INVESTIGATION TO DISCOVER MOST EFFECTIVE METHOD OF TEACHING TARGET COSTING TO CONSTRUCTION-MINDED INDIVIDUALS

A Thesis

by

JOSHUA JAMES HULLUM

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

May 2011

Major Subject: Construction Management

Investigation to Discover Most Effective Method of Teaching Target Costing to

Construction-minded Individuals

INVESTIGATION TO DISCOVER MOST EFFECTIVE METHOD OF TEACHING TARGET COSTING TO CONSTRUCTION-MINDED INDIVIDUALS

A Thesis

by

JOSHUA JAMES HULLUM

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

Approved by:

Co-Chairs of Committee,	Zofia K. Rybkowski
	John M. Nichols
Committee Member,	Anne B. Nichols
Head of Department,	Joseph P. Horlen

May 2011

Major Subject: Construction Management

ABSTRACT

Investigation to Discover Most Effective Method of Teaching Target Costing to Construction-minded Individuals.

(May 2011)

Joshua James Hullum, B.S., Texas A&M University

Co-Chairs of Advisory Committee: Dr. Zofia K. Rybkowski
Dr. John M. Nichols

The construction industry is in the midst of a progressive change in the way projects unfold from design and development to closeout and maintenance. There is a greater demand on contractors to build projects faster, with higher quality and an increased level of detail, while keeping costs lower than ever. Therefore, to meet such demands contractors must turn to an alternative approach of improving product and process with target costing. However, the adoption of target costing by the construction industry has been slow due to limitations in user understanding of the system.

The objective of this paper is to identify an effective approach for teaching target costing to construction-focused individuals, by establishing improved user understanding with visual aids, and by determining if user comprehension is influenced by the complexity of the visual supports provided in the lessons. The study challenged the long-implied assumption that the construction community is composed of visual learners, while also differentiating between the levels of success for supporting figures based upon their degree of detail. Results of this study will provide the basis for the

development of target costing material that is designed specifically for use in the education of construction industry professionals in Target Cost Estimating.

DEDICATION

This thesis is dedicated to my mother,

Cheryl Francis Hullum

for being my rock and inspiration,

you are my hero;

to my father,

Timothy J. Hullum

for being the father he never had to be,

you made me the man I am today;

and to

Amanda Julie Halbert

for providing continuous love and support,

you made this possible.

ACKNOWLEDGEMENTS

I would like to express my appreciation to Dr. Zofia Rybkowski for her continuous support and encouragement to dig deeper and challenge myself to foster growth and knowledge. My deepest gratitude goes to Dr. John Nichols for continuously going far and beyond his duty to ensure my success. Also, I thank Dr. Anne Nichols for great direction in focusing my research and challenging me to meet goals I previously thought were impossible. I would like to thank Dr. Kunhee Choi and James Smith for offering their classes as focus groups for my studies, without your assistance, this would not be possible.

I wish to thank the CIAC of Texas A&M construction science department for their generous grant to assist in my research. I would also thank my colleagues of Lean Lab with whom I have carried out this research. Thank you goes to: Brandon, Manish, James, and Dr. Rybkowski. Without their support and advice I would not have be able to achieve my goals.

My deepest admiration goes to Dr. James Smith for sharing his wisdom and being a mentor to me from the very beginning. Without you I would not have this opportunity before me. Many thanks go to Dawn Trog for all of her hard work behind the scenes. I would be a lost sheep if not for you, thank you for all that you do for every one of the graduate students.

Last but not least, praise to my Lord and Savior, Jesus Christ. Through you, all things are possible. May your name be exalted, honored, and glorified forever.

NOMENCLATURE

TC	Target Cost
TVD	Target Value Design
LPS	Last Planner System
CIAC	Construction Industry Advisory Council, Construction Science Department, Texas A&M University

TABLE OF CONTENTS

LIST OF FIGURES

Page

Page

LIST OF TABLES

CHAPTER I

INTRODUCTION

BACKGROUND TO THE STUDY

Target Costing (TC) first originated in Japan in the 1960s and remained a secret there for many years (Feil, Yook, & Kim, 2004). The Japanese viewed target costing as "*an activity which is aimed at reducing the life-cycle costs of new products, while ensuring quality, reliability, and other customer requirements, by examining all ideas from cost reduction at the product planning, research and development process*" (Kato, 1993). This business strategy quickly became a standard in the Japanese industry with over eighty percent of the established companies in assembly-type business adopting the process (Sakurai, 1989).

It was the Japanese auto industry, specifically Toyota, that assembled the many elements of target costing and transformed an easy cost-reduction tool into the holistic profit planning and cost management system used today (Ansari, Bell, & Okano, 2007; Cengiz & Ersoy, 2010). Although Japanese companies have known and applied target costing for decades, it has only been recently used in the United States and primarily adopted in the automotive and assembly industries (Ansari et al., 2007). Ellram (2006) states further that the use of target costing is still not widespread within the American production system.

This thesis follows the style of *Adult Education Quarterly*.

Banham (2000) supports this argument by estimating that "*only 65 companies – 85 percent of which are discrete-parts and finished-product manufacturers – have embraced [target costing]*" to the year 2000.

The construction industry has equally struggled to adopt the process into mainstream practice, which can be attributed in part to the educational level of the industry up until recently. As with commodity manufacturing, there are examples of success in the capital industry. However, the application of target costing across the industry is limited (Nicolini, Tomkins, Holti, Oldman, & Smalley, 2000; Zaman, 2004). Cheah and Ting (2005) point to a lack of understanding among managers and industrial practitioners as the root cause for low implementation of target costing within the construction industry. The critical issue is the ability of construction industry professionals to effectively learn how to use Target Costing (Cooper & Slagmulder, 1997).

PROBLEM STATEMENT

This research identifies the most effective learning style for construction-focused individuals to address the limited understanding of target costing within the construction community.

SUB-PROBLEM

The study will be based on the following sub-problems:

1. Are the learning abilities of the construction-minded population enhanced with the use of visual supports?
2. Does the complexity of the visual supports directly affect user learning ability?

SIGNIFICANCE OF RESEARCH

This research will provide valuable data on how to tailor target costing material to effectively reach the construction community. The data will also serve to assist the development of a teaching manual for target value design (TVD). TVD is a process within the movement of lean construction that is foundationally based upon the target costing process. The Construction Industry Advisory Council has awarded a grant to a Texas A&M University construction science lab team for the development of a TVD teaching manual to improve user understanding within the industry. Therefore, the need to improve user comprehension in the fields of target costing and TVD are evident and must be addressed for the future of the construction industry.

CHAPTER II

REVIEW OF LITERATURE

BACKGROUND

Target costing is defined as "*a structured approach to determine the life-cycle cost at which a proposed product with specified functionality and quality must be produced to generate the desired level of profitability over its life cycle when sold at its anticipated selling price*" (Cooper & Slagmulder, 1997). Target costing is a cost management and profit planning system which ensures new products meet market driven price and their desired financial return (Ansari et al., 2007). The objective of target costing is to effectively "*design costs out of products, not try to find ways to eliminate costs after products enter production*" (Cooper & Slagmulder, 1997).

Design determines the product's functionality, level of quality and the majority of associated costs (Ax, Greve, & Nilsson, 2008). Cooper and Chew (1996) report that seventy percent to eighty percent of product costs are built in and inextricable once the design is finalized and produced. Target manufacturing cost for a new product is calculated by determining a market driven price then subtracting the desired profit margin (Ansari, Bell, & CAM-I Target Cost Group., 1997; Clifton, Bird, Albano, & Townsend, 2004; Cooper & Slagmulder, 1997) as shown in equation 1:

$$\text{Target cost} = \text{Target price} - \text{Target margin} \tag{1}$$

Contemporary methods of establishing product price first assemble all costs then in addition, attach a profit margin. This is often termed cost plus and represents one of the common procurement techniques used by the US Government. In contrast, target costing employs a backward method of first identifying price then subtracting a desired profit margin to discover cost (Helms, Ettkin, Baxter, & Gordon, 2005). Rybkowski illustrates the target costing process in relation to contemporary methods of product pricing in Figure 1 (Rybkowski, 2009).

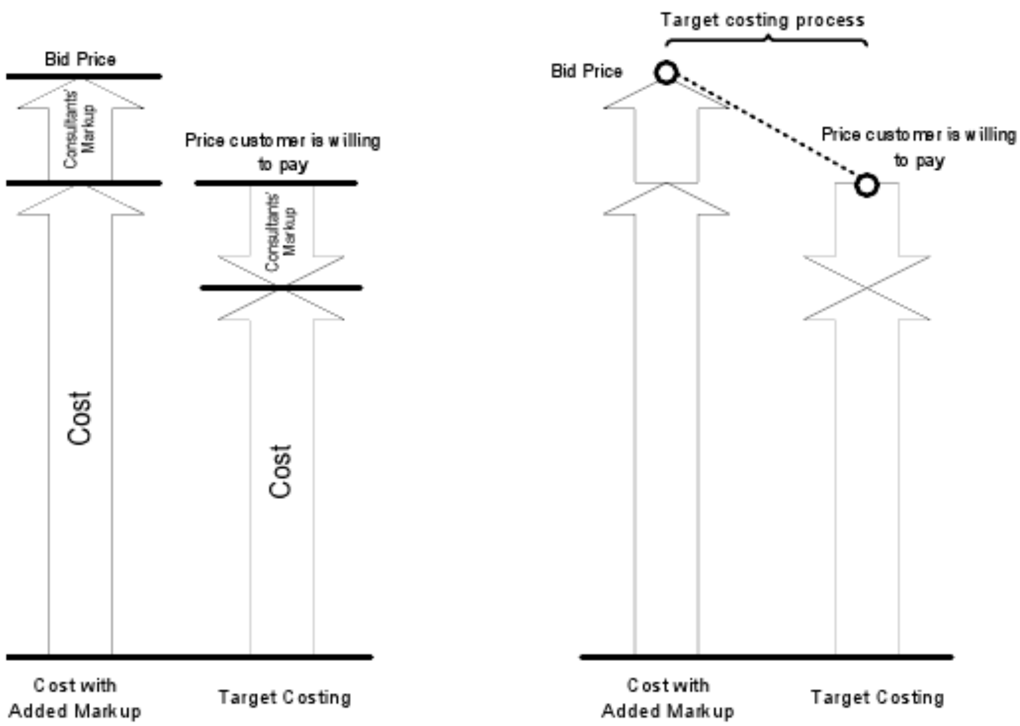

Figure 1. Target Costing Diagram (Rybkowski 2009)

The target cost for a product is achieved through life-cycle decomposition, function and component analysis, and cross-functional involvement. Life-cycle decomposition identifies and assigns "*total product cost into birth to death categories of research, manufacturing, distribution, service, general support, and disposal*" to understand where substantial costs are incurred (Ansari et al., 2007; Ansari et al., 1997) With knowledge of where sizeable costs are encountered along a product's life cycle, adjustments in design can ideally accommodate and ease the financial strain in that particular area. Function and component analysis first determine what value the customer places on each feature of a product and then identifies which functions and components are entailed within those features. Ansari et al. (1997) illustrates the process of identifying the value of each feature of a coffee grinder in *Figure 2*.

	Customer Ranking					
Customer Requirements	**1 (not important)**				**5 (very important)**	**Relative Ranking (%)**
Coffee tastes and smells like espresso					5	20%
Easy to clean				4		16
Looks nice		2				8
Has 6+ cup capacity			3			12
Starts automatically at designated time				4		16
Works well with different coffee beans	1					4
Keeps the coffee warm			3			12
Automatically shuts off			3			12
Total						100%

Figure 2. Customer Ranking (Ansari et al., 1997)

Figure 3 shows another of the figures from this work.

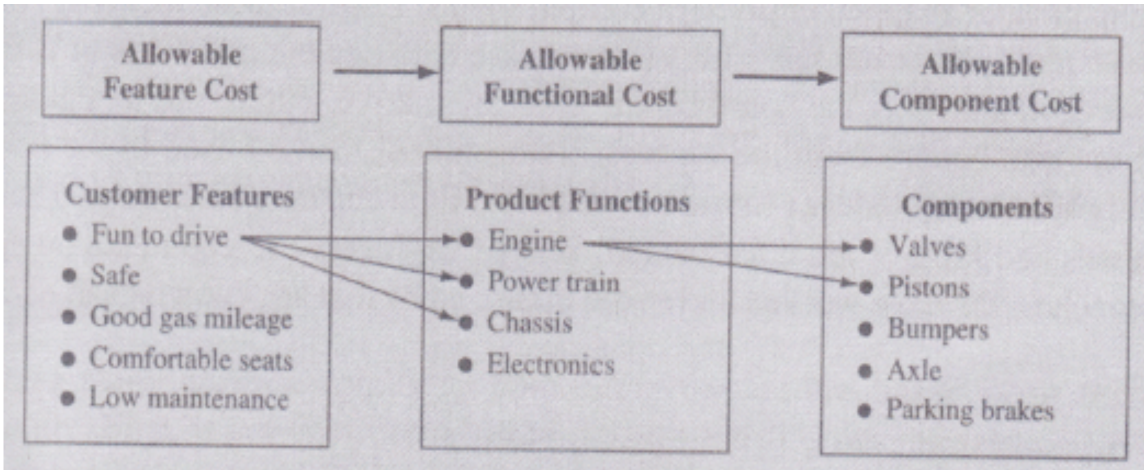

Figure 3. Feature – Function – Component Breakdown (Ansari et al., 1997)

Discovering customer value for each feature allows for a target cost to be assigned to each feature, function and component. Cross-functional involvement assembles members from designers to suppliers into teams to facilitate cost reduction ideas and initiate value engineering for target cost achievement. Value engineering (VE) is defined as a "*systematic, interdisciplinary examination of factors affecting the cost of a product so as to devise means of achieving the specified purpose at the required standard of quality and reliability at the target cost*" (Cooper & Slagmulder, 1997).

Functional teams first use value engineering to identify areas in need of cost reduction and then initiates brainstorming and idea development sessions for cost improvement strategies. Each idea is evaluated on its feasibility and potential success, and the strategies thought to be most effective are then put into practice to reduce costs. Each team is responsible for achieving their specific target cost for a particular function or component. Additionally, they must be aware of other teams and their target cost as well (Ansari et al., 2007). The reduction in product cost is the primary objective. Therefore, effective tradeoffs between functional teams for the improvement of the overall product cost are encouraged.

TARGET COSTING IN CONSTRUCTION

The construction industry was first challenged by Nicolini et al. (2000) to make use of target costing in new construction. The team showed it could be implemented with the appropriate amount of time and effort.

Ballard (2008) defines target costing as "*a method for shaping product and process design for delivery of customer value within constraints*." Nicolini et al. (2000) believes its "*introduction to the construction industry can support the effort to look for alternative procurement practices and supply-chain relations aimed at providing benefit for the clients in term of better value*." The process of target costing may have officially entered the construction industry with Nicolini, but its foundation elements have been present for a longer period. Koskela (1992) initiated a new process in product development for construction in 1992 with his work on the *Application of the New Production Philosophy in Construction*. Koskela emphasizes the need to better manage the flow of production by process planning and eliminating non-value-adding activities.

In 1994 as a part of the "*Review of Construction Procurement*," Latham (1994) made a set of recommendations which included:

> "1. *Develop better relations through partnering or partnership arrangements*

2. *Involve subcontractors earlier to achieve project objectives, and develop greater team involvement through the project life cycle and beyond.*
3. *Utilize the skill and knowledge of the subcontractors more fully and better, and recognize that subcontractors can and want to make a greater contribution.*
4. *Develop a more structured, standardized and ethical approach to the procurement and management of subcontractors*."

The theory of target costing has been further developed in the construction industry within the movement of lean construction. Koskela, Howell, Ballard, & Tommelein (2002) define lean construction as a "*way to design production systems to minimize waste of materials, time, and effort in order to generate the maximum possible amount of value.*" Within the process of lean construction is target value design (TVD), "*an approach which connects the design and target cost to the business case of the owner*" (Ballard, 2010). However, much like target costing, lean construction has had implementation trouble due in part to a limited understanding of the method by the industry.

Jorgensen and Emmitt (2008) believe that the process of lean lacks a shared uniformity and understanding making it a highly interpretive process. Porwal (2010) conducted twenty-six test case projects and surveys that reveal senior and mid-level AEC professionals' perceptions on implementing the last planner system (LPS), another area within the process of lean. His data shows user understanding as one of the limiting factors to successful implementation.

The Texas A&M Construction Industry Advisory Council has expressed interest in improved user understanding in the field of lean as well. They have rewarded a grant for the development of a target value design-teaching manual to a research team in Texas A&M Construction Science Department.

This current research addresses the issue of the limited understanding of target costing within the construction community. This study aims to identify the best approach and implement an improved method for teaching target costing to the construction-minded population. This work focuses on the incorporation of figures within oral lectures to assist in user comprehension of material presented.

This current work addresses the suggested research presented by Ainsworth and Loizou (2003) who call for further studies "*manipulating diagram style*" to explore features, which promote increased levels of user comprehension.

SUMMARY

Target cost methods represent one technique to reduce construction costs. Research into this area benefits this method, lean construction technical development and the broader community.

CHAPTER III

METHODOLOGY

INTRODUCTION

This research sought to determine if construction students are visual learners, who are those who learn more effectively with figures, and if the complexity of the presented figures in the teaching changed the comprehension level of the target cost material. The experimental work included three separate focus groups viewing a lecture covering the subject of target costing.

Each group contained between fifteen to forty participants consisting of construction science undergraduate students at Texas A&M University ranging from eighteen to twenty-five years of age. The material presented in each lecture is the main elements of instruction data obtained from three leading authors in the field of target costing (Ansari et al., 1997; Clifton et al., 2004; Cooper & Slagmulder, 1997).

Material was used from all three authors to provide a complete instructional view of target costing to the participants in the study. Each teaching process was subdivided into singular activities and visually illustrated with the use of sticky notes collected on a poster board as shown in Figure 4. The activities were arranged in order of their application in the target costing process.

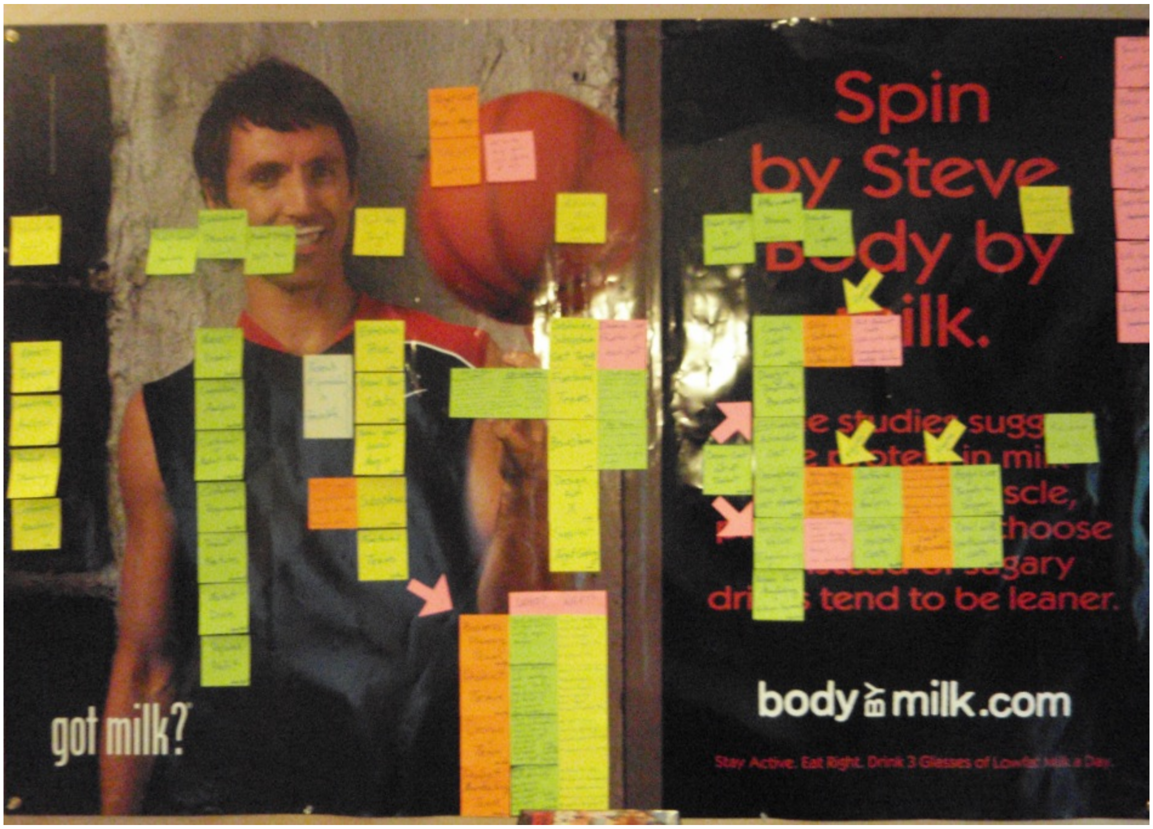

Figure 4. Target Costing Process

Each lecture covered the same target costing material. However, each presentation contained a unique feature distinguishing it from the other two.

The first two lectures included figures found in leading target costing literature that attempted to illustrate particular areas of the process. Nearly one hundred figures were identified and evaluated on their level of effectiveness in illustrating the concept presented. Effectiveness was determined upon the degree of progressive structure, categorization, and simplicity illustrated within each figure. The structure or configuration of a figure "*communicates a considerable amount of information by the way in which components are placed relative to each other,*" proving to be a vital attribute in the effectiveness of the figure (Winn, 1996). Miller (1964) believes categorization of a process is a fundamental and crucial behavior that "*enormously increases the effectiveness of teaching.*"

When testing participants on the effectiveness of diagrams, Butcher (2006) concluded that "*simplified diagrams most strongly supported information integration during learning*" better than detail figures. These three features have proven effective in prior research. Therefore, they were foundational elements in figure selection for this investigation.

Figure 5 illustrates an effective figure.

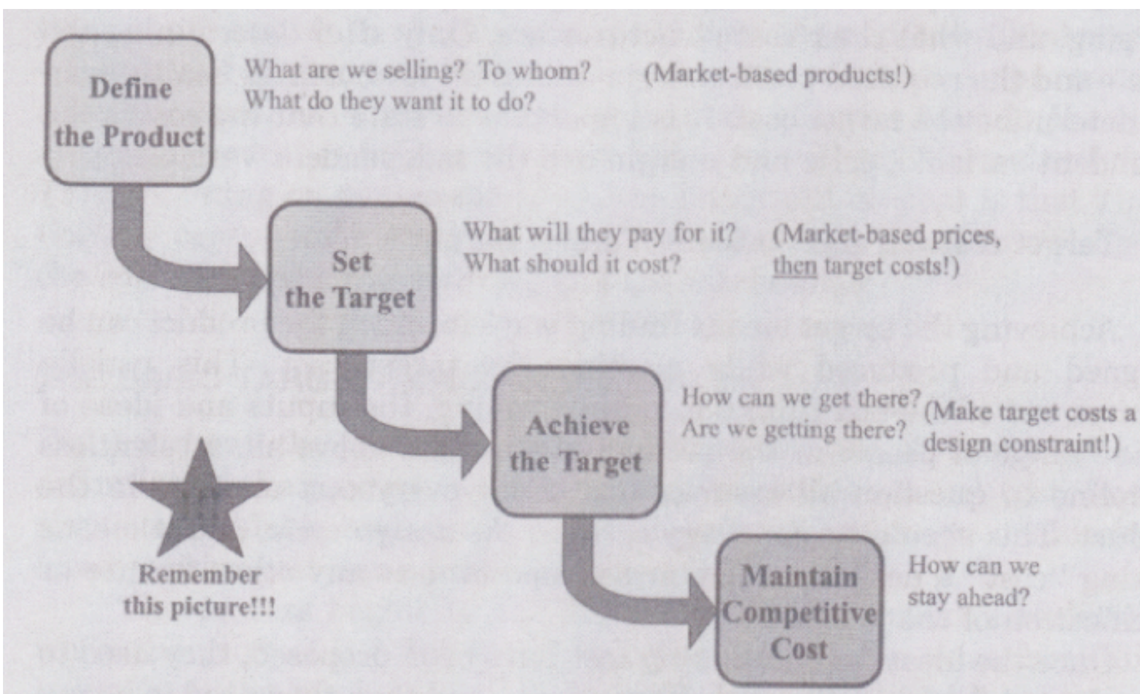

Figure 5. Effective Figure Illustration (Clifton et al., 2004)

The reasons this figure is effective are:

1. The figure shows a progressive structure giving order to the process
2. The boxes and arrows illustrate a separation between each of the steps, establishing a distinguishable categorization between each phase
3. The figure contains valuable information presented in a simple, concise and orderly manner

Figure 6 illustrates an ineffective figure.

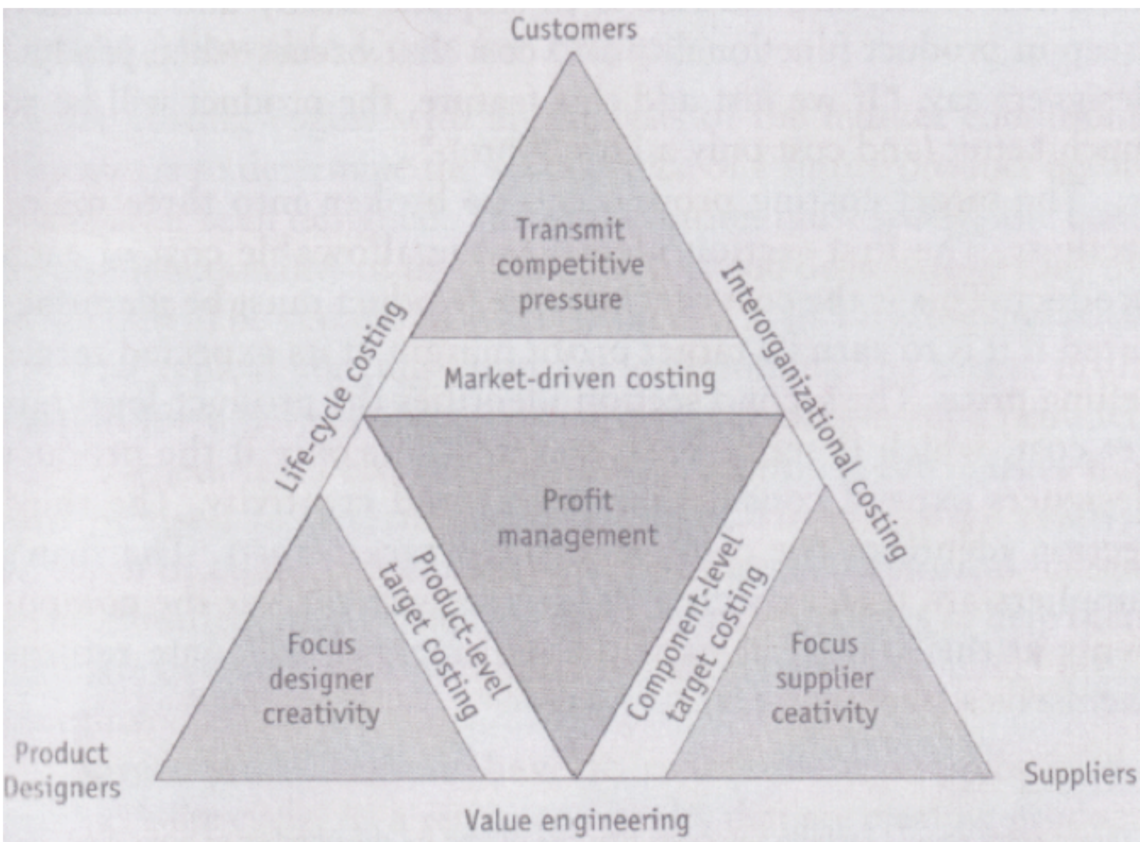

Figure 6. Ineffective Figure Illustration (Cooper & Slagmulder, 1997)

The reasons this figure is ineffective are:

1. The triangular figure lacks a structure showing progression
2. There is no distinguishable order between each section within the figure
3. Information is congested and presented in an convoluted manner

The first lecture group were shown:

1. Effective figures to help support the material presented
2. It was hypothesized this technique to produce the best results from an examination after the lecture

The second lecture group were shown:

3. Figures that were ineffective in illustrating the material
4. Figures labeled as ineffective possessed characteristics such as:
    a. excessive complexity
    b. lack of progression
    c. limited structure and organization
5. It was hypothesized that this lecture would produce worse results to lecture one, but provide superior results to the lecture three group

The third lecture group were shown:

6. No figures
7. It was hypothesized that this group would perform poorly compared to the other two groups.

There were two examinations, one prior to the lecture and one after the lecture. The pre-lecture examination comprised five multiple-choice questions covering basic terminology for the target costing process. The purpose of the preliminary examination was to establish the level of prior knowledge for the participants. This pre-examination allowed for an effective measurement of the amount of information gained from the lecture, assuming the participants answered truthfully.

The post-lecture examination was comprised two parts:

1. The first resembled the preliminary examination with five multiple-choice questions covering target costing information presented in the lecture. This portion of the post-lecture examination provides results that can be compared to the preliminary examination scores in order to measure the level of knowledge obtained through the lecture.
2. The second part was a hypothetical scenario involving the application of the target costing for a toaster manufacturing company. This portion of the post-lecture examination identifies if the participants' level of understanding is comprehensive enough to apply effectively the target costing process to an actual situation. This section also encourages the participants to discuss any figures that were particularly effective for learning the material presented in the lectures, if they were in group one or two.

PROCEDURE

The experiment procedure for each group was:

1. Conducted a preliminary examination of participants to establish the prior level of knowledge in target costing. The examination and answers are presented in Appendix A.
2. Presented the lectures to participants:
    a. Lecture #1 with effective figures. The lecture is presented in Appendix D.
    b. Lecture #2 with ineffective figures. The lecture is presented in Appendix E.
    c. Lecture #3 with no figures. The lecture is presented in Appendix F.
3. Conducted two post-lecture examinations:
    a. The first provided a quantitative measurement in recollection of concepts from the lecture. The first post examination is presented in Appendix B.
    b. The second provided qualitative data to illustrate if the participants were able to apply the material presented in the lecture. The second post examination is presented in Appendix C.
        i. Participants viewing a lecture with figures were verbally requested to recall and illustrate any figures they felt were effective to their learning.

The presentations were presented in the order of:

1. Lecture containing effective figures
2. Lecture containing ineffective figures

3. Lecture containing no figures

Lectures were presented in this order to account for the progressive level of comfort presenting the material in front of an audience. Due to the hypothesized outcome that the lecture containing no figures will produce the poorest results, the lecture without figures was presented last to ensure it was not placed at an initial disadvantage.

CHAPTER IV

RESULTS

INTRODUCTION

This chapter summarizes the results found when conducting the experiment. This chapter outlines:

- Quantitative Results
- Qualitative Results & Illustrations
- Summary of Results

QUANTITATIVE RESULTS

Introduction

Once all participants within the group had completed the preliminary examination, each participant's examination was graded. The results were entered into the spreadsheet illustrated in Appendix G.

Preliminary Results

All subjects demonstrated a lack of prior knowledge in the area of target costing with an average preliminary examination score of 3.67%. The results demonstrate the general lack of knowledge in the community of this type of costing system.

Post Lecture Results

After each of the three lectures, each participant was re-examined and the scores entered to the spreadsheet. The results are:

1. Participants viewing the lecture using effective figures had an average post-lecture score of thirty-eight percent.

2. The participants viewing lectures with ineffective figures averaged twenty-nine percent correct.
3. The participants viewing lectures with no figures averaged twenty-one percent correct.

The exam averages for all three post-lecture examinations are illustrated in Figure 7.

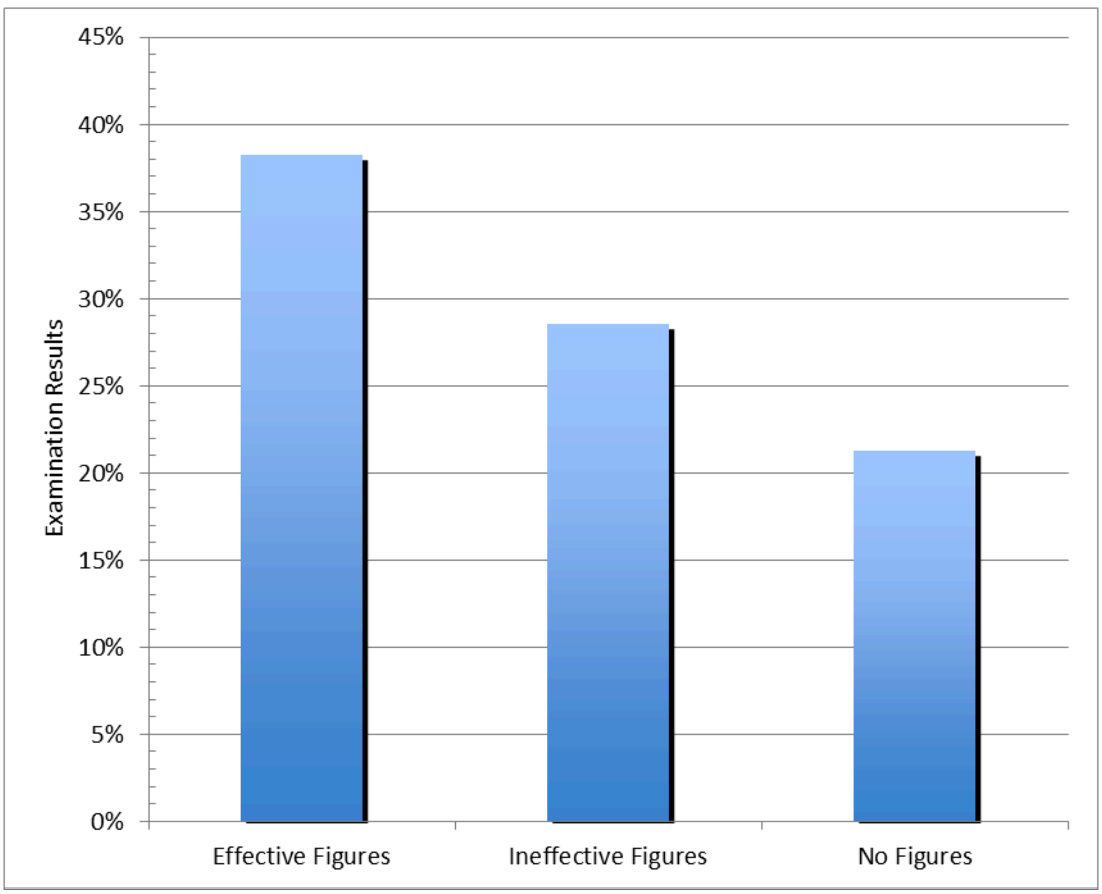

Figure 7. Post Lecture Exam Comparison

Exam results for all three lectures were entered into JMP 8.0 and Tukey's test (JMP., 2011) was used to calculate mean and variance. Tukey's test is a variant of the Student's t Test used for comparing more than two groups using studentized data.

Results indicated a statistical difference with ninety-five percent certainty between effective figures and no figures as illustrated in Table 1.

Table 1

Tukey's Test Results for the Examinations for the Three Lectures

	Lecture #1		Lecture #2		Lecture #3	
	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
Post-Lecture Examination	38.24	3.26	28.57	5.08	21.25	4.75

Level			Least Square Mean
Effective	A		38
Ineffective	A	B	28
No Figure		B	21

Levels not connected by same letter are significantly different (i.e. A A or B B)

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	2	3334.454	1667.23	4.6143
Error	61	22040.546	361.32	Prob > F
C. Total	63	25375		0.0136*

However, a statistical differnce between effective and ineffective figures could not be established at the five percent confidence level. The effective figure average score was nine percent higher than the ineffective figure.

A Student's t Test analysis assuming unequal variance showed that at the ten percent level the two populations are different for the effective and ineffective figures.

The percentage of participants who showed no advancement in target costing knowledge was much higher with the ineffective lecture than with effective figures and no figures lectures.

Analysis of Zero Scores

Figure 8 reveals thirty-one percent of ineffective figure examinations had a score of zero compared to six percent and thirteen percent for effective figures and no figures results, respectively.

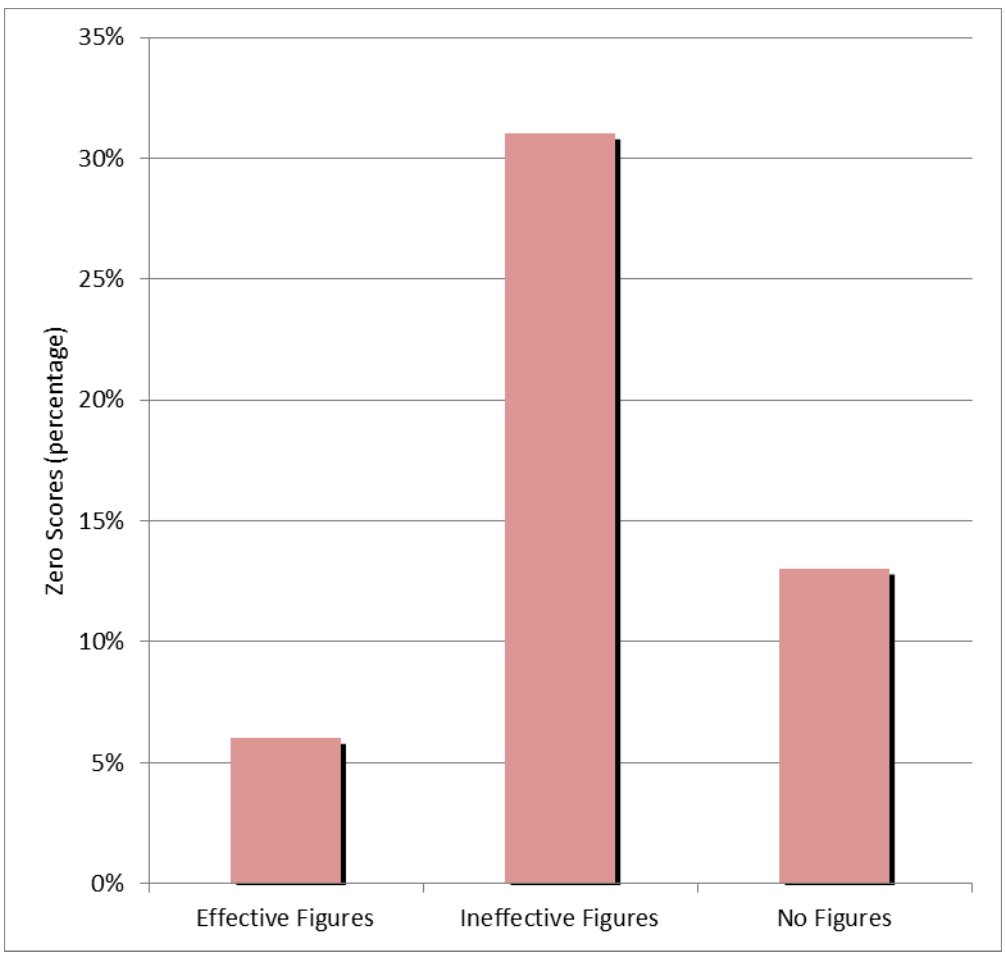

Figure 8. Percentage of Scores Equal to Zero in Post-Lecture Examinations

Use of Figures against No Figures

The use of effective figures collectively increased the user understanding for the entire group; where as ineffective figures did not increase user understanding for over a third of the participants.

Figure 9 shows the exam averages for figures and no figures.

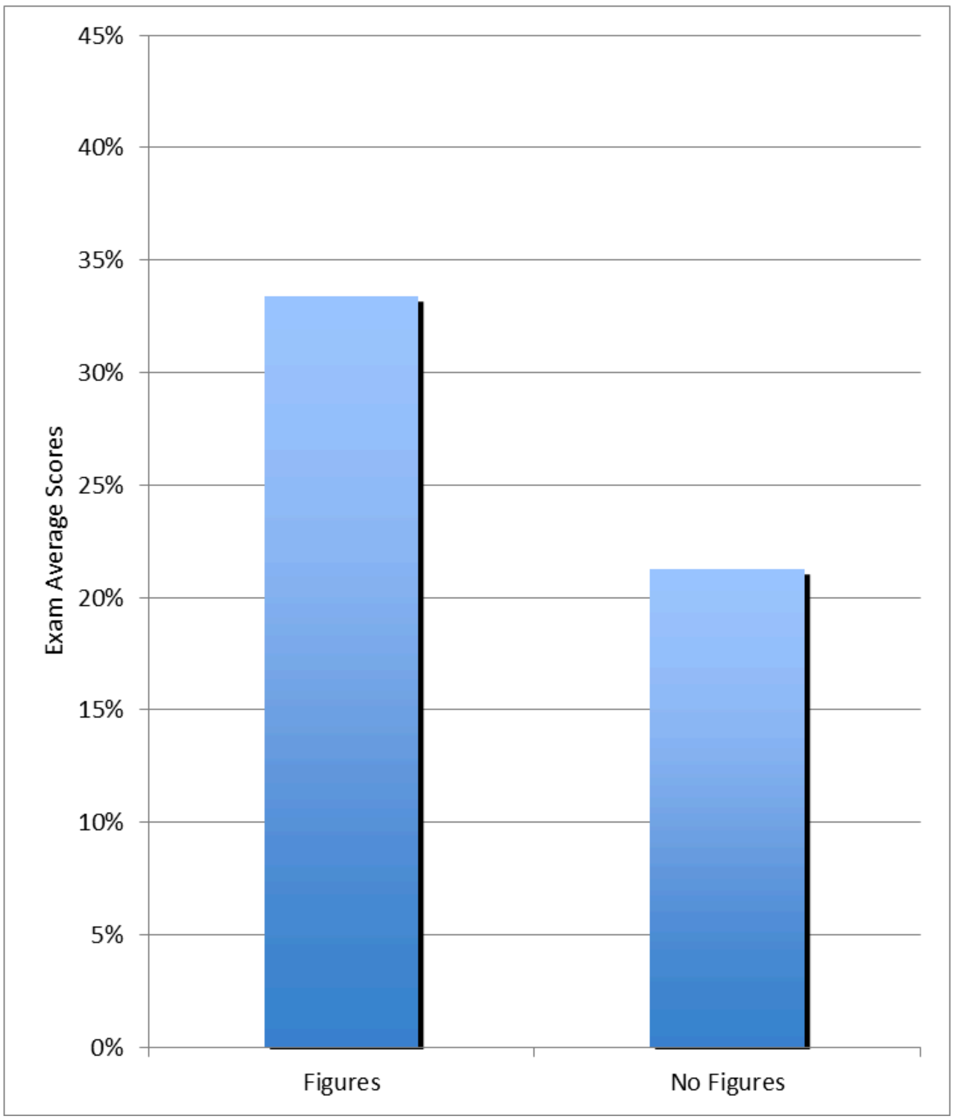

Figure 9. Exam Averages with and without Figures

Participants viewing a lecture including figures, effective figures or ineffective figures averaged an exam score of thirty-three percent, while participants viewing a lecture without figures averaged a score of twenty-one percent as shown in Figure 9. Examination results for the two dat sets shown in Figure 9 were analysed using JMP 8.0.

Tukey's test revealed a statistical difference between the two groups as shown in Table 2 at the five percent level.

Table 2

Tukey's test results for Figure and no Figure Examinations

	Figures		No Figures	
	Mean	Standard Deviation	Mean	Standard Deviation
Post-Lecture	35.42	2.78	21.25	4.81

Level			Least Square Mean
Yes	A		35.4
No		B	21.25

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	2408.333	2408.33	6.5015
Error	62	22966.667	370.43	Prob > F
C. Total	63	25375		0.0133*

Hypothetical Application

Each participant was then asked to apply their acquired knowledge to a hypotheical application. The application was a company trying to develop a new toaster.

The company had not previously manufactured toasters. This was the second post lecture examination. This is a written test.The students were scored on their ability to:

1. Define the product
2. Set the target
3. Achieve the target
4. Maintain competitive cost

The scoring was either zero or full marks. If a participant did not understand any part of the process a zero score was given for the examination, the resutls are illustrated in Figure 10.

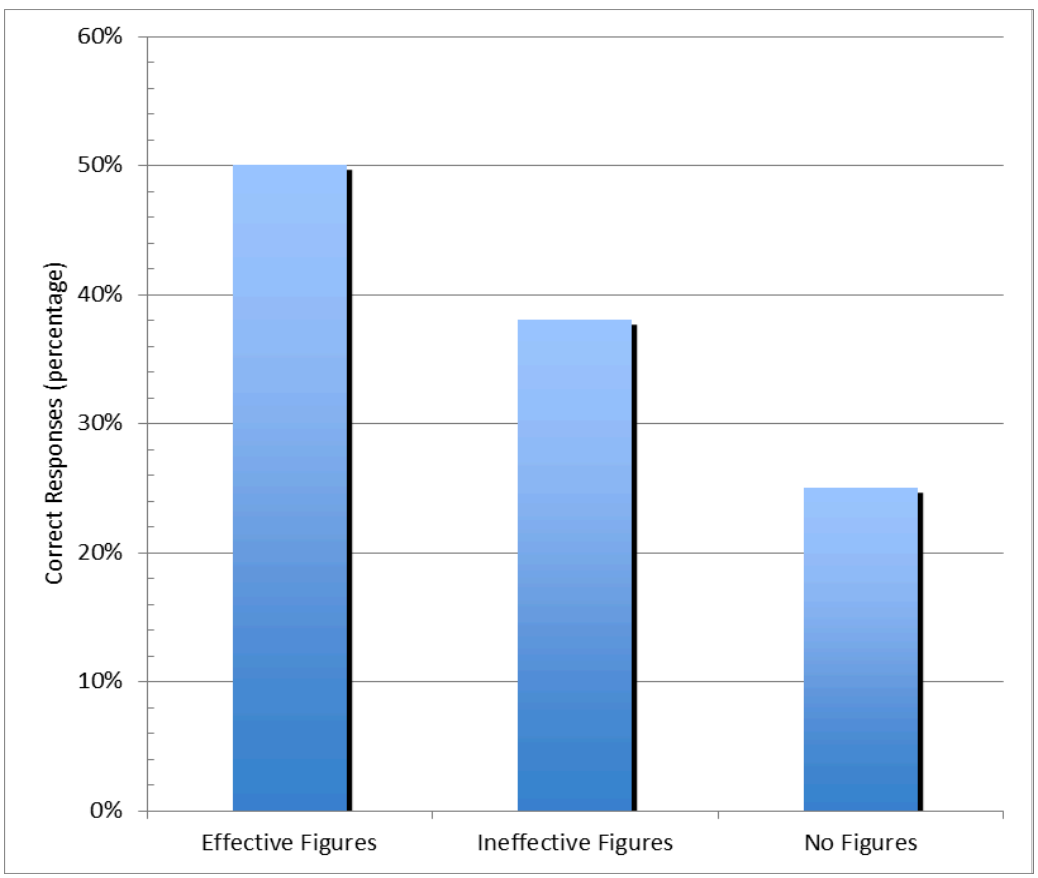

Figure 10. Effective Application of Target Costing Percentage

Participants ability to apply target costing to a hypothetical company showed an improved average score when compared to the written test, but the distribution between groups remained evident. Fifty percent of participants viewing the effective figures lecture were able to apply target costing, while ineffective figures and no figures lectures had thirty-eight percent and twenty-five percent correct user application, respectively.

QUALITATIVE RESULTS AND ILLUSTRATIONS

Simple, categorized and progressively structured figures were hypothesized to improved user understanding considerably more than figures which did not possess those traits. Although a statistical difference between the two could not be established, figure recollection for effective figures was significantly higher than ineffective figures. As illustrated in Figure 11, participants viewing the effective figures lecture had a twenty-four percent figure recollection rate, while participants viewing the ineffective figures lecture had none, and made no attempts to perform this task. It is self-evident there is a difference in the performance of the groups.

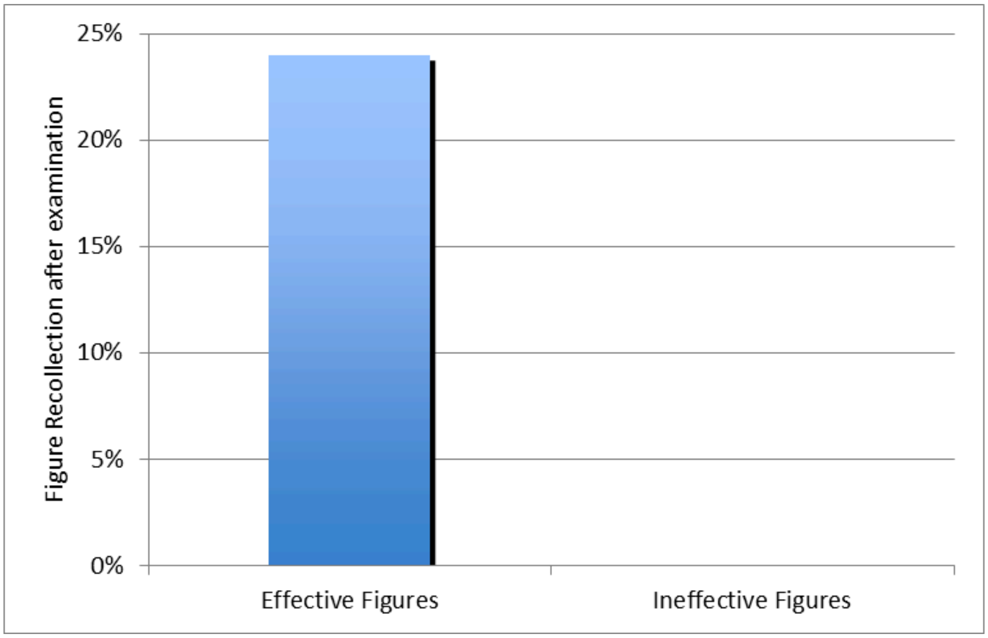

Figure 11. Percentage of Students Able to Effectively Recall a Figure Presented from the Lecture Presented

The accuracy and level of detail illustrated in participant drawings was very high as well. Figure 12 to Figure 15 show four of the most accurate participant recollection illustrations submitted by those viewing the effective figures lecture.

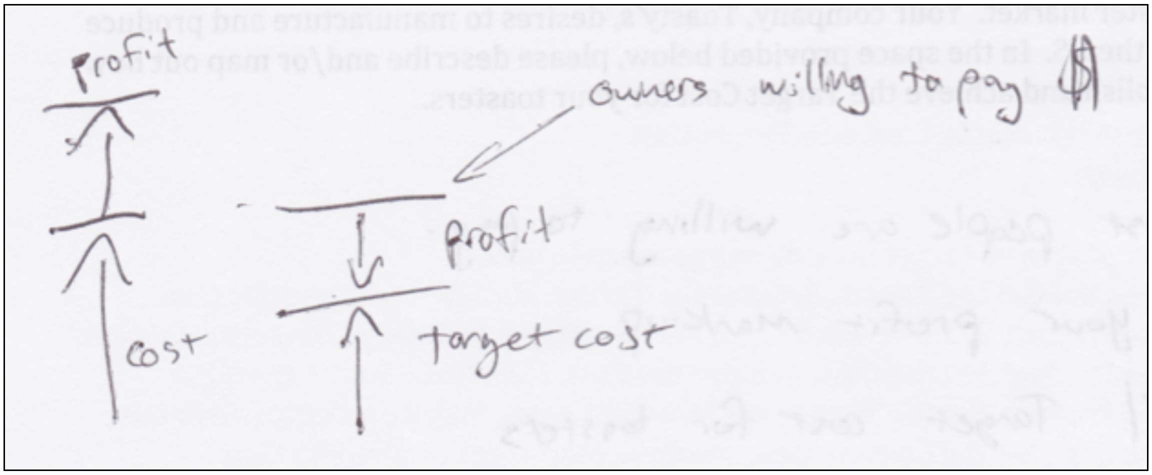

Figure 12. Participant Illustration: Establishing Target Cost

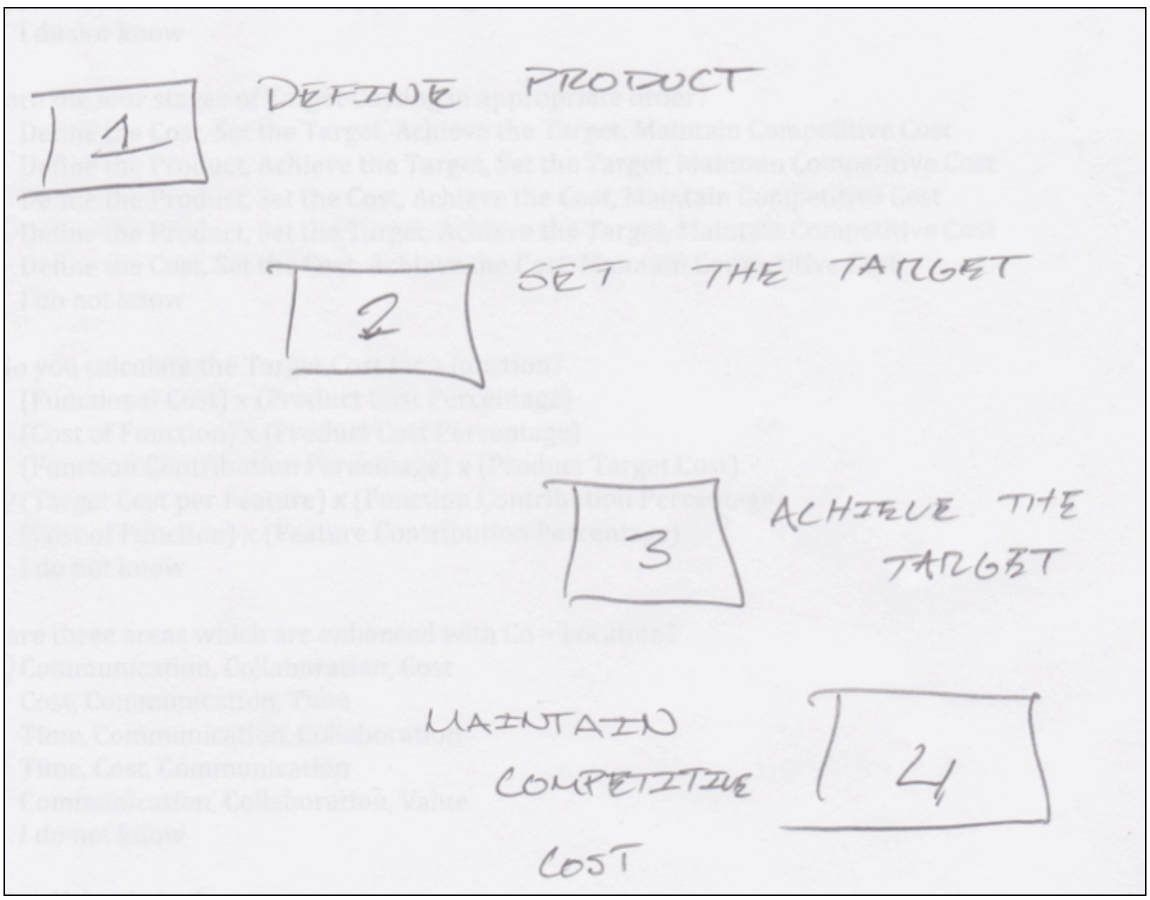

Figure 13. Participant Illustration: Target Costing Process (1)

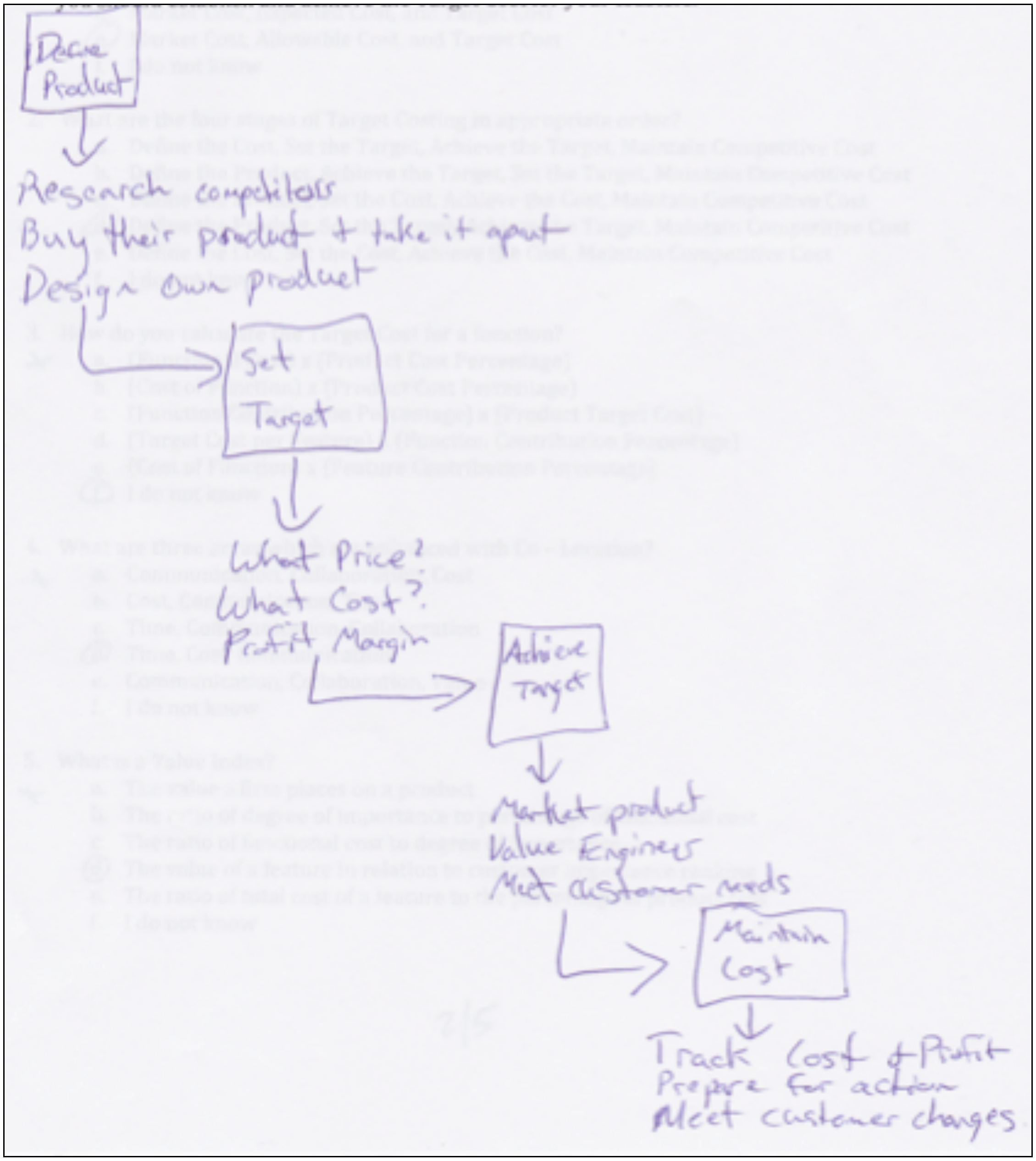

Figure 14. Participant Illustration: Target Costing Process (2)

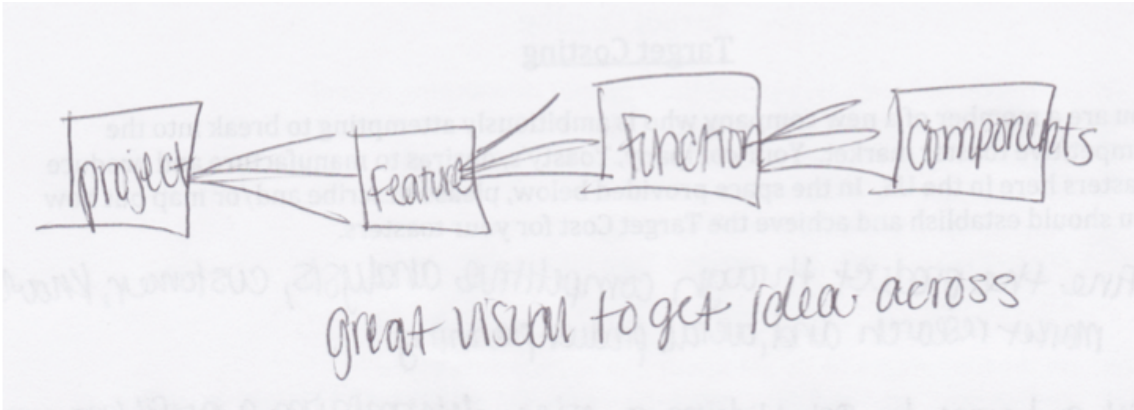

Figure 15. Participant Illustration: Subsystem Breakdown

SUMMARY OF RESULTS

Results from the experimental work are:

1. Participants viewing the effective figures, ineffective figures, and no figures lectures had an examination average of thirty-eight percent, twenty-nine percent, and twenty-one percent, respectively.
2. Participants viewing a lecture with figures had an average examination score of thirty-three percent correct, while participants viewing a lecture without figures had an average examination score of twenty-one percent.
3. A difference between examinations results of lectures using of figures and no figures was statistically proven with the use of Tukey's test in the JMP 8.0 program.
4. A statistical difference between effective and ineffective figures could not be established with the Tukey's test due to inconsistent results with a limited population, but was proven at the ten percent level with Student's t Test

CHAPTER V

CONCLUSION

The target costing process has shown areas of success within the field of construction. However, limited user understanding has restricted its success and adoption in the industry.

This thesis set out to address this issue and identify the most effective technique to teach target costing to construction-focused individuals. The research sought to identify if construction users demonstrate improved learning ability with the use of figures, as well as if the detail level of the figures affect their level of material comprehension.

Three lectures were developed presenting identical material on target costing. The first lecture included effective figures, the second included ineffective figures and the final lecture did not include any figures. Figures were rated and labeled as effective or ineffective based upon progressive structure, categorization, and simplicity. Each lecture was presented to a separate group of participants and a preliminary and post-lecture examination was administered to reveal user comprehension levels as well as figure recollection ability.

The results illustrated a statistical different in user comprehension between lectures including figures and the lecture without figures. Therefore, results prove that user comprehension increases with the use of figures. However, results infer participants viewing the lecture with effective figures learned more on average and as a group than participants viewing lecture with ineffective figures. This area should be addressed in future research.

Single trial runs were result of a tight schedule due to specific deadlines. However, with a larger sample population and increase number of trial runs, a statistical difference could potentially be established between effective and ineffective figures at the five percent level.

Evaluation of participant knowledge a week after the lectures should be explored to provide additional validity for figure effectiveness in material retention. Additionally, future research should develop a more standardized means of testing user comprehension by eliminating human variability in a lecture presentation.

REFERENCES

Ainsworth, S., & Loizou, A. (2003). The effects of self-explaining when learning with text or diagrams. *Cognitive Science, 27*, 669 - 681.

Ansari, S. L., Bell, J., & Okano, H. (2007). Target costing: Unchartered research territory. In C.S. Chapman., A.G. Hopwood & M.D. Shilds (Eds.), *Handbook of management accounting research* (pp. 507 - 530). Oxford: Elsevier Ltd.

Ansari, S. L., Bell, J. E., & CAM-I Target Cost Group. (1997). *Target costing – The next frontier in strategic cost management*. New York: Irwin-McGraw Hill.

Ax, C., Greve, J., & Nilsson, U. (2008). The impact of competition and uncertainty on the adoption of target costing. *Int. J. Production Economics, 115*, 92 - 103.

Ballard, G. (2008). The lean project delivery system: An update. *Lean Construction Journal, 1*, 1 - 19.

Ballard, G. (2010). Maximizing owner value through target value design. *AACE International Transactions*, 1 - 16.

Banham, R. (2000). Off target?: Why target costing has been slow to catch on here, despite its promise. *CFO, 16*(6), 127 - 130.

Butcher, K. R. (2006). Learning from text with diagrams: Promoting mental model development and inference generation. *Journal of Educational Psychology, 98*(1), 182 - 197.

Cengiz, E., & Ersoy, A. (2010). A literature review of target costing in ssci and sci&sci-expanded indexes. *Journal of Yasar University, 5*(19), 3131 - 3154.

Cheah, C., & Ting, S. K. (2005). Appraisal of value engineering in construction in Southeast Asia. *International Journal of Project Management, 23*(2), 151 - 158.

Clifton, M. B., Bird, H., Albano, R., & Townsend, W. (2004). *Target costing: Market-driven product design*. New York: Marcel Dekker, Inc.

Cooper, R., & Chew, W. B. (1996). Control tomorrow's costs through today's designs. *Harvard Business Review, January-February*, 88 - 97.

Cooper, R., & Slagmulder, R. (1997). *Target costing and value engineering*. Portland, OR: Productivity Press.

Ellram, L. (2006). The implementation of target costing in the United States: Theory versus practice. *The Journal of Supply Chain Management, Winter*, 13 - 26.

Feil, P., Yook, K., & Kim, I. (2004). Japanese target costing: A historical perspective. *International Journal of Strategic Cost Management, Spring*, 10-19.

Helms, M., Ettkin, L., Baxter, J., & Gordon, M. (2005). Managerial implications of target costing. Competitiveness Review*, 15*(1), 49 - 56.

JMP. (2011). *Basic analysis and graphing*. Cary, NC: JMP.

Jorgensen, B., & Emmitt, S. (2008). Lost in transition: The transfer of lean manufacturing to construction. *Engineering Construction & Architecture Management, 15*(4), 383 - 398.

Kato, Y. (1993). Target costing support systems: Lessons from leading Japanese companies. *Management Accounting Research, March*, 33-47.

Koskela, L. (1992). *Application of the new production philosophy to construction*. Palo Alto, CA: Stanford University.

Koskela, L., Howell, G., Ballard, G., & Tommelein, I. (2002). The foundations of lean construction. In R. Best & G. de Valence (Eds.), *Design and construction: Building in value* (pp. 211 - 226). Oxford: Butterworth-Heinemann.

Latham, M. (1994). *Constructing the team - final report of the government / industry review of procurement and contractual arrangements in the UK construction industry*. London: The Stationery Office.

Miller, H. L. (1964). *Teaching and learning in adult education*. New York: The MacMillan Company.

Nicolini, D., Tomkins, C., Holti, R., Oldman, A., & Smalley, M. (2000). Can target costing and whole life costing be applied to the construction industry? Evidence from two case studies. *British Journal of Management, 11*, 303 - 324.

Porwal, V. (2010). *Last planner system – Areas of application and implementation challenges.* Unpublished Thesis, Texas A&M University, College Station, TX.

Rybkowski, Z. K. (2009). *The application of root cause analysis and target value design to evidence-based design in the capital planning of healthcare facilities.* Unpublished Dissertation, University of California, Berkeley, Berkeley.

Sakurai, M. (1989). Target costing and how to use it. *Journal of Cost Management for Manufacturing Industry, Summer*(39-50).

Winn, W. (1996). Learning from maps and diagrams. *Educational Psychology, 3*(3), 211 - 247.

Zaman, M. (2004). Target costing implementation in Australian companies: An exploratory study of current corporate practice and strategic intent, *Fourth Asia*

Pacific Interdisciplinary Research in Accounting Conference (pp. 1-9). Singapore.

APPENDIX A

The preliminary examination for the three groups is shown in Figure 16. The answers are D, B, E, D, and A.

Preliminary Examination

February 16, 2011

<u>Target Costing</u>

1. How do you calculate the Target Cost for a function?
    a. (Functional Cost) x (Product Cost Percentage)
    b. (Cost of Function) x (Product Cost Percentage)
    c. (Function Contribution Percentage) x (Product Target Cost)
    d. (Target Cost per Feature) x (Function Contribution Percentage)
    e. (Cost of Function) x (Feature Contribution Percentage)
    f. I do not know

2. What is a Value Index?
    a. The value a firm places on a product
    b. The ratio of degree of importance to percentage of functional cost
    c. The ratio of functional cost to degree of importance
    d. The value of a feature in relation to customer importance ranking
    e. The ratio of total cost of a feature to the percentage of product cost
    f. I do not know

3. What four factors must be considered to define a product?
    a. Target Cost, Customer Knowledge, Function Analysis, Product Planning
    b. Customer Knowledge, Market Analysis, Product Planning, Target Cost
    c. Competitive Analysis, Product Planning, Target Cost, Consumer Knowledge
    d. Consumer Knowledge, Competitive Analysis, Market Analysis, Functional Analysis
    e. Product Planning, Market Analysis, Competitor Analysis, Customer Knowledge
    f. I do not know

4. Which of the following definitions best describes a functional group?
    a. A group of individuals who's goal is to establish the function of a product
    b. A group of individuals who define what functions to include in a product
    c. A group of individuals who's goal is to collectively identify the cost of a product
    d. A group of individuals who's goal is to collectively lower the cost of a function
    e. A group of individuals who direct and steer other team members to achieve a product Target Cost
    f. I do not know

5. What are four methods to reach your functional Target Cost?
    a. Brainstorming, Value Engineering, Functional Teams, Design for "X"
    b. Value Engineering, Functional Analysis, Function Breakdown Percentage (FBP), Brainstorming
    c. Design for "X", Functional Teams, Function Breakdown Percentage (FBP), Functional Analysis
    d. Function Identification, Cross-Functional Teams, Feature Assessment, Product Costing
    e. Functional Breakdown Percentage (FBP), Big Room, Brainstorming, Focus Groups
    f. I do not know

Figure 16. Preliminary Examination

APPENDIX B

The first post lecture examination for the three groups is shown in Figure 17. The answers are E, A, D, D, and B.

Post-Lecture Examination

February 16, 2011

Target Costing

1. What four factors must be considered to define a product?
   a. Target Cost, Customer Knowledge, Function Analysis, Product Planning
   b. Customer Knowledge, Market Analysis, Product Planning, Target Cost
   c. Competitive Analysis, Product Planning, Target Cost, Consumer Knowledge
   d. Consumer Knowledge, Competitive Analysis, Market Analysis, Functional Analysis
   e. Product Planning, Market Analysis, Competitor Analysis, Customer Knowledge
   f. I do not know

2. What are four methods to reach your functional Target Cost?
   a. Brainstorming, Value Engineering, Functional Teams, Design for "X"
   b. Value Engineering, Functional Analysis, Function Breakdown Percentage (FBP), Brainstorming
   c. Design for "X", Functional Teams, Function Breakdown Percentage (FBP), Functional Analysis
   d. Function Identification, Cross-Functional Teams, Feature Assessment, Product Costing
   e. Functional Breakdown Percentage (FBP), Big Room, Brainstorming, Focus Groups
   f. I do not know

3. How do you calculate the Target Cost for a function?
   a. (Functional Cost) x (Product Cost Percentage)
   b. (Cost of Function) x (Product Cost Percentage)
   c. (Function Contribution Percentage) x (Product Target Cost)
   d. (Target Cost per Feature) x (Function Contribution Percentage)
   e. (Cost of Function) x (Feature Contribution Percentage)
   f. I do not know

4. Which of the following definitions best describes a functional group?
   a. A group of individuals who's goal is to establish the function of a product
   b. A group of individuals who define what functions to include in a product
   c. A group of individuals who's goal is to collectively identify the cost of a product
   d. A group of individuals who's goal is to collectively lower the cost of a function
   e. A group of individuals who direct and steer other team members to achieve a product Target Cost
   f. I do not know

5. What is a Value Index?
   a. The value a firm places on a product
   b. The ratio of degree of importance to percentage of functional cost
   c. The ratio of functional cost to degree of importance
   d. The value of a feature in relation to customer importance ranking
   e. The ratio of total cost of a feature to the percentage of product cost
   f. I do not know

Figure 17. Post Lecture Examination 1

APPENDIX C

The second post lecture examination for the three groups is shown in Figure 18.

Post-Lecture Examination

February 16, 2011

<u>Target Costing</u>

1. You are a part of a company who is ambitiously attempting to break into the competitive toaster market. Your company, Toasty's, desires to manufacture and produce toasters here in the US. In the space provided below, please describe and/or map out how you should establish and achieve the Target Cost for your toasters.

Figure 18. Post Lecture Examination 2

APPENDIX D

Figure 19 to *Figure 24* show the first lecture. This is the lecture with the effective figures. To see a better quality image please refer to the supplemental file, Appendix D.

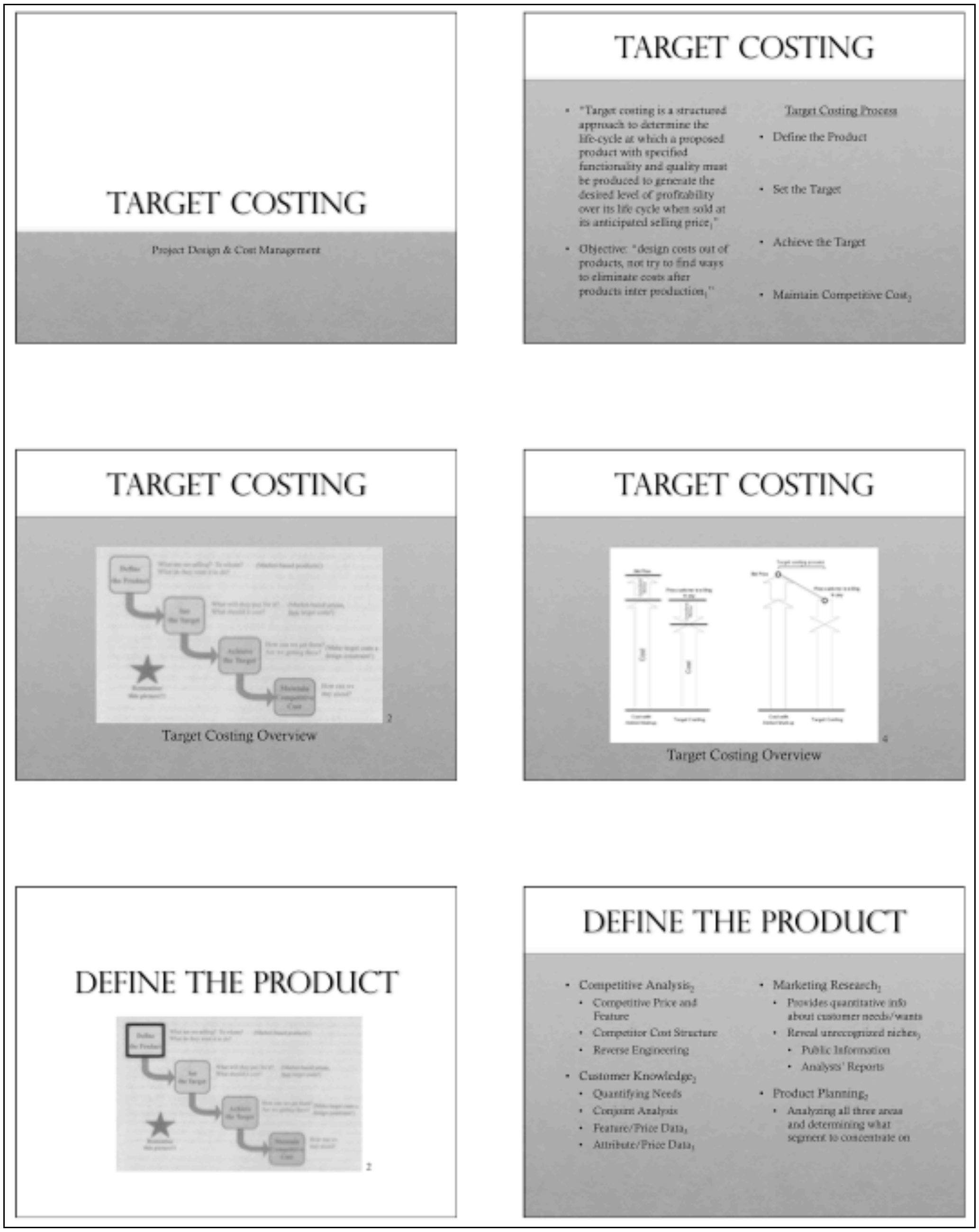

Figure 19. Lecture One Slides 1 to 6

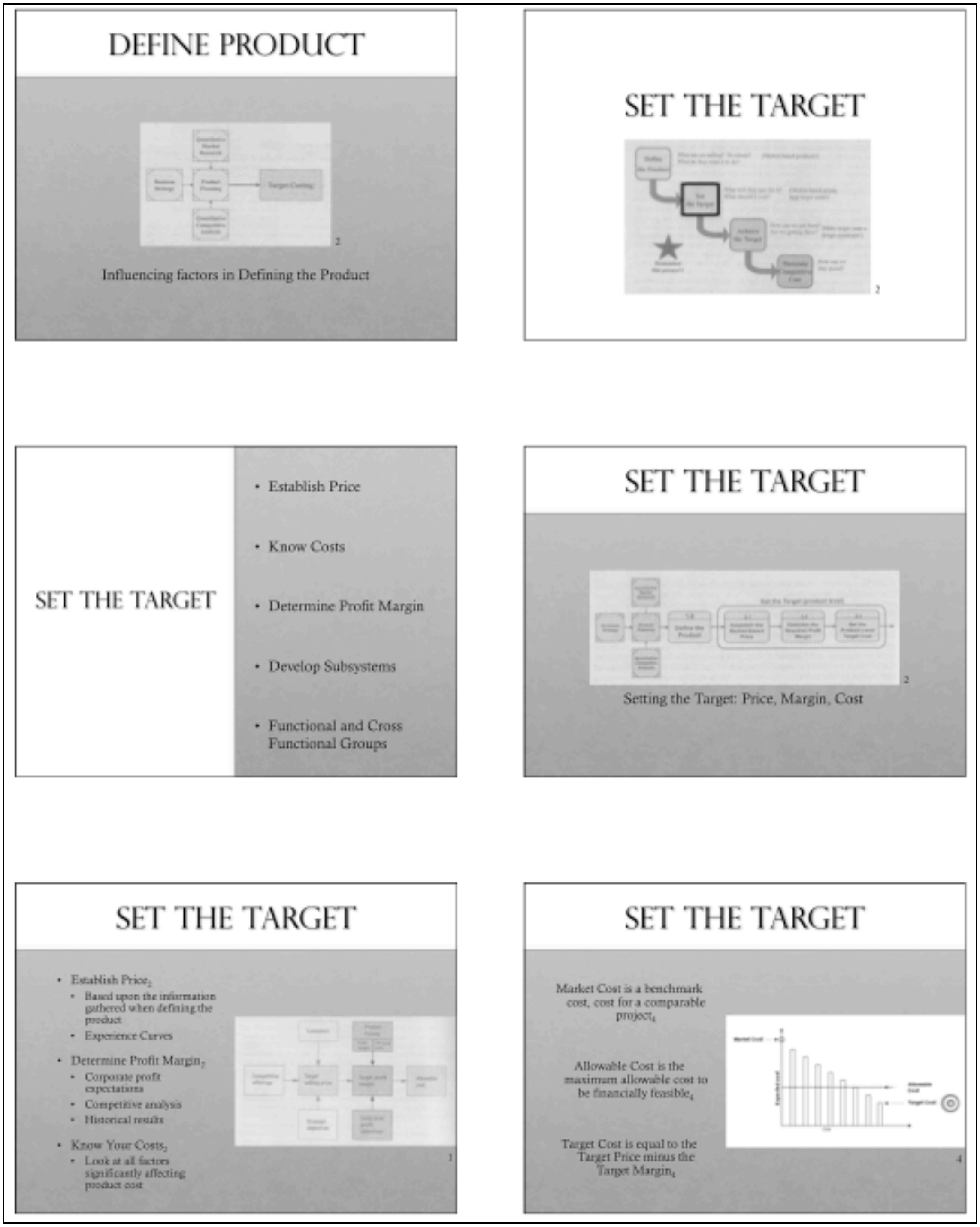

Figure 20. Lecture One Slides 7 to 12

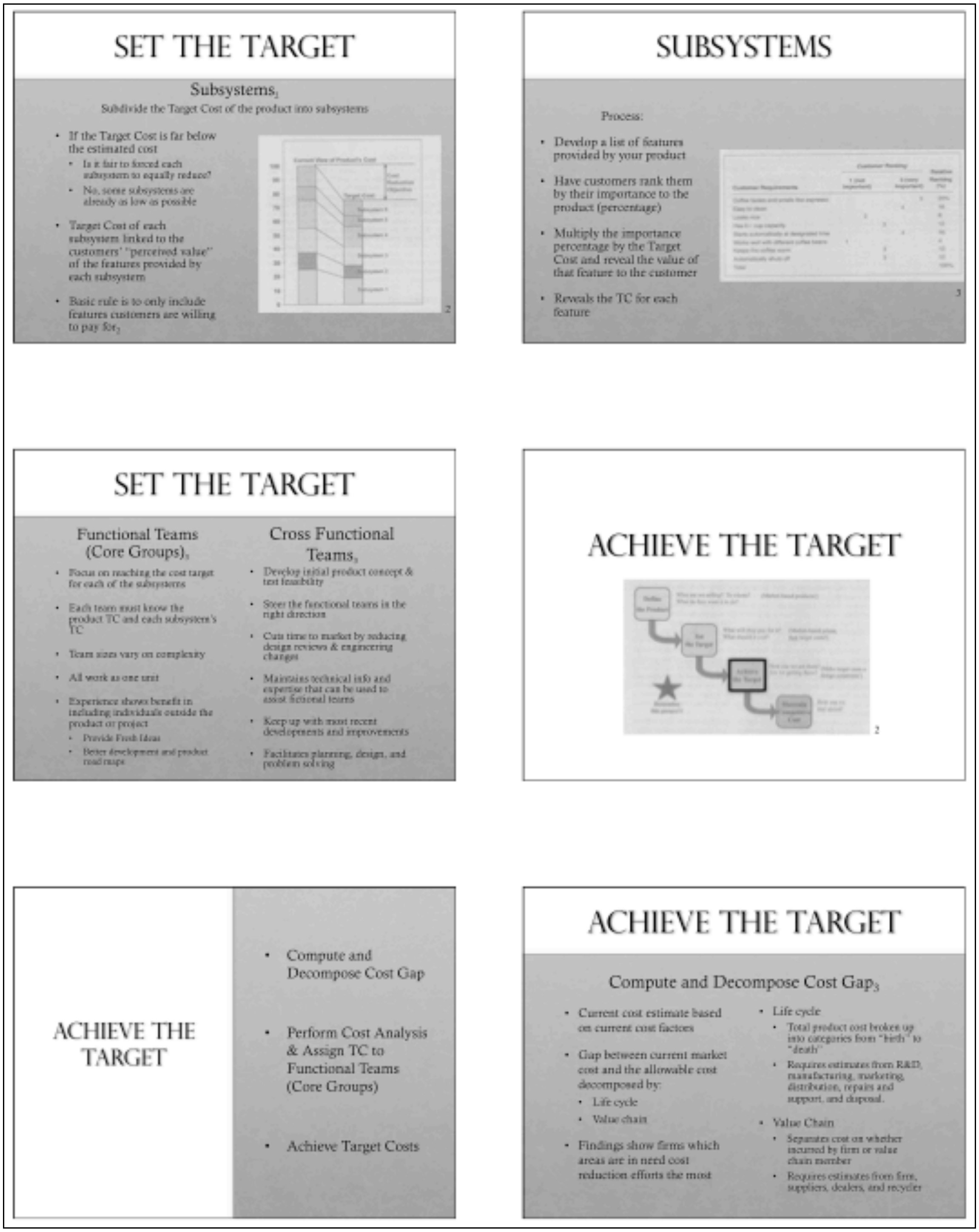

Figure 21. Lecture One Slides 13 to 18

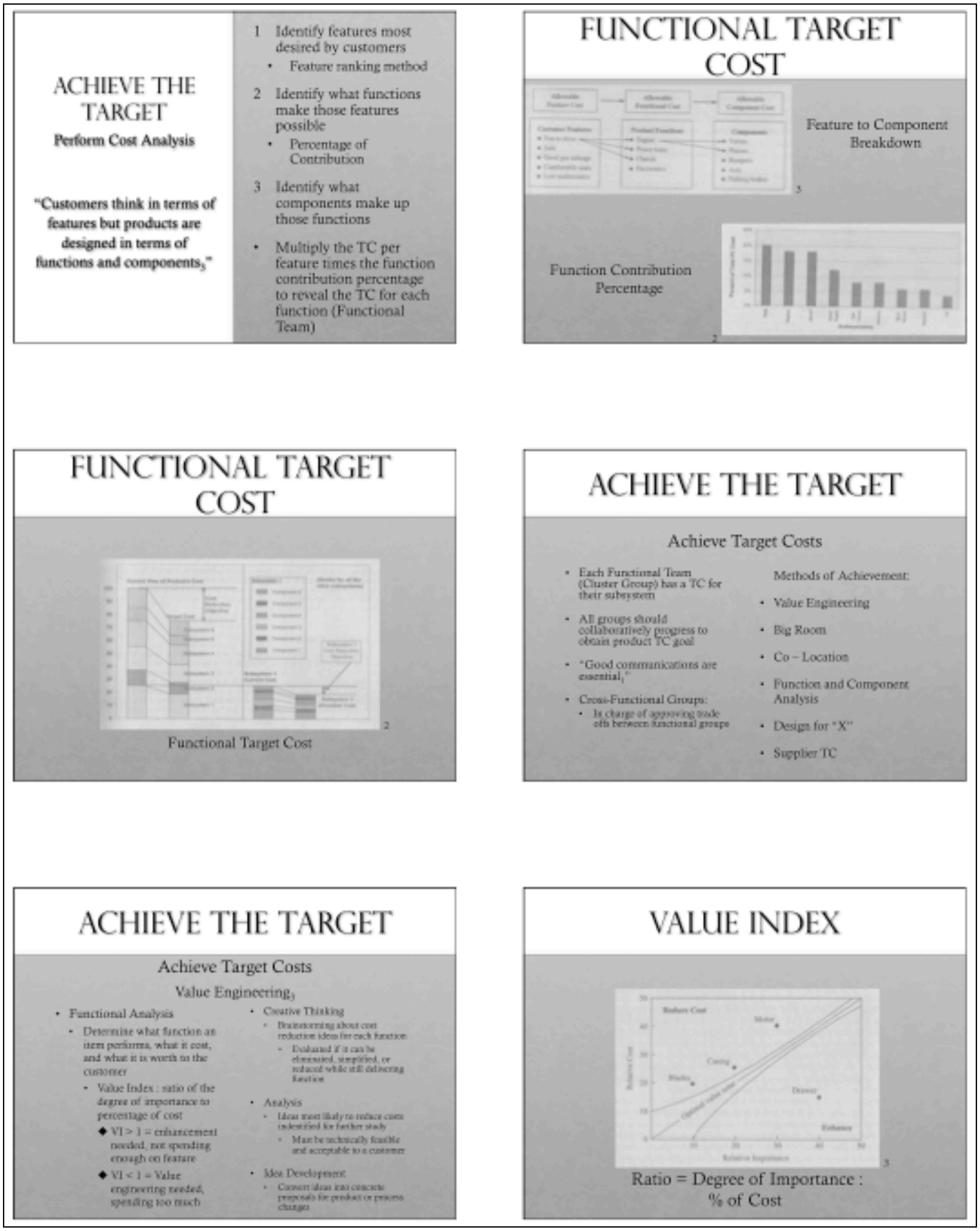

Figure 22. Lecture One Slides 19 to 24

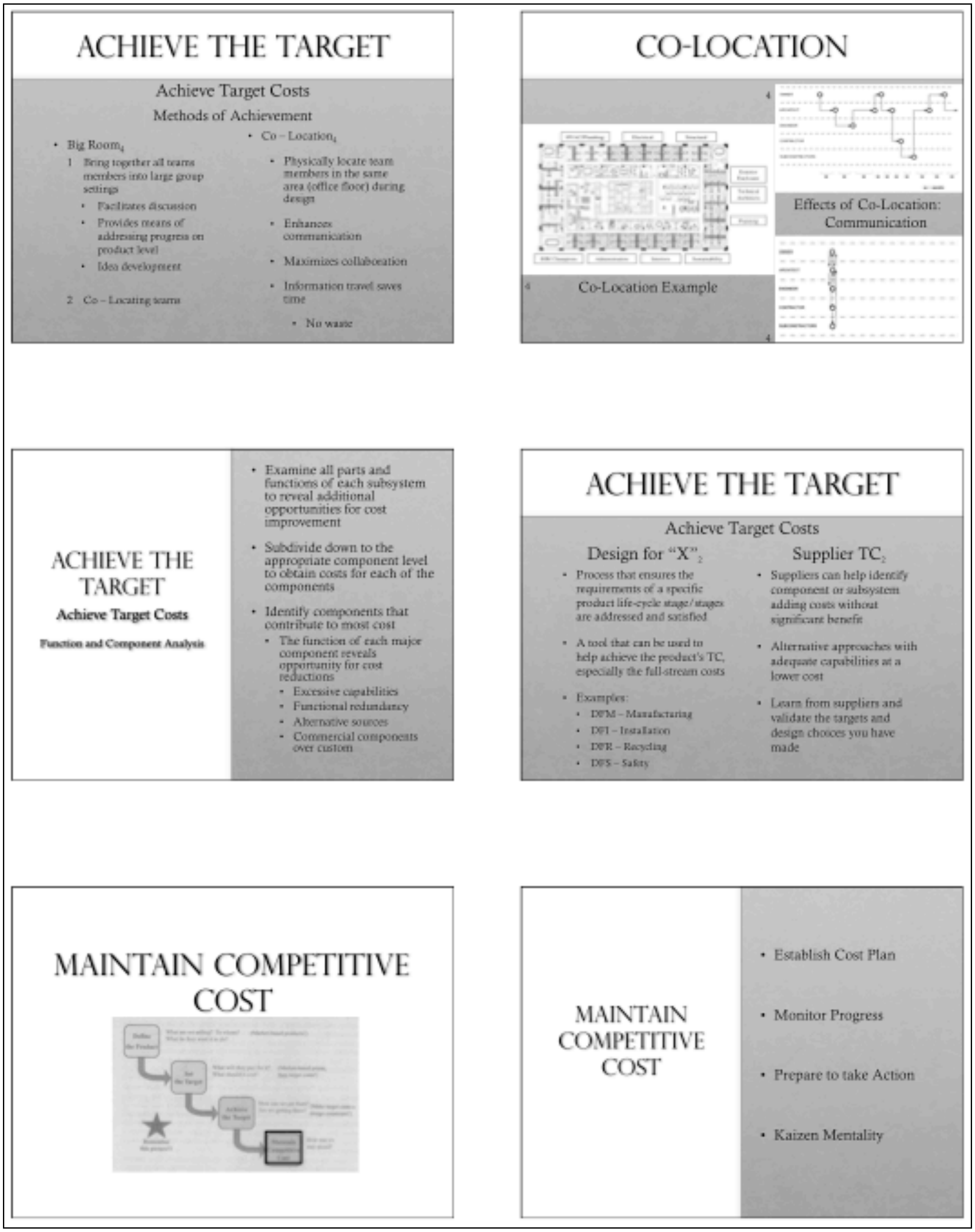

Figure 23. Lecture One Slides 25 to 30

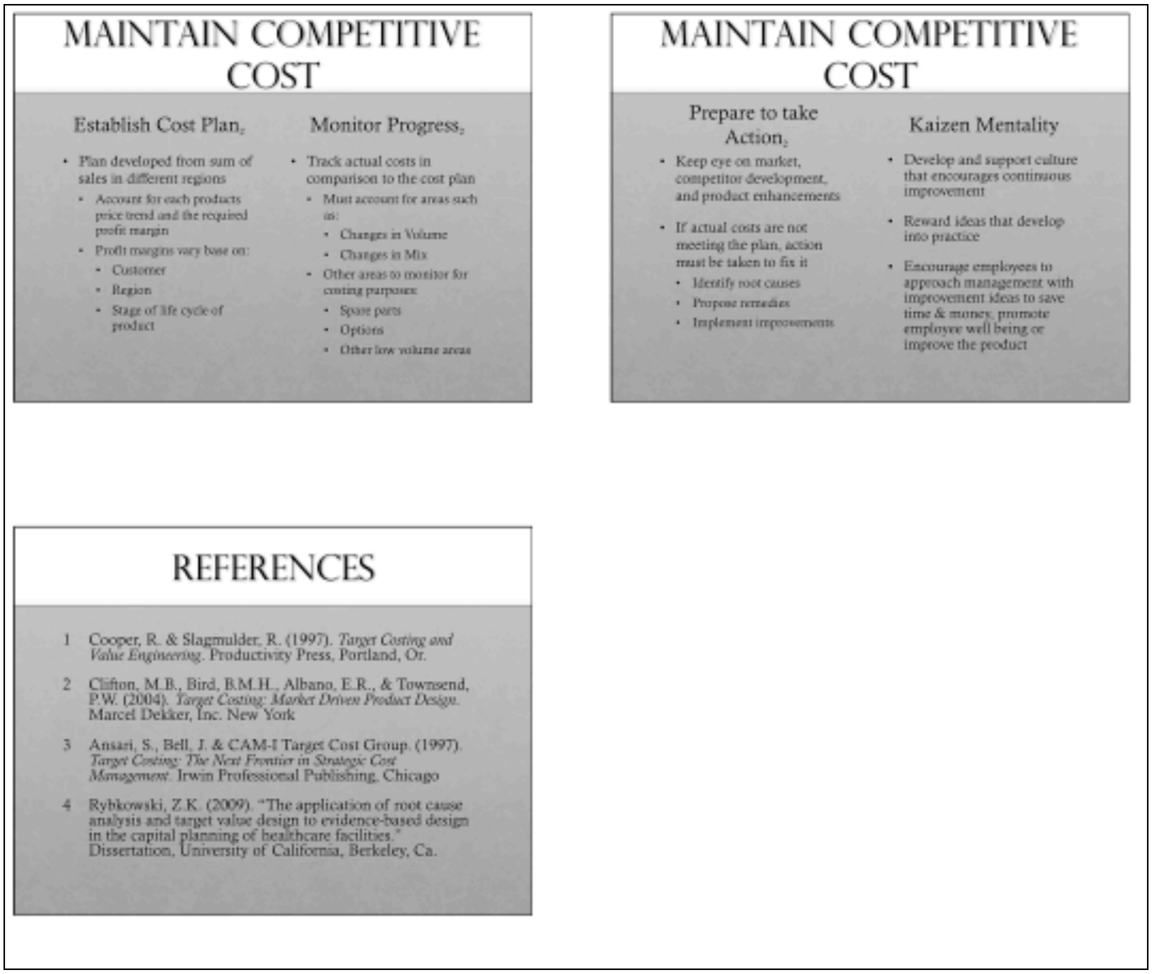

Figure 24. Lecture One Slides 31 to 33

APPENDIX E

Figure 25 to Figure 30 show the second lecture. This is the lecture with the ineffective figures. To see a better quality image, please refer to the supplemental file, Appendix E.

Figure 25. Lecture Two Slides 1 to 6

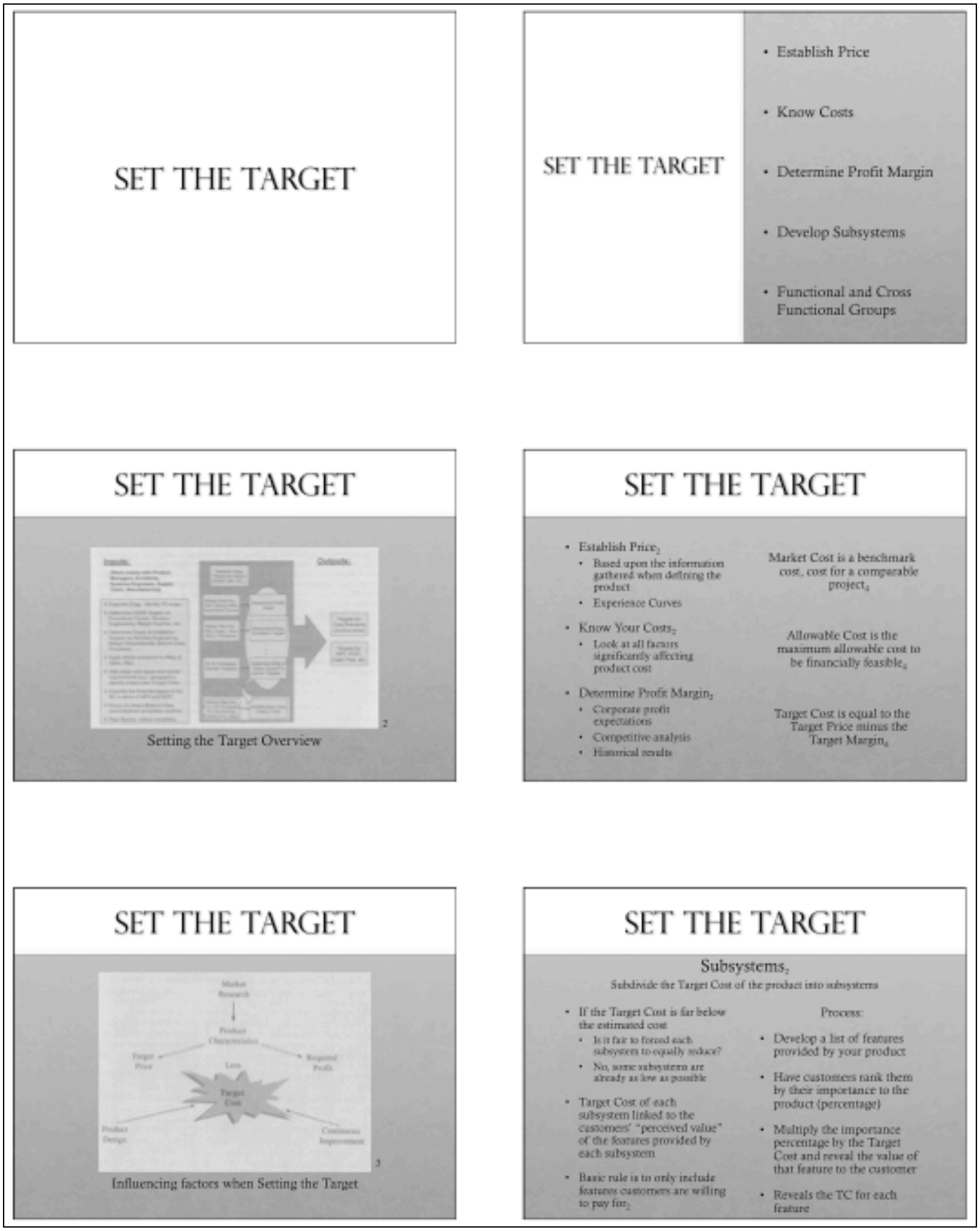

Figure 26. Lecture Two Slides 7 to 12

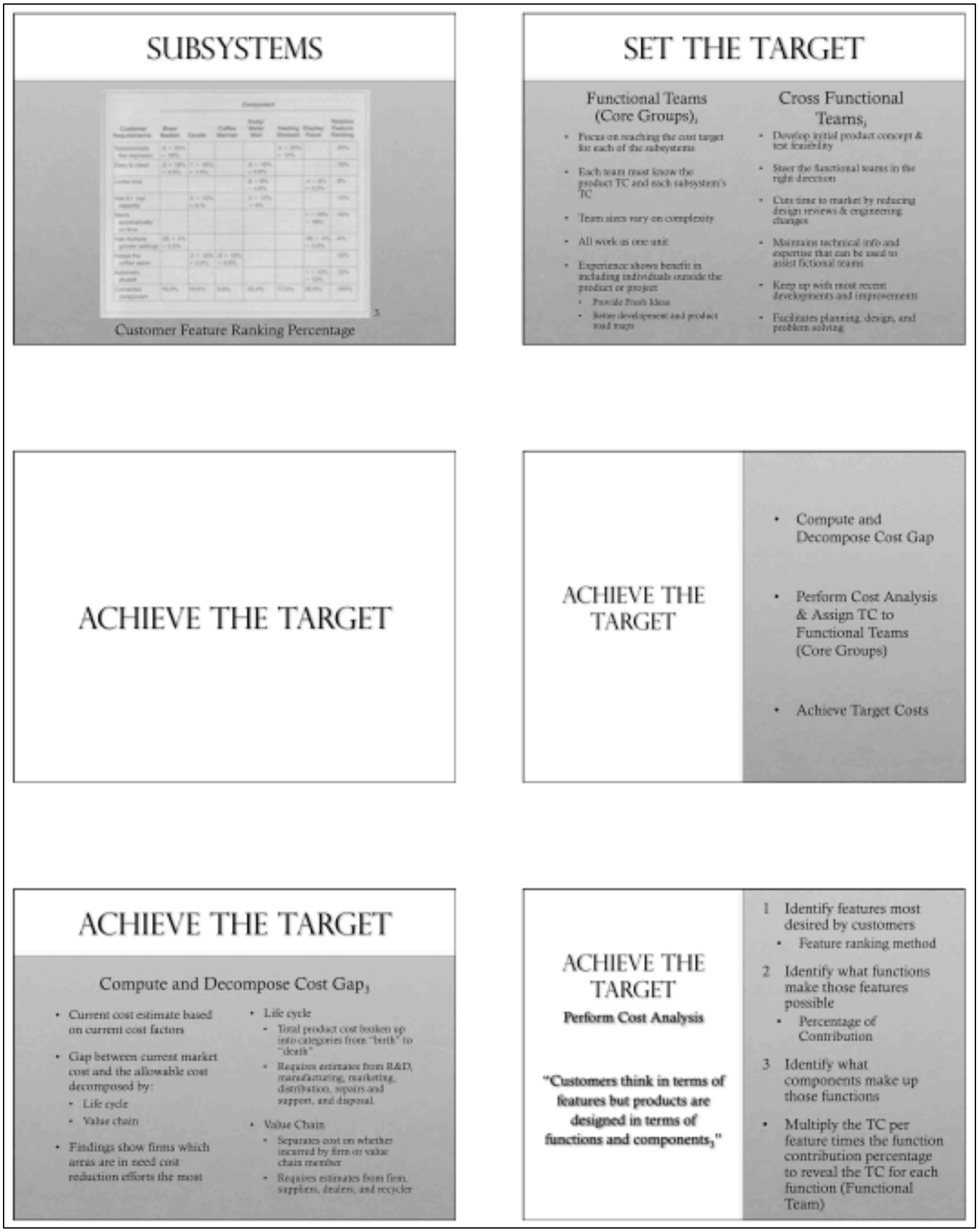

Figure 27. Lecture Two Slides 13 to 18

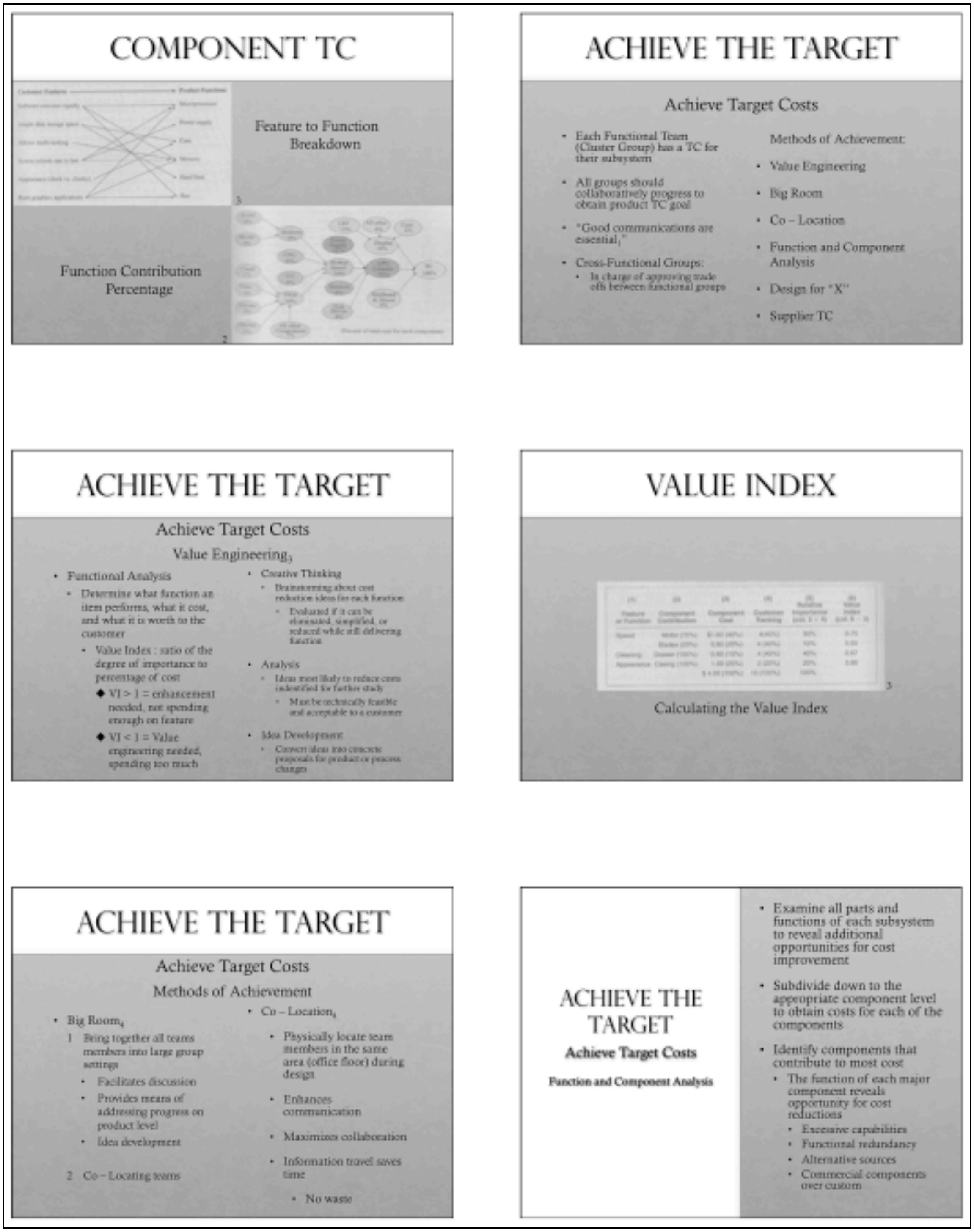

Figure 28. Lecture Two Slides 19 to 24

Figure 29. Lecture Two Slides 25 to 30

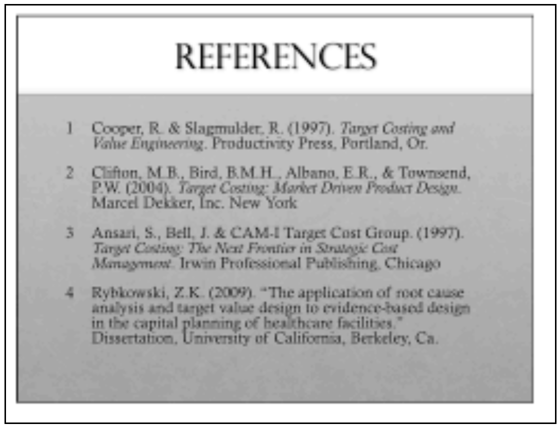

Figure 30. Lecture Two Slide 31

APPENDIX F

Figure 31 to show the third lecture. This is the lecture with the no figures. To see a better quality image, please refer to the supplemental file, Appendix F.

Figure 31. Lecture Three Slides 1 to 6

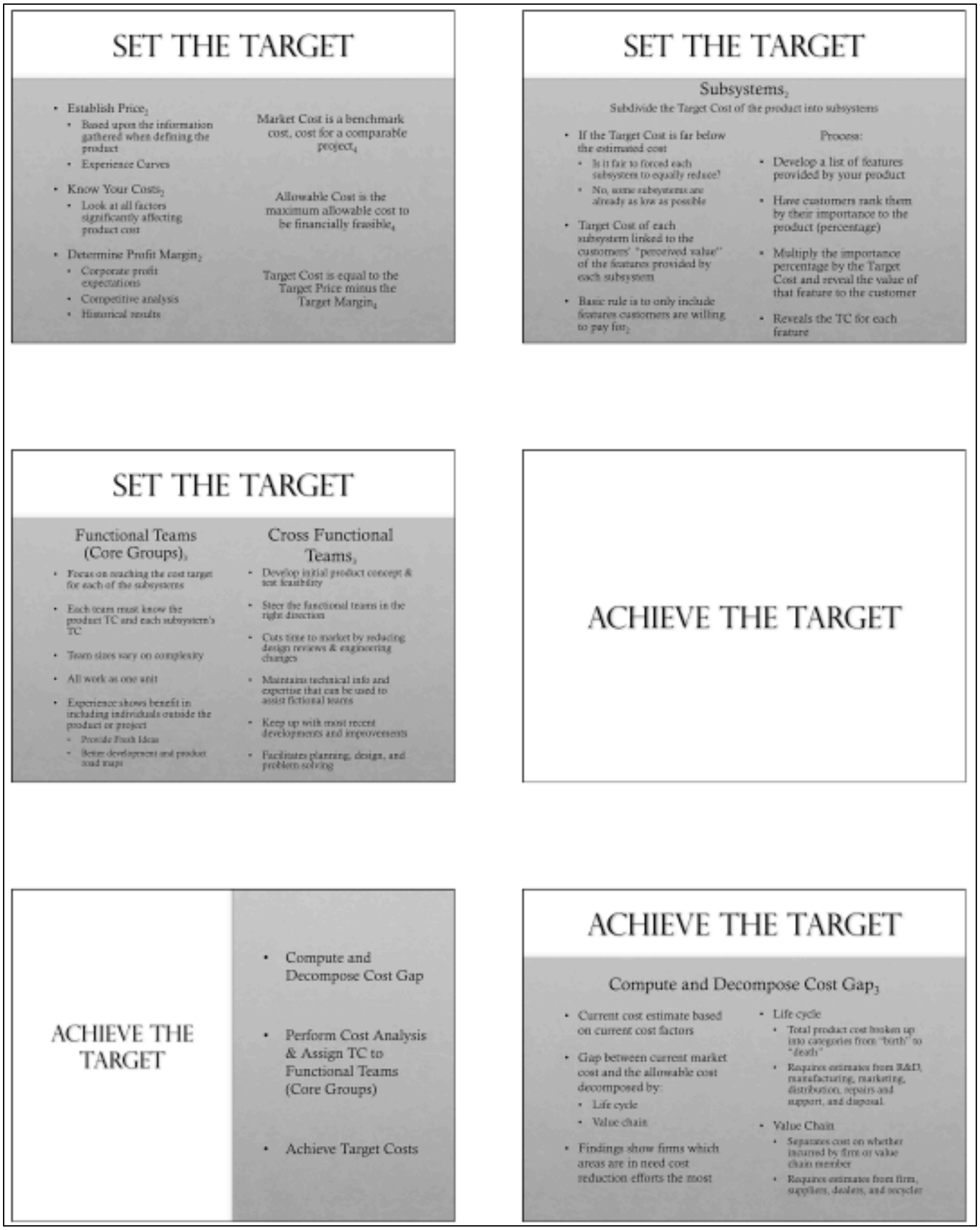

Figure 32. Lecture Three Slides 7 to 12

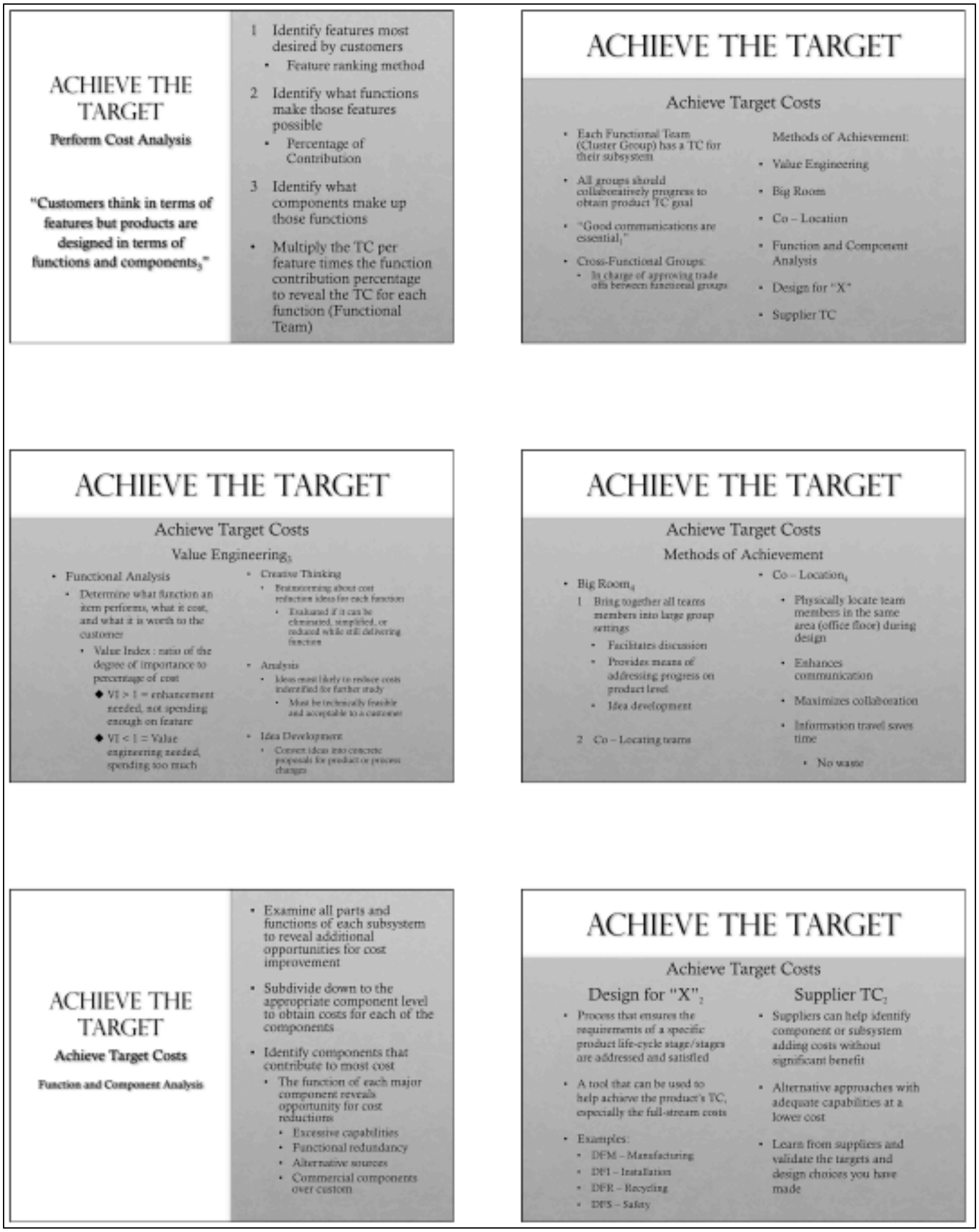

Figure 33. Lecture Three Slides 13 to 18

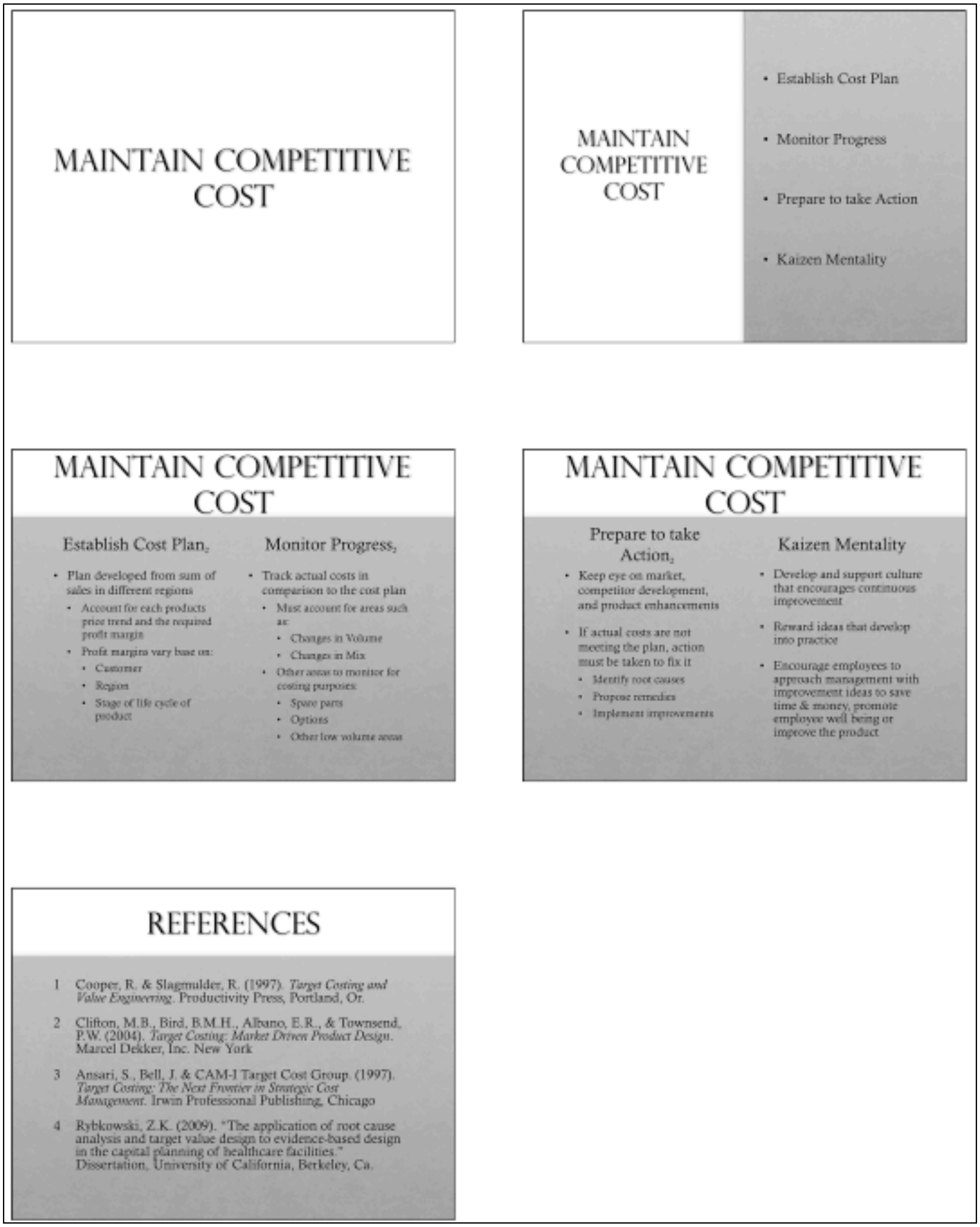

Figure 34. Lecture Three Slides 19 to 23

APPENDIX G

Table 3 presents the results for the preliminary and the first post-examination.

Table 3

Test Results Summary – Final Row is the Average Values for the Test

Lecture One Tests		Lecture Two Tests		Lecture Three Tests	
Preliminary	Post-Lecture	Preliminary	Post-Lecture	Preliminary	Post-Lecture
40%	40%	20%	40%	0%	20%
0%	60%	0%	60%	0%	20%
0%	60%	0%	40%	0%	20%
0%	40%	0%	60%	0%	20%
0%	20%	0%	60%	0%	20%
0%	60%	0%	20%	0%	40%
0%	40%	0%	0%	20%	20%
0%	20%	0%	40%	0%	40%
0%	40%	0%	20%	0%	40%
20%	40%	0%	0%	0%	0%
20%	20%	0%	0%	0%	20%
20%	80%	0%	20%	0%	20%
0%	60%	0%	40%	0%	20%
0%	0%	0%	0%	20%	20%
0%	40%			0%	20%
0%	60%			60%	0%
20%	20%				
0%	20%				
0%	20%				
0%	20%				
0%	20%				
0%	40%				
0%	60%				
0%	20%				
0%	60%				
0%	40%				
0%	20%				
0%	0%				
0%	60%				
20%	60%				
0%	60%				
0%	40%				
0%	40%				
0%	20%				
4.1%	**38%**	**1.4%**	**28%**	**6.2%**	**21%**

VITA

Name: Joshua James Hullum

Address: 3137 TAMU Langford Building A,
Room 424 Department of Construction Science
College of Architecture, Texas A & M University
College Station, Texas 77843-3137

Email Address: joshhullum@gmail.com

Education: M.S. Construction Management May 2011
B. S. Agriculture Leadership and Development May 2009
Texas A&M University
College Station, TX