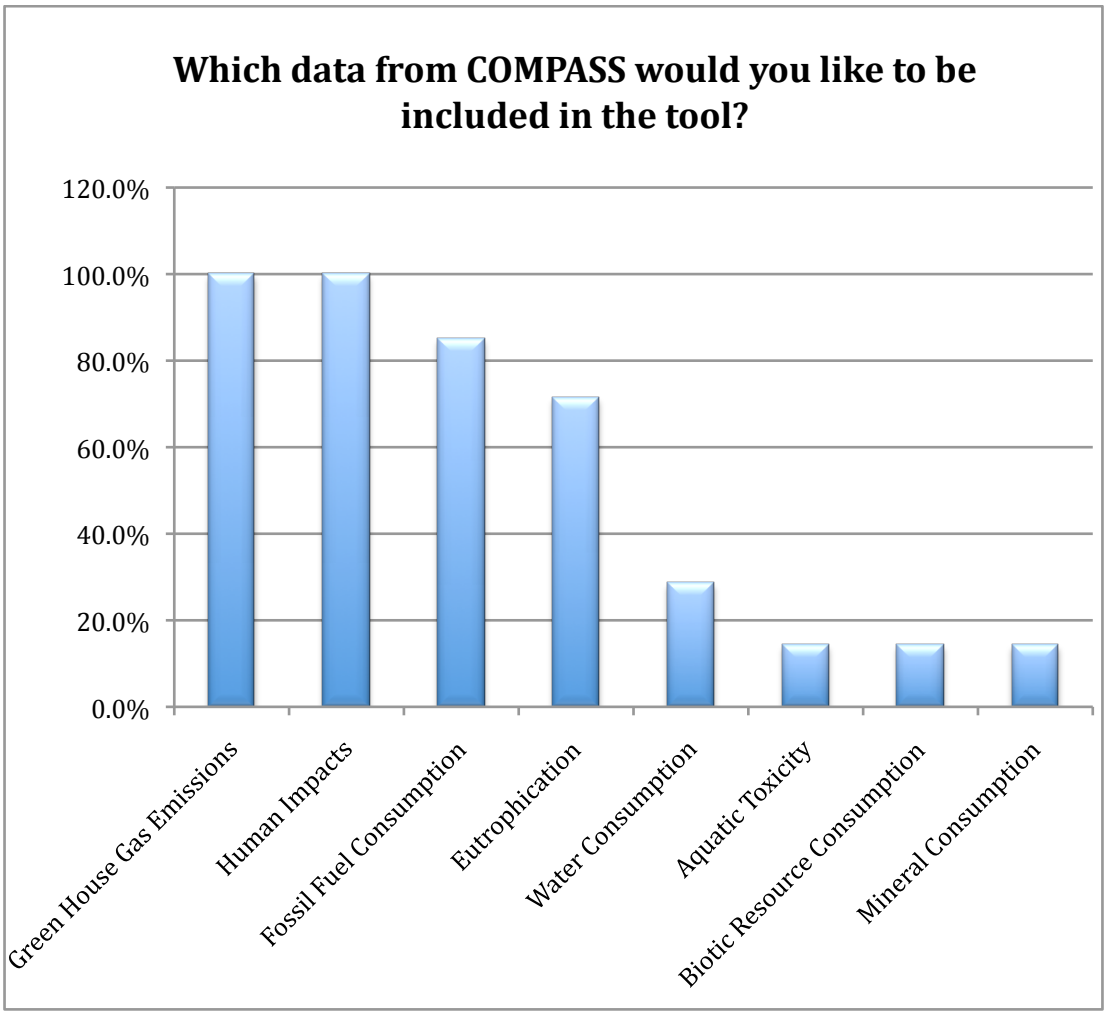
Furthermore, the comfort levels, as they pertain to the abundance of information are equally divided between *Very Comfortable* to *Somewhat Comfortable,* at 50% and *Somewhat Uncomfortable*, at 50% as well.



Graph 15 – COMPASS^{SM} Life Cycle Metrics Applicability

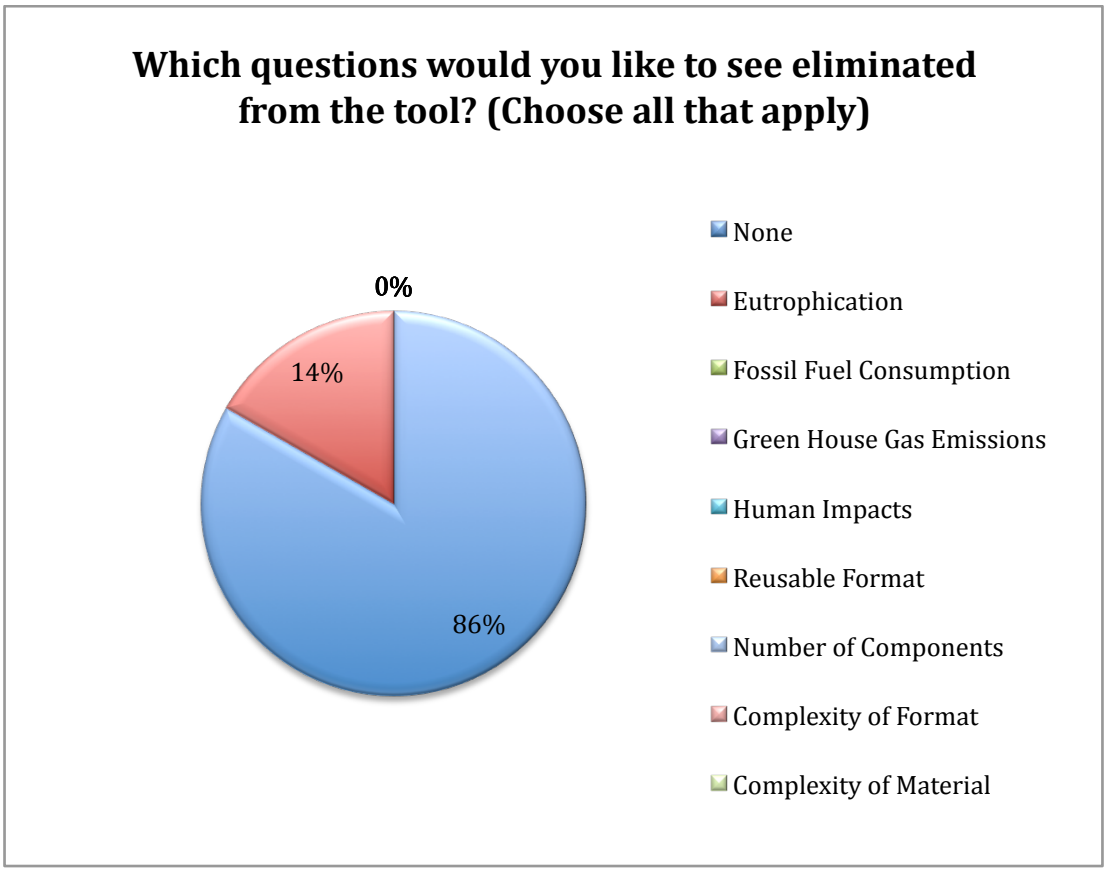
The survey respondents found the available data to be applicable as a whole, with 88% choosing one of the options. Alternatively, 12.5% found that none of the data is applicable to them, indicating that they would not use the available information.

The Eutrophication data was not found to be applicable by any of the participants.



Graph 16 – Inclusion of COMPASS℠ data

All respondents found that Green House Gas Emissions and Human Impacts are the two data points that should be included in the design tool. Additionally, about 85% were interested in the inclusion of Fossil Fuel consumption. Interestingly, although not finding Eutrophication data to be applicable, 71% were interested in the inclusion of the data into the tool. Interest in water consumption data was confirmed by 28% of the respondents, while Aquatic Toxicity, Biotic Resource and Consumption and Mineral Consumption was of interest to 14%, each.



Graph 17 – Data Elimination from Tool

The subjects found that all information, excluding Eutrophication should remain in the tool, with 86% choosing not to eliminate any questions and 14% choosing to eliminate Eutrophication. The balance of the questions, from both COMPASS^{SM} and the original tool are to remain in the quantitative design tool.

Conclusions and Discussion

The results of the survey have rendered an unexpected conclusion. Looking back at the hypotheses that were generated in the beginning of the process, and analyzing them versus the found results, it becomes evident that practically none of the assumptions that led to the hypotheses were accurate, and the created tool was not the appropriate mixture of qualitative and quantitative information for the participants. The hypotheses on page 8 assumed that quantitative life cycle assessment data, coupled with product and package design parameters will allow the packaging engineers an improved design experience.

The quantitative (COMPASS^{SM} based) design tool was expected to provide three different solutions, when compared to the PDOT:

1. Decrease decision-making time.
2. Increase engineers satisfaction in the final design decision
3. Consistency in decision making between engineers.

Based on the results in the previous chapter it becomes evident that only one of the three hypotheses was moderately correct.

Hypothesis #1 was based on the supposition that quantitative LCA data will reduce subjectivity, and the additional time that would have taken to reach a design decision based on qualitative information would be eliminated, thus saving hours at a time, per design project. Graph 6 shows that this hypothesis was slightly correct, although the time-savings were not as significant as expected. When comparing the two design tools, the respondents found that the time to reach a decision ranged between 0 and over-1-hour with the quantitative design tool, while the qualitative design tool required them between 0 and over-2-hours. However, when comparing the means of responses for both groups it becomes clear that both tools are the same, and as such the superiority of the Sustainable Packaging Design Tool with regards to decision-making time cannot be determined.

Hypothesis #2 was based on the assumption that having LCA data will increase the engineer's confidence in the final design decision, and as such increase the satisfaction in the decision. The results in graph 7 show that the majority

(~86%) of the subjects were satisfied with their design decisions using the Qualitative design tool (PDOT). When using the quantitative design tool they were also satisfied, but the percentage declined to 62%, showing that although the majority of participants were satisfied with their decisions, it is unlikely that it was due to the use of the tools. Moreover, the graph also showed that the hypothesis was incorrect and satisfaction declined when using the Sustainable Packaging Design Tool This leads to the conclusion that additional quantitative data does not correlate with confidence and satisfaction in design decisions.

Hypothesis #3 was based on the premise that quantitative data from a third party (i.e. COMAPSS™) will increase the consistency of design decisions, based on a decrease in design subjectivity. Assuming the engineers will make their decision based on the recommendations of the tool. Graph 5 shows that the respondents found the Sustainable Packaging Design Tool to be *somewhat difficult*, while they found the qualitative tool (PDOT) to be easier to use. In consecutive informal, verbal one-on-one dialogues, I was told that due to the learning curve that the users will have to go through in order to understand the tool better, versus the limited free time they had to devote to that process, it will be less likely that they would use that tool. It was also mentioned that they are very much accustomed to their previous design processes, and are unlikely to change their ways. Unless this new process would be officially implemented, mandated and monitored by the company, and would reflect badly on them if it wasn't done, they would not use the new tool. This is also supported by a comment to the last question, stating, "The Compass based tool does add additional steps in the process, which is a concern. As a tool to compare designs early in the process, I think Compass provides some very good data; however, for many commercialization projects, it is intuitive which design is better and we don't need numbers to make a decision."

Overall, when asked to choose between the two tools, graph 13 demonstrated that 71% of the respondents chose the qualitative design tool (PDOT) over the quantitative design tool (SPDT), showing that they are reluctant to use the new tool, and as such eliminate consistency based on LCA data. Furthermore, graph

14 shows that although 50% of the respondents felt *somewhat comfortable* with understanding the information presented in COMPASS[SM], the abundance of the information made 50% feel somewhat uncomfortable, consequently showing that, although the information was understandable, the large amount of information alarmed them more than aided in the design process. Lastly, the comments to the last question also become an indication of the subjects' perceptions and interests in the new tool. One of the subjects indicated that he/she "Most likely wouldn't use it," while another participant said, " I look forward to the COMPASS data source expanding to include regions where much of our packaging is produced." This also asserted that at this point, the information that is presented in the tool is not useful, and will not be used by the engineers in Eastman Kodak. Based on the information and results at hand, it is obvious that there was a clear preference towards the qualitative design tool (PDOT).

It is extremely important to note that the group of participants was extremely small, both due to the amount of packaging engineers in Eastman Kodak, and their ability and willingness to participate and contribute to the study. Furthermore, their interest in the study was limited due to the amount of additional work the tool would require of them if implemented, and as such the answers might not be as objective as one might anticipate. It is a known fact (Yeatts, 2000) that "an old dog can't learn new tricks," or to put in terms of this study, an experienced engineer does not want to adopt to new tools, having been accustomed to his/her own, proven successful, process for multiple years, and as such they might have chosen to answer the questions in a manner that skewed the results. Additionally, the environment and culture in the company at the time, where experience and habits could trump new knowledge might have been two of the contributing factors to the overall conclusions. This suggests that it's not a quantitative tool that is less liked, it's additional, new processes that are disliked and avoided.

Despite the negative reactions of the subjects in the study, it is safe to assume that the participation in the study sensitized them to the topic of sustainability, and increased their understanding of the issue.

Further Studies

1. Presenting and studying the two tools in different companies, based on:
    a. Different geographic location: companies in southwest vs. northeast.
    b. Different industries: consumer care vs. food products
    c. Different supply chain structures: Vertically integrated vs. partnered.
    d. With modifications made to fit each company's material's matrix (list), or creating a global matrix that would hold true for most companies.
2. Studying a range of companies, across multiple industries in multiple regions, while using multiple subjects. This will allow for a significant statistical sample, thus reaching significant conclusions and reproducible data.
3. Creating a decision making tool that would truly encompass all the aspects of sustainability, including not only an environmental impact, but a current financial section, where material prices would be updated on a weekly basis, as well as the social impacts that a material or format could have on the manufacturing society and the target market.

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Appendix

Appendix I – Package Development Optimization Tool

Objective Package size, number of components and material choice are the main factors that affect the minimization of environmental impact of a packaging system. Use this tool to ensure that the minimum amount of material is being utilized to protect the product, and that the material choices are aligned with the material strategy matrix included in this tool.
Prerequisite The product development checklist has been applied and the product is robust and will yield use of minimized packaging components.

Request This tool must be completed between gate 2 and 4 in the traditional KMCP process.

PACKAGE DEVELOPMENT OPTIMIZATION TOOL

Package Engineer: | Date:

Cat #: | Product Name: | SPG:

		Type	Current Packaging Format	Type	Option 1	Type	Option 2
Material	When choosing materials, start by considering materials on the promote list. Specify materials used in packaging format. *Reference to the material strategy matrix.* *Matrix drives use of recycled materials, recyclable materials and materials with reduced environmental impact.* *See Material Matrix on page 3*						
Space Utilization	Calculate space utilized in the shipping container (vessel) assume full container						
Package Weight	Calculate the weight of the *Material matrix takes priority over weight (i.e. paperboard weighs more, but is better than PVC)* Can you reduce weight?						
Number of Components	How many total packaging components are included in the design? Can packaging components be eliminated?						
Complexity of Materials	Define the complexity of materials (i.e. Multi layer films). Can less complex materials be used?						
Reusable Format	Identify any reused components that will be reused. Can other materials be reused?						
Complexity of Format	Specify the number of materials included in the design. Can you reduce the number of dissmilar materials used?						
Overall Cost	**Baseline**						
Which option did you decide to move forward with?							

	Restrict	Minimize	Neutral	Promote	Observe
Paper		SBS		Kraft - RC	
		Bleached		Molded Pulp - RC	
				Paperboard - RC	
Plastic	PVC	Mixed Resin	HDPE - Virgin Resin	HDPE - RC	PLA
		PS - Expended	LDPE - Virgin Resin	LDPE - RC	Bioplastics
			PET	RPET	
			Polyurethane		
			PS - Injection molded		
			PP		
			Nylon		
Metal			Galvaneal Steel		
			Coated Tin Free Steel		
			Zinc Coated Steel (fasteners)		
			Aluminum		
Wood	Methyle Bromide Treated		Solid Lumber	Manufactured Lumber	
Glass		All grades			
Other	HM Ink		Inks		Soy Based Ink
		Laminated Films	Cold set latex adhesive	Reusable Format Containers	Biodegradable
			Coatings (labels, cartons, flexibles, wood containers)		

Appendix II - Packaging Design Survey at Eastman Kodak

Details:

- Survey was distributed among Packaging Engineers at Eastman Kodak.
- Five out of the nine engineers agreed to fill out the survey
- Collection of results was conducted in February 2009.

Survey Questions:

1. What type of products do you design packaging for? (Choose all that apply)
    - Consumables
    - Electronic Devices
    - Media
    - Liquids
    - Small Equipment
    - Large Equipment
    - Other

2. What software tools do you use in the design process?(Choose all that apply)
    - ArtiosCAD
    - AutoCAD
    - SolidWorks
    - TOPS
    - Other

3. When designing a packaging system for a product, what design tools do you use? (Choose all that apply)
    - HSE Toolbox - Packaging Optimization Standard
    - KMCP Check List
    - Wal-Mart Scorecard
    - None
    - Other

4. Please define your strategy for developing a package design.
(i.e. your steps from project inception to commercialization)

5. What considerations impact your material and format choice? (Please rank 1-5, 1 being your 1st consideration)

	Economic (Cost/Price)	Environmental	Social (Cultural/Consumer expectations/Manufacturing needs)	Marketing Requirements	Supply Chain and Distribution
Material					
Format					

6. When you design a package, how often do you design it yourself and how often do you use an external supplier for the design?

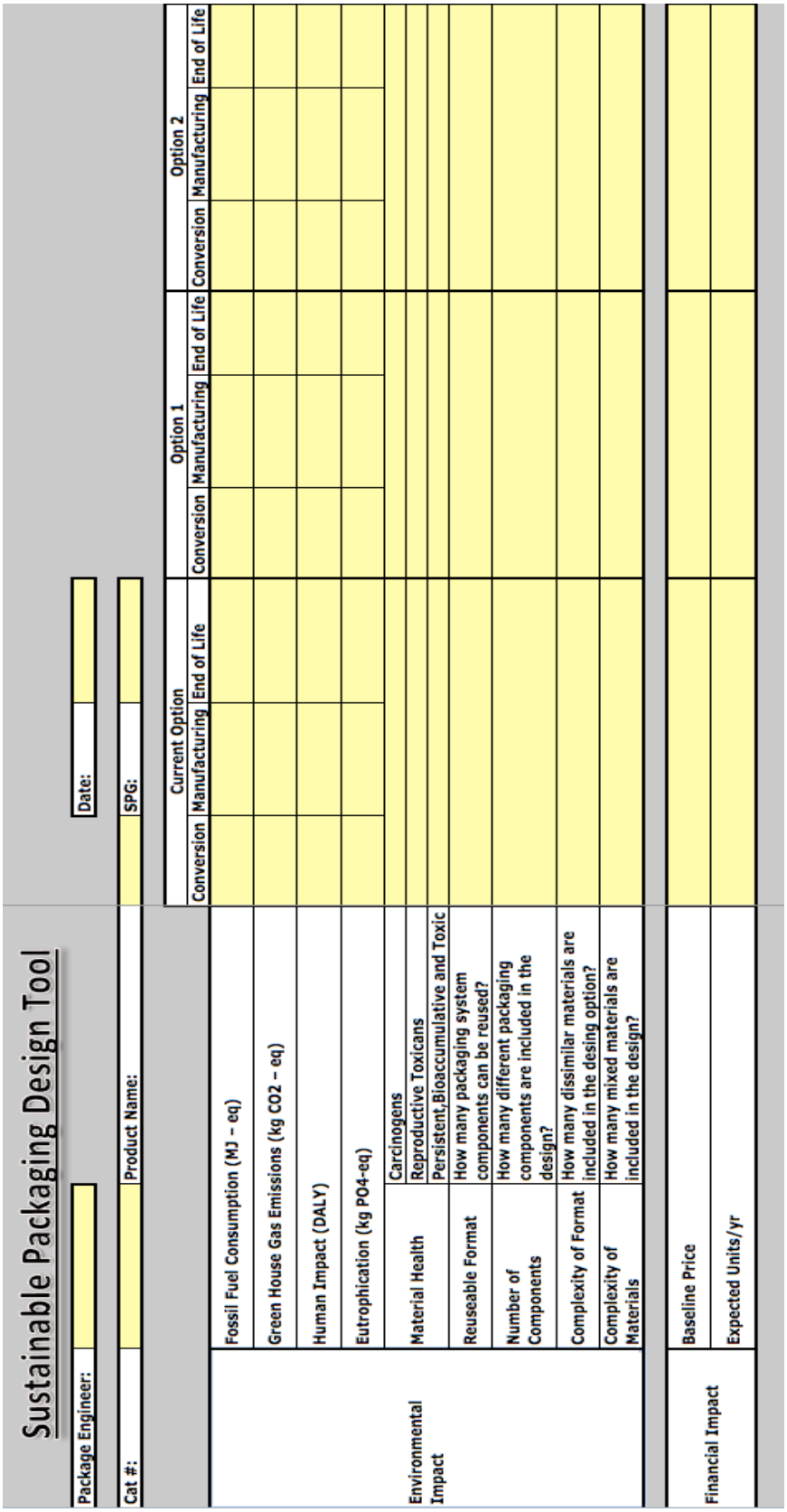
- I use a supplier 100% of the projects
- I use a supplier 75% of the projects
- I use a supplier 50% of the projects
- I use a supplier 25% of the projects
- I design the packaging for all my projects

7. When choosing materials, are there any materials you tend to avoid beyond those restricted by the HSE product standards?

8. When developing a package, do you specifically seek materials with minimized environmental impact, and if so, what are they?

Appendix III – Sustainable Packaging Design Tool

Data Input Page



Sustainable Packaging Design Tool

Package Engineer:

Date:

Cat #:

Product Name:

SPG:

			Current Option			Option 1			Option 2		
			Conversion	Manufacturing	End of Life	Conversion	Manufacturing	End of Life	Conversion	Manufacturing	End of Life
Environmental Impact	Fossil Fuel Consumption (MJ – eq)										
	Green House Gas Emissions (kg CO2 – eq)										
	Human Impact (DALY)										
	Eutrophication (kg PO4-eq)										
	Material Health	Carcinogens									
		Reproductive Toxicans									
		Persistent,Bioaccumulative and Toxic									
	Reuseable Format	How many packaging system components can be reused?									
	Number of Components	How many different packaging components are included in the design?									
	Complexity of Format	How many dissimilar materials are included in the desing option?									
	Complexity of Materials	How many mixed materials are included in the design?									
Financial Impact	Baseline Price										
	Expected Units/yr										

Summary Page

Sustainable Packaging Design Tool

Package Engineer:	0			Date:	0
Cat #:	0	Product Name:	0	SPG:	0

			Current Option	Option 1	Option 2	Option 3
Environmental Impact	Fossil Fuel Consumption (MJ – eq)		0	0	0	0
	Green House Gas Emissions (kg CO2 – eq)		0	0	0	0
	Human Impact (DALY)		0	0	0	0
	Eutrophication (kg PO4-eq)		0	0	0	0
	Material Health	Total Hazardous Inputs	0	0	0	0
	Reuseable Format	How many packaging system components can be reused?	0	0	0	0
	Number of Components	How many different packaging components are included in the design?	0	0	0	0
	Complexity of Format	How many dissimilar materials are included in the desing option?	0	0	0	0
	Complexity of Materials	How many mixed materials are included in the design?	0	0	0	0
Financial Impact	Total Annual Cost ($$)		0	0	0	0
Total Impact			Minimal	Minimal	Minimal	Minimal
Which option did you decide to move forward with?						

Appendix IV – Survey of Subjects

1) Which BU are you affiliated with? (Choose all that apply)

- FPEG
- CDG
- GCG

2) What type of products do you design packaging for? (Choose all that apply)

- Consumables
- Electronic Devices
- Media
- Liquids
- Powders
- Small Equipment
- Large Equipment
- Other

3) After using the quantitative design tool, please determine the level of ease/difficulty required to reach a final design decision.

	Very Easy	Somewhat Easy	Neither Difficult nor Easy	Somewhat Difficult	Very Difficult
Sustainable Packaging Design Tool(COMPASS based)					
Packaging Optimization Development Tool/or previous design process					

4) After using the quantitative design tool, please determine the time required to reach a final design decision.

	Right after completion and results summary	Over 1/2 hour	Over 1 hours	Over 2 hours	Over 4 hours
Sustainable Packaging Design Tool(COMPASS based)					

Packaging Optimization Development Tool/or previous design process					

5) How satisfied are you with your final design decisions?

	Very Satisfied	Somewhat Satisfied	Neither Satisfied nor Dissatisfied	Somewhat Dissatisfied	Very Dissatisfied
Sustainable Packaging Design Tool(COMPASS based)					
Packaging Optimization Development Tool/or previous design process					

6) Do you feel that the Quantitative Design Tool gives you a better understanding of the impact of your design decisions on the environment?

- Yes
- No
- If Not, please Elaborate

Note Questions 7-10 have the same answer structure

7) Which considerations have previously impacted your MATERIAL choice? (Please rank, 1 being your primary consideration)

8) Which considerations have previously impacted your FORMAT choice? (Please rank, 1 being your primary consideration)

9) After using the quantitative tool, which considerations are impacting your MATERIAL choice? (Please rank, 1 being your primary consideration)

10) After using the quantitative tool, which considerations are impacting your FORMAT choice? (Please rank, 1 being your primary consideration)

	1	2	3	4	5

Environmental					
Economic					
Social (Cultural/Consumer expectations/Manufacturing needs)					
Marketing Requirements					
Supply Chain and Distribution					

11) If you could choose between the two tools, which one would you choose to use most often?

- Quantitative: Design Tool (COMPASS based)
- Qualitative: Packaging Optimization Development Tool

12) How comfortable are you with the data presented in COMPASS?

	Very Comfortable	Somewhat Comfortable	Neither Comfortable nor Uncomfortable	Somewhat Uncomfortable	Very Uncomfortable
Understanding the Data available					
Abundance of data presented					

13) Which data did you find to be most applicable and useful to you?

- Fossil Fuel Consumption
- Green House Gas Emissions
- Human Impacts
- Eutrophication
- None

14) Which data from COMPASS would you like to be included in the tool?

- Fossil Fuel Consumption
- Green House Gas Emissions
- Human Impacts
- Eutrophication
- Water Consumption
- Biotic Resource Consumption
- Mineral Consumption
- Aquatic Toxicity

15) Which questions would you like to see eliminated from the tool?

- Fossil Fuel Consumption
- Green House Gas Emissions
- Human Impacts
- Eutrophication
- Reusable Format

- Number of Components
- Complexity of Format
- Complexity of Material
- None
- If you chose any, excluding "None" please elaborate

16) Which questions would you like to see added to the tool?
Open ended

17) Please write any opinions, ideas, comments, concerns
Open ended

Appendix V – Survey Responses
To questions outlined in Appendix IV

1st workshop held on June 8th, 2009. (Respondents #1-#4)
2nd workshop help on June 18th, 2009. (Respondents #5-#8)

Questions are followed by responses by each respondent.
Note: As all surveys were anonymous, each respondent is assigned a number starting at #1 to denominate their responses.

1) Which BU are you affiliated with? (Choose all that apply)

Respondent #1: CDG
Respondent #2: CDG, GCG
Respondent #3: FPEG, CDG, GCG
Respondent #4: CDG
--
Respondent #5: FPEG, GCG
Respondent #6: CDG
Respondent #7: GCG
Respondent #8: FPEG, CDG, GCG

2) What type of products do you design packaging for? (Choose all that apply)

Respondent #1: Consumables
Respondent #2: Electronic Devices, Small Equipment, Large Equipment
Respondent #3: Consumables, Liquids, Powders, Small Equipment, Large Equipment
Respondent #4: Electronic Devices
--
Respondent #5: Consumables, Media, Liquids, Powders.
Respondent #6: Consumables, AiO printers
Respondent #7: Electronic Devices, Media, Liquids, Powders, Small Equipment, Large Equipment
Respondent #8: Consumables, Media, Liquids, Powders, Small Equipment, Large Equipment. (Liza, I am checking lots of stuff because I feel like I am answering for the entire group. If you think otherwise, toss my info and tell me to resubmit.)

3) After using the quantitative design tool, please determine the level of ease/difficulty required to reach a final design decision.

	Very Easy	Somewhat Easy	Neither Difficult nor Easy	Somewhat Difficult	Very Difficult
Sustainable Packaging		Respondent #6	Respondent #1 Respondent #8	Respondent #3 Respondent #4	

Design Tool(COMPASS based)				Respondent #5 Respondent #7	
Packaging Optimization Development Tool/or previous design process		Respondent #3 Respondent #4 Respondent #5 Respondent #6	Respondent #1 Respondent #2 Respondent #7 Respondent #8		

4) After using the quantitative design tool, please determine the time required to reach a final design decision.

	Right after completion and results summary	Over 1/2 hour	Over 1 hours	Over 2 hours	Over 4 hours
Sustainable Packaging Design Tool(COMPASS based)	Respondent #1 Respondent #2 Respondent #4 Respondent #5 Respondent #8	Respondent #6 Respondent #7	Respondent #3		
Packaging Optimization Development Tool/or previous design process	Respondent #1 Respondent #2 Respondent #3 Respondent #4 Respondent #5 Respondent #8	Respondent #6		Respondent #7	

5) How satisfied are you with your final design decisions?

	Very Satisfied	Somewhat Satisfied	Neither Satisfied nor Dissatisfied	Somewhat Dissatisfied	Very Dissatisfied
Sustainable Packaging Design Tool (COMPASS based)	Respondent #5 Respondent #8	Respondent #1 Respondent #4 Respondent #6	Respondent #2 Respondent #7	Respondent #3	
Packaging Optimization Development Tool/or previous design process	Respondent #5	Respondent #1 Respondent #3 Respondent #4 Respondent #6 Respondent #8	Respondent #7		

6) Do you feel that the Quantitative Design Tool gives you a better understanding of the impact of your design decisions on the environment?

Respondent #1: No. I feel that this tool just reinforces my qualitative assessment. I feel that the fact that it doesn't include distribution life cycle is a major deficiency.
Respondent #2: No.
Respondent #3: Yes.
Respondent #4: Yes.
--
Respondent #5: Yes.
Respondent #6: Yes.
Respondent #7: Somewhat, the program is rather difficult as the steps progress.
Respondent #8: Yes.

Note Questions 7-10 have the same answer structure

7) Which considerations have previously impacted your MATERIAL choice? (Please rank, 1 being your primary consideration)

	1	2	3	4	5
Environmental	Respondent #6	Respondent #3 Respondent #7	Respondent #2 Respondent #5	Respondent #1	Respondent #4 Respondent #8
Economic	Respondent #3 Respondent #4 Respondent #5 Respondent #7 Respondent #8	Respondent #1 Respondent #2	Respondent #6		
Social			Respondent #4 Respondent #7	Respondent #5 Respondent #8	Respondent #1 Respondent #3 Respondent #6
Marketing Requirements	Respondent #1 Respondent #2	Respondent #4 Respondent #5 Respondent #6 Respondent #8		Respondent #3	Respondent #7
Supply Chain and Distribution			Respondent #1 Respondent #3 Respondent #8	Respondent #4 Respondent #6 Respondent #7	Respondent #5

8) Which considerations have previously impacted your FORMAT choice? (Please rank, 1 being your primary consideration)

	1	2	3	4	5
Environmental		Respondent #7	Respondent #6	Respondent #1 Respondent #5	Respondent #2 Respondent #3 Respondent #4 Respondent #8
Economic	Respondent #2 Respondent #3 Respondent #4 Respondent #5 Respondent #7 Respondent #8	Respondent #1		Respondent #6	

Social			Respondent #3 Respondent #4 Respondent #7	Respondent #2 Respondent #8	Respondent #1 Respondent #5 Respondent #6
Marketing Requirements	Respondent #1 Respondent #6	Respondent #3 Respondent #4 Respondent #5 Respondent #8	Respondent #2		Respondent #7
Supply Chain and Distribution		Respondent #2 Respondent #6	Respondent #1 Respondent #3 Respondent #5 Respondent #8	Respondent #4 Respondent #7	

9) After using the quantitative tool, which considerations are impacting your MATERIAL choice? (Please rank, 1 being your primary consideration)

	1	2	3	4	5
Environmental	Respondent #6	Respondent #3 Respondent #5 Respondent #7		Respondent #1 Respondent #4	Respondent #2 Respondent #8
Economic	Respondent #2 Respondent #3 Respondent #4 Respondent #5 Respondent #7 Respondent #8	Respondent #1	Respondent #6		
Social			Respondent #7	Respondent #2 Respondent #4 Respondent #5 Respondent #8	Respondent #1 Respondent #3 Respondent #6
Marketing Requirements	Respondent #1	Respondent #4 Respondent #6 Respondent #8	Respondent #2 Respondent #5	Respondent #3	Respondent #7
Supply Chain and Distribution		Respondent #2	Respondent #1 Respondent #3 Respondent #8	Respondent #6 Respondent #7	Respondent #4 Respondent #5

10) After using the quantitative tool, which considerations are impacting your FORMAT choice? (Please rank, 1 being your primary consideration)

	1	2	3	4	5
Environmental		Respondent #5 Respondent #6 Respondent #7		Respondent #1 Respondent #4	Respondent #2 Respondent #3 Respondent #8
Economic	Respondent #2 Respondent #3 Respondent #4 Respondent #5 Respondent #7 Respondent #8	Respondent #1	Respondent #6		
Social			Respondent #3 Respondent #4 Respondent #7	Respondent #2 Respondent #8	Respondent #1 Respondent #5 Respondent #6
Marketing	Respondent #1	Respondent #2	Respondent #5		Respondent #7

Requirements	Respondent #6	Respondent #3 Respondent #4 Respondent #8			
Supply Chain and Distribution			Respondent #1 Respondent #2 Respondent #8	Respondent #3 Respondent #5 Respondent #6 Respondent #7	Respondent #4

11) If you could choose between the two tools, which one would you choose to use most often?

Respondent #1: Qualitative: Packaging Optimization Development Tool

Respondent #2: Qualitative: Packaging Optimization Development Tool

Respondent #3: Qualitative: Packaging Optimization Development Tool

Respondent #4: Qualitative: Packaging Optimization Development Tool

--

Respondent #5:

Respondent #6: Qualitative: Packaging Optimization Development Tool

Respondent #7: Quantitative: Design Tool (COMPASS based)

Respondent #8: Quantitative: Design Tool (COMPASS based)

12) How comfortable are you with the data presented in COMPASS?

	Very Comfortable	Somewhat Comfortable	Neither Comfortable nor Uncomfortable	Somewhat Uncomfortable	Very Uncomfortable
Understanding the Data available		Respondent #1 Respondent #5 Respondent #6 Respondent #8	Respondent #2 Respondent #7	Respondent #3 Respondent #4	
Abundance of data presented	Respondent #7	Respondent #1 Respondent #5 Respondent #6		Respondent #2 Respondent #3 Respondent #4 Respondent #8	

13) Which data did you find to be most applicable and useful to you?

Respondent #1: Green House Gas Emissions

Respondent #2: Human Impacts

Respondent #3: Fossil Fuel Consumption

Respondent #4: None

--

Respondent #5: Green House Gas Emissions

Respondent #6: Human Impacts

Respondent #7: Fossil Fuel Consumption

Respondent #8: Green House Gas Emissions

14) Which data from COMPASS would you like to be included in the tool?

Respondent #1:

- Fossil Fuel Consumption
- Green House Gas Emissions
- Human Impacts
- Eutrophication
- Water Consumption
- Biotic Resource Consumption
- Aquatic Toxicity

Respondent #2:

Respondent #3:

- Fossil Fuel Consumption
- Green House Gas Emissions
- Human Impacts
- Eutrophication

Respondent #4:

- Fossil Fuel Consumption
- Green House Gas Emissions
- Human Impacts
- Eutrophication

--

Respondent #5:

- Fossil Fuel Consumption
- Green House Gas Emissions
- Human Impacts
- Eutrophication
- Water Consumption

Respondent #6:

- Fossil Fuel Consumption
- Green House Gas Emissions
- Human Impacts
- Mineral Consumption

Respondent #7:

- Green House Gas Emissions
- Human Impacts

Respondent #8:

- Fossil Fuel Consumption
- Green House Gas Emissions
- Human Impacts
- Eutrophication

15) Which questions would you like to see eliminated from the tool?

Respondent #1: None. I don't know enough about it to comment.

Respondent #2:
Respondent #3: None
Respondent #4: None
--
Respondent #5: None
Respondent #6: Eutrophication
Respondent #7: None. Enough information to make a decision.
Respondent #8: None

16) Which questions would you like to see added to the tool?

Respondent #1: Impact on distribution life cycle phase.
Respondent #2:
Respondent #3: Distribution information. Cost.
Respondent #4:
--
Respondent #5: It would be useful to somehow factor in transportation impacts when considering space utilization. Perhaps simply including the pallet utilization data as part of the comparison between options would be a sufficient comparison as with the current qualitative tool.
Respondent #6:
Respondent #7: Same as above. I wouldn't use this as much as a engineer.
Respondent #8:

17) Please write any opinions, ideas, comments, concerns

Respondent #1: I would need more training and more experience working with Compass to comment intelligently on any of this.
Respondent #2:
Respondent #3: Concern - That the material list is incomplete
Respondent #4:
--
Respondent #5: The Compass based tool does add additional steps in the process, which is a concern. As a tool to compare designs early in the process, I think Compass provides some very good data; however, for many commercialization projects, it is intuitive which design is better and we don't need numbers to make a decision.
Respondent #6:
Respondent #7: Good presentation, however, I had a problem following along with the program. Most likely wouldn't use it.
Respondent #8: I look forward to the COMPASS data source expanding to include regions where much of our packaging is produced.