Proceedings of the 2014 HPC Fall Meeting

Friday, November 14, 2014
Sabbatini Lounge
Christian Brothers University
650 East Parkway South
Memphis, TN 38104
2014 HPC Fall Meeting
Friday, November 14, 2014
Sabbatini Lounge, 2nd Floor of Thomas Center, Christian Brothers University
650 East Parkway South, Memphis, TN 38104

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>8:00 a.m. – 8:30 a.m.</td>
<td>Check-in/Continental Breakfast</td>
</tr>
</tbody>
</table>
| 8:30 a.m. – 10:00 a.m. | Session 1: The Chopping Block: Your Target Audience
                       | Michael Graber, Southern Growth Studio                               |
| 10:00 a.m. – 10:15 a.m. | Coffee Break                                                         |
| 10:15 a.m. – 12:15 noon | Session 2: Design Thinking Innovation in Action                   |
|                  | Jay Morgan, Bayer Consumer Care                                      |
| 12:15 noon – 1:00 p.m. | Lunch                                                                |
| 1:00 p.m. – 2:45 p.m. | Session 3: Innovation in Your Own Backyard: Taking It All Home      |
|                  | Zark Strasburger, Memphis College of Art                              |
| 2:45 p.m. – 2:55 p.m. | Coffee Break                                                         |
| 2:55 p.m. – 3:45 p.m. | Session 4: Consortium Research Project Progress Report             |
|                  | Truck Vibration Transmissibility through a Wooden Pallet: A Preliminary Study
                  | Michael Kist and Siripong Malasri, Healthcare Packaging Consortium |
|                  | Shock Absorption Property of Crumb Rubber: A Preliminary Study       |
|                  | Waleed Alnashwan, Badar Aloumi, Alex Othmani, Michael Kist, and Siripong Malasri, Healthcare Packaging Consortium |
|                  | Corrugated Box Compression Strength: A Preliminary Study             |
|                  | Badar Aloumi, Waleed Alnashwan, Michael Kist, Alex Othmani, and Siripong Malasri, Healthcare Packaging Consortium |

Campus Map: http://www.cbu.edu/about/campusmap.html

Members
Bayer Consumer Care, FedEx, Medtronic, MicroPort Orthopedics, Olympus Surgical Technologies America, Plastic Ingenuity, Smith & Nephew, The Pallet Factory, The Royal Group, Wright Medical, WS Packaging
2014 HPC Fall Meeting
Friday, November 14, 2014
Participants

1. Katrina Adams  MicroPort Orthopedics
2. James Aflaki  Christian Brothers University
3. Waleed Alnashwan  Christian Brothers University
4. Badar Aloumi  Christian Brothers University
5. Rajesh Balasubramanian  Autozone
6. Danny Barulli  FedEx
7. Charlotte Bates  AutoZone
8. Divya Choudhary  Christian Brothers University
9. Bret Cook  The Royal Group
10. Donna Cook  The Royal Group
11. Broc Couling  Smith & Nephew
12. Ronald Fotso  Christian Brothers University
13. Richard Gadoski  Century Wealth Management
14. Jay Gilman  FedEx
15. Michael Graber  Southern Growth Studio
16. Brenda Harkness  MicroPort Orthopedics
17. Matthew Johnson  Christian Brothers University
18. Michael Kist  Christian Brothers University
19. Phillip Le  Bayer Consumer Care
20. Steve Lerro  The Royal Group
21. Siripong Malasri  Christian Brothers University
22. Paul Marshall  Smith & Nephew
23. Bob Moats  Christian Brothers University
24. Jay Morgan  Bayer Consumer Care
25. Michael Ostrowski  MicroPort Orthopedics
26. Alex Othmani  Christian Brothers University
27. Ali Pourhashemi  Christian Brothers University
28. Wayne Provus  The Royal Group
29. Kevin Raburn  MicroPort Orthopedics
30. Asit Ray  Christian Brothers University
31. Larry Rutledge  Christian Brothers University
32. Melissa Simpson  Bayer Consumer Care
33. Zark Strasburger  Memphis College of Art

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Bayer Consumer Care, FedEx, Medtronic, MicroPort Orthopedics, Olympus Surgical Technologies America, Plastic Ingenuity, Smith & Nephew, The Pallet Factory, The Royal Group, Wright Medical, WS Packaging
<table>
<thead>
<tr>
<th></th>
<th>Name</th>
<th>Organization</th>
</tr>
</thead>
<tbody>
<tr>
<td>34.</td>
<td>Rebecca Wauford</td>
<td>Christian Brothers University</td>
</tr>
<tr>
<td>35.</td>
<td>James Williams</td>
<td>MicroPort Orthopedics</td>
</tr>
<tr>
<td>36.</td>
<td>Joe Zhou</td>
<td>FedEx</td>
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</tbody>
</table>
The Chopping Block: Your Target Audience

*Michael Graber*¹

**Abstract:** Empathy, ethnography, and human-entered design are three often mislabeled and misunderstood phrases in the first phase of the Innovation Process. In reality, these forms of primary research help package designers, marketers, and engineers create products and packages that add value to those who buy them. In this session, we will learn the basics, do an exercise, and look at both the theories and application of these tools, as well as learn about some famous examples of breakthrough products that used this process.

**Keywords:** Breakthrough Products; Innovation

**Presenter:**

*Michael Graber* - Michael Graber is the managing partner of the Southern Growth Studio, an innovation and strategic growth firm based in Memphis. Visit [www.southerngrowthstudio.com](http://www.southerngrowthstudio.com) or Michael’s LinkedIn profile ([https://www.linkedin.com/profile/view?id=3223991&trk=nav_responsive_tab_profile](https://www.linkedin.com/profile/view?id=3223991&trk=nav_responsive_tab_profile)) to learn more.

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¹ Southern Growth Studio, 619 South Cooper Street, Memphis, TN 38104, michael@southerngrowthstudio.com
Abstract: There is a lot of buzz about Design Thinking based innovation. But what is this approach and how might someone use it to create products and experiences that will delight customers? This session will provide a fast-paced hands-on workshop that will take you through the 5 steps in design thinking in 90 minutes and then debrief what just happened. We will also look at ways this approach has created some amazing innovations in the world and how you might become an experience practitioner of the approach.

Keywords: Design Thinking; Innovation

Presenter:

Jay Morgan - Jay Morgan is Vice President Research & Development, Chief Operating Officer Research Operations for Bayer Consumer Care (formerly Merck Consumer Care). He is accountable for driving growth through innovative product development of Merck's OTC Drug, Device and Cosmetic products. His breadth of experience includes leadership of global product development, R&D Support Services, Portfolio Management, R&D Resource Allocation, R&D IT Systems for both OTC Drug and Cosmetic organizations. Prior to joining Merck, Jay led product development teams for several leading consumer companies such as Maybelline, Bath & Body Works, and Victoria's Secret prior to joining Merck Consumer Care in 2001. Jay currently manages development for all Merck Consumer Brands including Claritin, Afrin, Coppertone, Dr. Scholl's, Miralax, Lotrimin, Tinactin and Coricidin. Mr. Morgan also has experience in evaluating local emerging market R&D operations to optimize performance in countries such as Brazil, China, Russia and Mexico. In addition to R&D Operations, Mr. Morgan has been focusing on transforming MCC's innovation approach to a more consumer empathetic, iterative and prototype driven approach (Design Thinking). This transformation requires creating a deep relationship with the consumer as well as creating a diverse ultra-collaborative internal environment.

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1 Bayer Consumer Care, 3030 Jackson Avenue, Memphis, TN 38151, jay.morgan@bayer.com
Innovation in Your Own Backyard: Taking It All Home

Zark Straburger

Abstract: The challenge of adopting new innovative processes often lies in translating theory into practice. By applying the Design Thinking process to your work, you can create fertile ground for radical development in your organization. Building on the first session, Design Thinking Innovation in Action, this workshop will help you translate the steps of human-centered design into the context of your work environment. You will identify key elements to help you kick start change in your own workflow and business, and begin an action plan to use Design Thinking to revolutionize your own products, services, and practice.

Keywords: Innovation; Design Thinking

Presenter:

Zark Strasburger - Zark Strasburger is an assistant professor of Design and Foundations at the Memphis College of Art and the co-ordinator of Partnership for Academic Leadership on Sustainability.

1 Memphis College of Art, 1930 Poplar Avenue, Memphis, TN 38104, zstrasburger@mca.edu
Truck Vibration Transmissibility through a Wooden Pallet: A Preliminary Study

Michael Kist and Siripong Malasri

Abstract: Experiments were conducted to determine the effect of the weight of a load on the pallet resonance. Tests were run with loads of various magnitudes using the ASTM D4169 [1] standards for truck with the sine sweep method. A softwood pallet was secured to a vibration table, which was used to oscillate the pallet as it would be if it were being transported via truck. Accelerometers were used to provide feedback to the table’s controller as well as measure the acceleration that the pallet experienced from any vibration or shocks. The table had an accelerometer attached to control its vibration acceleration, or input acceleration, \( a_1 \). Another accelerometer was attached on the top of the pallet to record the output acceleration \( a_2 \) that a package would feel if it were palletized. Transmissibility is defined as the ratio of output over input \( (a_2/a_1) \) [2]. In this preliminary study, a sine sweep from 3 – 100 Hz with a constant \( a_1 \) of 0.5g was used [1]. The pallet weighed 30 lbs. A load varying from 0 lbs (Empty Pallet) to 120 lbs, in 40 lb increments, was placed on the pallet. Preliminary results indicated that as weight increased, the frequency of vibration at peak transmissibility increased. For a typical pallet of with a unit load of around 400 lbs, this frequency at peak transmissibility shifts over the typical truck vibration range of 3 – 100 Hz. In addition, the transmissibility decreased as the weight increased. This reduced the potential damages to palletized packages and products.

Keywords: Transmissibility; Softwood Wooden Pallet; Truck Vibration

References:

Presenter:

Dr. Siripong Malasri is the Dean of the Engineering Department and Director of the Healthcare Packaging Consortium at Christian Brothers University, a Registered Professional Engineer in the State of Tennessee, and an ISTA certified packaging laboratory professional. He has authored various publications related to transport packaging and currently serves as Editor-in-Chief for the International Journal of Advanced Packaging Technology. Dr. Malasri is also a member of the National Society of Professional Engineers, Institute of Packaging Professionals, International Safe Transit Association, TAPPI, and Engineers Club of Memphis.
Shock Absorption Property of Crumb Rubber: A Preliminary Study

Waleed Alnashwan, Badar Aloumi, Alex Othmani, Michael Kist, and Siripong Malasri

Abstract: Crumb rubber is recycled rubber from automotive scrap tires in which the steel has been removed. Three different sizes of crumb rubber were tested for its shock absorption property: (1) 6-14 mesh, (2) 10-30 mesh, and (3) 50-80 mesh. A 100-g shock recorder (tri-axial accelerometer) was mounted in a corrugated box with a layer of viscoelastic foam underneath to prevent the impact acceleration from exceeding 100g. The corrugated box was then secured to the bottom of a plastic tote. The average impact accelerations obtained from twenty 18-inch drops were used as a base value. Then, 1-inch thick sample of each crumb rubber size was placed between the shock recorder and foam. The average of twenty 18-inch drops was used to determine the percent reduction of impact acceleration. The preliminary result indicated that smaller grain size crumb rubber absorbed more impact than larger grain size, i.e., 15% reduction for 6-14 mesh size (the largest used in this study), 21% for 10-30 mesh size (medium), and 31% for 50-80 mesh size (smallest used in this study).

Keywords: Sustainability; Crumb Rubber; Impact/Shock Absorption

Presenter:

Dr. Siripong Malasri is Engineering Dean and Healthcare Packaging Consortium Director at Christian Brothers University. He is a registered professional engineer in the State of Tennessee and is an ISTA certified packaging laboratory professional. He has authored various publications related to transport packaging. Currently he serves as Editor-in-Chief for the International Journal of Advanced Packaging Technology. Dr. Malasri is a member of National Society of Professional Engineers, Institute of Packaging Professionals, International Safe Transit Association, TAPPI, and Engineers Club of Memphis.

1 Healthcare Packaging Consortium, Christian Brothers University, 650 East Parkway South, Memphis, TN 38104, pong@cbu.edu
Corrugated Box Compression Strength: A Preliminary Study
Badar Aloumi, Waleed Alnashwan, Michael Kist, Alex Othmani, and Siripong Malasri

Abstract: The McKee formula, \( BCT = 5.876 \times ECT \times \sqrt[4]{U \times d} \), has been widely used to predict compression strength of corrugated boxes, where \( BCT \) is box compression strength (lb), \( ECT \) is edge crush test of the corrugated cardboard (lb/in), \( U \) is the footprint perimeter (in), and \( d \) is the thickness of the corrugated cardboard (in). In this preliminary study, the effect of box volume, box height, and the direction of the load on box compression strength were investigated. Results were compared to the estimated value given by the McKee formula to determine the effect of such variables on the formula’s accuracy. Boxes used in this study were Regular Slotted Containers (RSC), 200# single-wall corrugated cardboard.

Keywords: McKee Formula; Corrugated Box Compression Strength; Edge Crush Test

Presenter:
Dr. Siripong Malasri is the Dean of the Engineering Department and Director of the Healthcare Packaging Consortium at Christian Brothers University, a Registered Professional Engineer in the State of Tennessee, and an ISTA certified packaging laboratory professional. He has authored various publications related to transport packaging and currently serves as Editor-in-Chief for the International Journal of Advanced Packaging Technology. Dr. Malasri is also a member of the National Society of Professional Engineers, Institute of Packaging Professionals, International Safe Transit Association, TAPPI, and Engineers Club of Memphis.

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Additional Materials
growth. (noun)
1. the act or process of growing.
2. increase.
3. development from a simpler to more complex stage.
4. development from another but related stage.

Like a plant, you are either growing or dying.
We help companies Grow.
We specialize in market strategy and innovation to help our clients make strategic moves in the marketplace.
• bring new products or services to the market
• expand into new markets
• redefine to gain market share

The Studio quickens client moves into new markets or stimulates innovative leaps within an existing space.
Bright individuals with diverse professional backgrounds to crack the code and solve complex problems.

business analysts
ad agency veterans
interactive specialists
economists
MBAs
social anthropologists
mathematicians
services

• Ideation and co-creation workshops
• Design thinking workshops
• Product design & prototype
• Usability and user experience testing

• Primary qualitative research
• Consumer experience
• Customer segmentation & personas
• Customer at-risk analysis
• Trendcasting

• Industry and competitor studies
• Market sizing and validation
• ROI forecasting
• Scenario & risk analysis
• Pricing optimization
• Business valuation

• Business plan creation
• Growth opportunity prioritization
• Market penetration & expansion
• Brand strategy & market positioning
• Sales & channel strategy

• Pilot design
• Test marketing
• Change management

Don’t just add to the sea of sameness
Audience

The chopping block.

Design Thinking in Practice

Methods for investigating ill-defined problems and posting human centric solutions.

Rapid generation and iterative testing.

1. Empathize.
2. Define.
3. Ideate.
4. Prototype.
5. Test.
6. Redesign.

Keep the designs centered on the people using the products.
Exercise

Focus: The chopping block.

1. Empathy – pick a partner and ask them about their favorite food to eat. Ask questions. Go deep. Inquire about their likes and dislikes about this experience.
2. Define – write a one-sentence brief about what may improve the experience for your partner.
3. Ideate – Draw three different not-yet-invented utensils that may improve their experience.
5. Iterate – Redraw the prototype based on the feedback.
6. Partners will present what worked for them.

25 minute refresher exercise on design thinking and utensils.

Why Improve the experience? How GE Healthcare Did it.

Medical procedures can be scary for patients, and medical personnel are often wrapped up in the technical aspects and emotions can easily be ignored. To improve the user experience for both patients and doctors, GE Healthcare has set up a team of 60 design thinkers.

Keep the designs centered on the people the products serve.
GE Example, Cont.
The first step in the GE process was to observe each step in the process of a medical procedure. Often, when users are asked to describe the process, they leave out crucial parts of it, because they don’t notice they are doing certain things, such as fumbling with wires and tubes. Once the process is mapped out and the problems are pinpointed, it’s time to look for solutions.

Empathy for the patients was the first step toward understanding how they felt during the process.

Design Thinking in Practice: GE

The team came up with the idea of making medical equipment look more like everyday objects, to reduce the disconnect. An MRI machine was designed to remind patients of open hands, in order to install calming feelings. The inside of the device can be decorated subtly with patterns and shapes, so patients have something to look at while the exam is going on. Some MRI devices offer the patient a choice of various musical backgrounds, visual scenery and mood-lighting. Offering the patient a choice gives him some control in a scary and uncertain time.

Another design eliminated the need for intravenous poles, encasing the device inside a transportable bag. This makes it easier for cancer patients to be mobile inside the hospital.
Design Thinking in Practice, GE

Ensembles of people work together and hierarchy is non-existent. The team uses techniques such as ideation and theatrical improvisation to get the creative juices flowing and to spark fresh perspectives that reframe the problem in the user’s context.

A collaborative process without rank and “experts.”

Charmr

Adaptive Path used the design thinking process to improve the user experience for those with chronic diabetes.

Very Human Insights:
- No vacation from diabetes
- Oppression of numbers
- In the way
An emotional life issue

“Medical device manufacturers are stuck in a bygone era; they continue to design these products in an engineering-driven, physician-centered bubble…Devices are also life devices, Amy Tenderich, Founder & Editor, Diabetes Mine

Charmr:
Six Design Principles

1. Wear it during sex.
2. Make better use of data.
3. Easy to learn and teach/No numbers.
4. Less stuff.
5. Keep diabetics in control.
Packaging Innovations in Healthcare.

REVITALIZATION.

Packaging Innovations in Healthcare.

REINVENT.
Packaging Innovations in Healthcare.

REFRAME.

Overcome Black Friday with free help®
I’m tired and shiatsu foot massage by Abraham Lincoln
Product Innovations in Healthcare.

RETHINK.

https://www.indiegogo.com/projects/scanadu-scout
Product Innovations in Healthcare.

RETHINK.

Audience

The chopping block.

->WHO? Are all of your audiences represented?
->Do you have a non-ranked team?
->Empathy?
->WHAT? Define problem for patients, caregivers, and doctors?
->WHICH problem is actually an opportunity to change the game?
->HAVE you set aside time for team to ideate, co-create, prototype, and test?

Remember who uses the product or package you are designing.
1. Studio: workplace for the teaching or practice of an art
Design Thinking

Make Things People Want >> Make People Want Things

Innovation = Ideas + Execution
Innovation Can Originate From Many Places
...and should originate from all corners

Successful Innovation is Viable, Feasible and Desirable.
...collaboration is therefore critical

Innovation Beyond the Core is Vital to Sustained Growth

We had become great at milking the cow. Frappuccino is a $1B brand. But a line extension only creates incrementally.

Innovation is having the courage to make bets on new categories and experiences.
The future of Starbucks is linked to our ability to create game-changing innovation.
Corporate Strategy Drives Innovation Strategy Drives Innovation Tool Set

Corporate Strategy
Franchise Strategy
Innovation Strategy

Core Business
- Incremental Marketing Excellence
- Product Improvement
- Articulated Insights

Adjacencies
- Incremental d.think
- Open Innovation
- Breakthrough New Technologies

Beyond the Core
- Incremental d.think
- Open Innovation
- Unarticulated Insights
- Breakthrough
- d.think
- New Ventures/Switch

X% Y% Z%

Resource Allocation

What is Design Thinking?

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Is [d.think](#) a best practice?
Leading companies think so...

As Ron Shaich, CEO of Panera Bread, says "Design thinking leads to that future." When you're open to "top-down innovation," you're open to achieving the best possible results for your business—and that's a design for success.

And if you only think this kind of approach works at "sexy" companies like Apple and Google, think again. Health care might be the last place where you expect design thinking to make a significant impact, but that's just what happened at Kaiser Permanente...

The focus on design-led innovation helped Philips Lighting to transform itself over the past decade from a company that simply pushed products into the market into one that designs them with customer desires in mind, says CEO Rudy Provoost.

For Lawrence Murphy, the chief engineer of global design for GE Healthcare who leads the sessions and helped start the program, the goal is to equip employees with new problem-solving tools to help the company evolve to "imagination at work" from its focus on operations efficiency tool Six Sigma.

P&G measures the performance of design-thinking inspired ideas and products, says Tripp. In those terms, "We're beating our success criteria. Quantitative measures show we're doing very well."

The creation of the chief design officer role is part of J&J's effort to "accelerate innovation globally and strengthen the equity of our core brands across our consumer, medical devices and pharmaceuticals business," Ms. Peterson said in a statement. "This role will also work with our marketing and R&D organizations to further unlock the power of design."

Ernesto Quinteros, best known for work on such technology products as iPhone and iPad cases and mobile wireless routers, will become J&J’s chief design officer May 5. Part of Mr. Quinteros' mission is to lead a companywide effort to apply design thinking – which integrates user experience into product, packaging and technology.

He'll be based at J&J's New Brunswick, N.J. headquarters, reporting to Sandi Peterson, J&J group worldwide chairman, who oversees consumer brands such as Band-Aid, Johnson's Baby Shampoo, Tylenol and Neutrogena along with the company's vision care and diabetes solutions businesses.
Is d.think a best practice?
It creates solutions like this...

Switching to PillPack is easy.

Pill Pack video

Memphis Innovation Bootcamp

Empathize Define Ideate Prototype Test
The Design Process Journey

Design Challenge?
Wondering what you will be diving into?
An Introduction to Design Thinking
In One Hour

Redesign the gift-giving experience...for your partner.
Start by gaining empathy.

1 Interview

2 Dig Deeper
Reframe the problem.

3 Capture findings 3min

**Goals and Wishes:** What is your partner trying to achieve through gift-giving?

*use verbs*

**Insights:** New learnings about your partner’s feelings and motivations. What’s something you see about your partner’s experience that maybe s/he doesn’t see?*

*make references from what you heard*

4 Take a stand with a point-of-view 3min

- [ ] partner’s name/description
- [ ] needs a way to [ ] user’s need
- [ ] because (or “but…” or “Surprisingly…”)
- [ ] insight

---

Ideate: generate alternatives to test.

5 Sketch at least 5 radical ways to meet your user’s needs. 5min

- [ ] sketch your problem solution ideas

6 Share your solutions & capture feedback. 10min (2 sessions x 5 minutes each)

**Notes**

- [ ] Switch roles & repeat sharing.

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Iterate based on feedback.

7 Reflect & generate a new solution. 5min
Sketch your big idea, note details if necessary!

Build and test.
8 Build your solution.
Make something your partner can interact with!
[not here]
7min

9 Share your solution and get feedback.
△ What worked... △ What could be improved...
?
Questions...

! Ideas...
8min (2 sessions x 4 minutes each)
debrief
(what the hell just happened)

Doug Dietz
MRI: The Anxiety Journey

MRI: An Adventure
Design Thinking

• Learn by doing.
• Don’t just ask to solve a problems, ask to define what the problem is.
• Start with empathy for people they design for, uncovering real human needs they want to address.
• Iterate to develop an unexpected range of possible solutions
• Create rough prototypes to take back out into the field and test with real people.
• Have a bias is toward action, followed by reflection on personal discoveries about process.
• Experience is measured by iteration. Each cycle brings stronger insights and more unexpected solutions.

I am always doing that which I cannot do, in order that I may learn how to do it.  
Pablo Picasso
Innovation In Your Own Backyard: Taking It All Home

Zark Strasburger
Memphis College of Art
Memphis Innovation Bootcamp

What should I redesign?
identify:

Where and How can I start using Design Thinking in my organization?

values:

• failure is the birthplace of success
• empathy
• iteration
• low-fidelity prototyping
• collaboration
• show > tell
• tension
• beginners mindset
• challenge assumptions (and yourself)
exercise:

practice the process

what is the core of your job?
what are your favorite tasks?

what gets in the way?
pick: 3

draw: each scenario

describe: how you feel

share & review
who do you interact with?

how often?
how key?

what tasks do I do?
how often?

how essential?
how do i fit in?

investigate: 3 challenges
get > do > send
input > action > output
inception > creation > implementation

share
observe
discover
who were the interactions with?

what did you do?

how did you feel?

opportunities?
what next?

that’s all good, but...
but i don’t make the decisions

• practice right where you are
• little changes add up
• don’t wait for permission
• previous failure = fertile ground
• tension = opportunity

creativity:

getting comfortable with being uncomfortable
Truck Vibration Transmissibility through a Wooden Pallet: A Preliminary Study

Michael Kist1 and Siripong Malasri2

Abstract: Experiments were conducted to determine the effect of the weight of a load on the pallet resonance. Tests were run with loads of various magnitudes using the ASTM D4169 [1] standards for truck with the sine sweep method. A softwood pallet was secured to a vibration table, which was used to oscillate the pallet as it would be if it were being transported via truck. Accelerometers were used to provide feedback to the table’s controller as well as measure the acceleration that the pallet experienced from any vibration or shocks. The table had an accelerometer attached to control its vibration acceleration, or input acceleration, \(a_1\). Another accelerometer was attached on the top of the pallet to record the output acceleration \(a_2\) that a package would feel if it were palletized. Transmissibility is defined the ratio of output over input \(a_2/a_1\) [2]. In this preliminary study, a sine sweep from 3 – 100 Hz with a constant \(a_1\) of 0.5g was used [1]. The pallet weighed 30 lbs. A load varying from 0 lbs (Empty Pallet) to 120 lbs, in 40 lb increments, was placed on the pallet. Preliminary results indicated that as weight increased, the frequency of vibration at peak transmissibility increased. For a typical pallet of with a unit load of around 400 lbs, this frequency at peak transmissibility shifts over the typical truck vibration range of 3 – 100 Hz. In addition, the transmissibility decreased as the weight increased. This reduced the potential damages to palletized packages and products.

Keywords: Transmissibility; Softwood Wooden Pallet; Truck Vibration

Introduction

A pallet is the structural foundation of a unit load which allows handling and storage efficiencies. Most pallets are made of wood. Goods or shipping containers are often placed on a pallet secured with strapping, stretch wrap or shrink wrap and shipped. Most pallets can easily carry a load of 2,205 lbs, though a typical pallet of personal care products carries around 400 lbs of weight. Truck vibration is typically in the range of 3 to 100 Hz. When a wooden pallet is placed on the bed of a truck, the vibration from the truck will propagate throughout the truck and the pallet. A transmissibility study was done to investigate the extent of propagation and its severity. In this preliminary study, the effect of weight on the peak transmissibility and the corresponding frequency was investigated.

Materials & Methods

In this study, a standard North American pallet, known as GMA pallet, was used. The pallet made from yellow pine softwood. It was secured to a vibration table (Fig. 1). The pallet was then loaded with weights evenly on the four corners to simulate a unit load. The load was varied from 0 lbs (the Empty Pallet Case) to 120 lb in 40 lb increments. An accelerometer was attached near the center top of the pallet. Figure 1 shows setup for the empty pallet case. Fig. 2 shows an example of one of the loaded cases (40 lbs in this case).

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Forced vibration occurs when the base an object is attached or resting on moves and vibration input propagates through the base into the object, which can be thought of as a mass-spring system. Transmissibility is defined by the equation [2]:

\[
Transmissibility (Q) = \frac{\text{response}}{\text{input}} = \frac{\text{output}}{\text{input}} = \frac{a_2}{a_1}
\]

where \( Q \) is transmissibility, \( a_2 \) is the output vibration, and \( a_1 \) is the forced vibration inputted by the table or vehicle. Transmissibility is the ratio of vibration response or a measured acceleration in \( g \) to vibration input or an inputted acceleration by the controller, and it is a function of the input (forced) vibration. The mass-spring system can respond in the following three possible ways: coupling, amplification, attenuation. Coupling occurs when the transmissibility equals one. Amplification occurs when transmissibility is greater than one, and attenuation occurs...
when transmissibility is less than one. Resonance occurs at the maximum amplification. A sample plot of transmissibility is shown in Fig. 3. According to the sine method variant of ASTM 4169 for Truck Vibration [1], the vibration was performed at a constant acceleration of 0.5g.

![Sample Transmissibility Plot](image)

**Figure 3: A Sample Transmissibility Plot (0.5g, 40-lb on the pallet)**

<table>
<thead>
<tr>
<th>Assurance Level</th>
<th>Frequency Range [Hz]</th>
<th>Amplitude [g]</th>
<th>Time [Minutes]</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>3 to 100</td>
<td>0.50</td>
<td>15</td>
</tr>
<tr>
<td>II</td>
<td>3 to 100</td>
<td>0.50</td>
<td>10</td>
</tr>
<tr>
<td>III</td>
<td>3 to 100</td>
<td>0.50</td>
<td>5</td>
</tr>
</tbody>
</table>

Table 1: ASTM D4169 Sine Vibration Method [1]

Assurance Level is the level of test intensity based on its probability of occurring in a typical distribution cycle. Level I is a test with a high level of intensity and has a low probability of occurrence. Level III is a test with a low level of intensity, but has a high probability of occurring. Level II is the middle ground. The time is a dwell time, which after identifying key frequencies would be dwelled at to determine the level of destruction to the package and the product. If a particular product and package was being tested, dwelling at the key frequencies would show how the extent of damage. For the case of this experiment, the key information was the frequency range and amplitude, which was entered into the vibration table’s controller. The truck case was selected; so, the testing input is a frequency range from 3 to 100 Hz and 0.50 g.
This table was included as it gives information about the range where the most intense vibrations will occur due to the structural elements of the vehicle (in this case, a truck). The most intense input will occur at 4 to 16 Hz, while less intense elements will occur from 1 to 4 and from 40 to 80. There will be a very low level element from 80 to 200. In other words, the sine method from 3 to 100 Hz will account for the key elements the pallet and its load are likely to experience. The power spectral density (PSD) of the signal, when multiplied by the appropriate factor, describes the power contributed to the wave, by a frequency, per unit frequency.

**Results**

Fig. 4 summarizes transmissibility plots of weights on pallet of 0, 40, 80, and 120 lbs. Peak transmissibility and corresponding frequency were summarized in Table 3 and plotted in Figs. 5 and 6.
**Table 3**: Effect of Weight to Transmissibility

<table>
<thead>
<tr>
<th>Weight [lb]</th>
<th>Peak Transmissibility</th>
<th>Corresponding Frequency [Hz]</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>2.4</td>
<td>70</td>
</tr>
<tr>
<td>40</td>
<td>2.1</td>
<td>95</td>
</tr>
<tr>
<td>80</td>
<td>1.8</td>
<td>93</td>
</tr>
<tr>
<td>120</td>
<td>1.8</td>
<td>100</td>
</tr>
</tbody>
</table>

**Figure 5**: Peak-Transmissibility Frequency versus Weight

\[ y = 0.22x + 76.3 \]

\[ R^2 = 0.7265 \]

**Figure 6**: Peak Transmissibility versus Weight

\[ y = -0.0053x + 2.34 \]

\[ R^2 = 0.8909 \]
Conclusion

As weight increases the peak transmissibility decreases (Fig. 6), which reduces the severity of vibration. In addition, the frequency associated with peak transmissibility also increases as weight increases. A typical pallet of personal care products carries around 400 lbs of weight. The peak-transmissibility frequency is pushed beyond the typical truck vibration frequency range of 3 – 100 Hz. Thus, the heavier the pallet’s load, the less severe the vibrations experienced will be. It should be noted that this is a preliminary study; and, as such, more testing will be done.

References:


Authors:

*Michael Kist* received a B.S. in Mechanical Engineering and Packaging Engineering Certificate from Christian Brothers University in May 2014. Currently, he works on packaging research projects for the Healthcare Packaging Consortium.

*Dr. Siripong Malasri* is the Dean of the Engineering Department and Director of the Healthcare Packaging Consortium at Christian Brothers University, a Registered Professional Engineer in the State of Tennessee, and an ISTA certified packaging laboratory professional. He has authored various publications related to transport packaging and currently serves as Editor-in-Chief for the International Journal of Advanced Packaging Technology. Dr. Malasri is also a member of the National Society of Professional Engineers, Institute of Packaging Professionals, International Safe Transit Association, TAPPI, and Engineers Club of Memphis.
Shock Absorption Property of Crumb Rubber: A Preliminary Study

Waleed Alnashwan, Badar Aloumi, Alex Othmani, Michael Kist, and Siripong Malasri

2014 HPC Fall Meeting
November 14, 2014

Presentation Outline

• Crumb Rubber
• Materials
• Experiment
• Data & Results
• Conclusion
• Q&A
Crumb Rubber

- Shredded automobile tires with steel removed
- Available in different mesh sizes
- Example: 10 mess size has 10 holes per inch
- Applications: Playgrounds, running tracks, rubberized asphalt concrete pavements, etc.

Materials

<table>
<thead>
<tr>
<th>ASTM E11 Sieve No.</th>
<th>mm</th>
<th>Weight Retained (g)</th>
<th>Individual % Retained</th>
<th>Cumulative % Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>4.0</td>
<td>0.0</td>
<td>0.0%</td>
<td>100.0%</td>
</tr>
<tr>
<td>6</td>
<td>3.36</td>
<td>2.9</td>
<td>2.9%</td>
<td>97.1%</td>
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<tr>
<td>10</td>
<td>2.0</td>
<td>8.1</td>
<td>80.2%</td>
<td>16.9%</td>
</tr>
<tr>
<td>14</td>
<td>1.41</td>
<td>15.0</td>
<td>14.9%</td>
<td>2.1%</td>
</tr>
<tr>
<td>18</td>
<td>1.0</td>
<td>7.1</td>
<td>7.1%</td>
<td>0.0%</td>
</tr>
<tr>
<td>Pan</td>
<td></td>
<td>1.9</td>
<td>0.0%</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>102.90</td>
<td>100.0%</td>
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</table>

(www.wikipedia.org)
### 10-30 Mesh

<table>
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<th>mm</th>
<th>Weight Retained (g)</th>
<th>Individual % Retained</th>
<th>Cumulative % Passing</th>
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</thead>
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<td>8</td>
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<td>0.0%</td>
<td>100.0%</td>
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<tr>
<td>10</td>
<td>2.0</td>
<td>2.0%</td>
<td>100.0%</td>
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</tr>
<tr>
<td>16</td>
<td>1.41</td>
<td>20.4%</td>
<td>20.4%</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>1.0</td>
<td>14.6%</td>
<td>35.0%</td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>0.65</td>
<td>14.6%</td>
<td>49.6%</td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>0.42</td>
<td>4.1%</td>
<td>53.7%</td>
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</tr>
<tr>
<td>Pan</td>
<td>3.9</td>
<td>2.1%</td>
<td>55.8%</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>101.80</td>
<td>100.0%</td>
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</table>

### 50-80 Mesh

<table>
<thead>
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<th>ASTM E11 Sieve No.</th>
<th>mm</th>
<th>Weight Retained (g)</th>
<th>Individual % Retained</th>
<th>Cumulative % Passing</th>
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<tr>
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<td>0.47</td>
<td>0.0%</td>
<td>100.0%</td>
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</tr>
<tr>
<td>50</td>
<td>0.297</td>
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<td>34.0%</td>
<td></td>
</tr>
<tr>
<td>60</td>
<td>0.351</td>
<td>16.0%</td>
<td>50.1%</td>
<td></td>
</tr>
<tr>
<td>70</td>
<td>0.211</td>
<td>11.2%</td>
<td>61.3%</td>
<td></td>
</tr>
<tr>
<td>80</td>
<td>0.178</td>
<td>9.3%</td>
<td>70.6%</td>
<td></td>
</tr>
<tr>
<td>100</td>
<td>0.149</td>
<td>5.1%</td>
<td>75.7%</td>
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<tr>
<td>120</td>
<td>0.104</td>
<td>5.1%</td>
<td>80.8%</td>
<td></td>
</tr>
<tr>
<td>140</td>
<td>0.055</td>
<td>1.1%</td>
<td>81.9%</td>
<td></td>
</tr>
<tr>
<td>170</td>
<td>0.085</td>
<td>1.4%</td>
<td>83.3%</td>
<td></td>
</tr>
<tr>
<td>200</td>
<td>0.074</td>
<td>0.9%</td>
<td>84.2%</td>
<td></td>
</tr>
<tr>
<td>Pan</td>
<td>0.0</td>
<td>0.0%</td>
<td>100.0%</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>103.10</td>
<td>100.0%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Experiment

18-in drop height
20-drop average
1-in thick of crumb rubber

Data & Results

<table>
<thead>
<tr>
<th>Impact Acceleration (g)</th>
<th>6-14 mesh</th>
<th>10-30 mesh</th>
<th>50-80 mesh</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>62.26</td>
<td>67.91</td>
<td>48.72</td>
</tr>
<tr>
<td>2</td>
<td>63.59</td>
<td>55.29</td>
<td>47.81</td>
</tr>
<tr>
<td>3</td>
<td>68.28</td>
<td>58.8</td>
<td>48.43</td>
</tr>
<tr>
<td>4</td>
<td>62.52</td>
<td>62.79</td>
<td>47.48</td>
</tr>
<tr>
<td>5</td>
<td>65.68</td>
<td>64.27</td>
<td>49.75</td>
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<td>6</td>
<td>64.16</td>
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<td>66.56</td>
<td>57.84</td>
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<td>8</td>
<td>65.34</td>
<td>63.51</td>
<td>52.37</td>
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<tr>
<td>9</td>
<td>63.71</td>
<td>64.57</td>
<td>50.77</td>
</tr>
<tr>
<td>10</td>
<td>60.91</td>
<td>62.5</td>
<td>53.31</td>
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<td>11</td>
<td>60.46</td>
<td>64.53</td>
<td>51.23</td>
</tr>
<tr>
<td>12</td>
<td>67.20</td>
<td>52.83</td>
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<td>65.28</td>
<td>63.71</td>
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<td>16</td>
<td>66.64</td>
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<tr>
<td>17</td>
<td>67.23</td>
<td>58.98</td>
<td>54.26</td>
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<td>18</td>
<td>67.47</td>
<td>61.21</td>
<td>59.24</td>
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<td>19</td>
<td>67.30</td>
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<td>20</td>
<td>66.67</td>
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</tr>
<tr>
<td>Avg (g)</td>
<td>65.52</td>
<td>61.41</td>
<td>53.33</td>
</tr>
<tr>
<td>SD (g)</td>
<td>2.04</td>
<td>3.50</td>
<td>4.06</td>
</tr>
</tbody>
</table>

Base Impact (g) = 77.53

Mesh    | Avg Impact (g) | % Reduc
--------|----------------|--------
6-14 Mesh  | 65.52          | 15.49  |
10-30 Mesh | 61.41          | 20.79  |
50-80 Mesh | 53.33          | 31.22  |

% Reduction of Impact Acceleration From Base Value (g)

Base Impact (g) = 77.53

Mesh    | Avg Impact (g) | % Reduc
--------|----------------|--------
6-14 Mesh  | 65.52          | 15.49  |
10-30 Mesh | 61.41          | 20.79  |
50-80 Mesh | 53.33          | 31.22  |
Conclusion

• Finer grain reduces more impact

• Comparison with other materials using the same base material and same thickness of 1 inch
  • Bubble Wrap: 40%
  • Rice Hull: 20%
  • Coconut Fiber: 40%
Corrugated Box Compression Strength: A Preliminary Study

Badar Aloumi, Waleed Alnashwan, Michael Kist, Alex Othmani, and Siripong Malasri

2014 HPC Fall Meeting
November 14, 2014

Presentation Outline

• Corrugated Paper and Box Compression Strength
• Materials
• Experiment
• Data & Results
• Conclusion
• Q&A
Corrugated Paper

- Regular Slotted Container (RSC)
  - All flaps have same length
  - Two outer flaps normally lengthwise
  - Flap lengths are ½ of box width

(Flute Designation) Flutes per linear foot | Flute thickness (in) 
--- | --- 
A flute | 33 +/- 3 | 3/16 
B flute | 47 +/- 5 | 1/8 
C flute | 59 +/- 5 | 3/32 
E flute | 90 +/- 4 | 1/8 
F flute | 120 +/- 4 | 3/32

(www.wikipedia.org)

Corrugated Box

(www.bennettpackaging.com)
Box Compression Strength

Clamp method (TAPPI T839)

The McKee formula
Box compression is predicted or calculated using a formula. The most widely used formula is known as the McKee Formula. It employs ECT, caliper, and box perimeter to predict box compression.

A version of the McKee formula

\[ C = 5.87 \times P \times \sqrt{hZ} \]

where:
- \( P \) = Edge Crush Test value
- \( h \) = caliper of the corrugated board
- \( Z \) = box perimeter \( 2(L + W) \)

Materials

- Single-wall RSC boxes of different footprint dimensions and height
Experiment

Data & Results

<table>
<thead>
<tr>
<th>Thickness (in)</th>
<th>Top Load</th>
<th>Side Load</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>63.94</td>
<td>35.43</td>
</tr>
<tr>
<td>2</td>
<td>76.91</td>
<td>40.44</td>
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<tr>
<td>3</td>
<td>71.61</td>
<td>38.94</td>
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<tr>
<td>4</td>
<td>74.03</td>
<td>33.39</td>
</tr>
<tr>
<td>5</td>
<td>61.56</td>
<td>37.89</td>
</tr>
<tr>
<td>6</td>
<td>67.69</td>
<td>37.48</td>
</tr>
<tr>
<td>7</td>
<td>59.72</td>
<td>45.82</td>
</tr>
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<td>8</td>
<td>53.67</td>
<td>36.31</td>
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<td>9</td>
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<td>37.81</td>
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<td>62.39</td>
<td>32.39</td>
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<td>11</td>
<td>52.52</td>
<td>34.51</td>
</tr>
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<td>12</td>
<td>50.21</td>
<td>31.93</td>
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<td>13</td>
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<td>36.77</td>
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<td>14</td>
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<td>48.39</td>
<td>32.05</td>
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<tr>
<td>16</td>
<td>56.8</td>
<td>38.69</td>
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<td>17</td>
<td>47.91</td>
<td>38.73</td>
</tr>
<tr>
<td>18</td>
<td>59.55</td>
<td>33.26</td>
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<tr>
<td>Avg</td>
<td>59.86</td>
<td>36.63</td>
</tr>
<tr>
<td>SD</td>
<td>8.88</td>
<td>3.48</td>
</tr>
<tr>
<td>SD (Avg) =</td>
<td>14.84</td>
<td>9.51</td>
</tr>
<tr>
<td>Side/Top (ECT) =</td>
<td>0.61</td>
<td></td>
</tr>
</tbody>
</table>

Side load ECT is 61% of top load ECT (200#)
ECT (lb/in) = 29.93 18.31
### Top & Side Max Load (lb), 200# Single Wall

<table>
<thead>
<tr>
<th></th>
<th>3&quot;x3&quot;x3&quot;</th>
<th>5&quot;x5&quot;x5&quot;</th>
<th>7&quot;x7&quot;x7&quot;</th>
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</thead>
<tbody>
<tr>
<td>Top Load</td>
<td>Side Load</td>
<td>Top Load</td>
<td>Side Load</td>
</tr>
<tr>
<td>1</td>
<td>262</td>
<td>118</td>
<td>326</td>
</tr>
<tr>
<td>2</td>
<td>293</td>
<td>95</td>
<td>394</td>
</tr>
<tr>
<td>3</td>
<td>268</td>
<td>116</td>
<td>352</td>
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<tr>
<td>4</td>
<td>263</td>
<td>106</td>
<td>331</td>
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<tr>
<td>5</td>
<td>242</td>
<td>103</td>
<td>342</td>
</tr>
<tr>
<td>6</td>
<td>269</td>
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<td>7</td>
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<td>98</td>
<td>327</td>
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<tr>
<td>8</td>
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<td>118</td>
<td>350</td>
</tr>
<tr>
<td>9</td>
<td>236</td>
<td>108</td>
<td>342</td>
</tr>
<tr>
<td>10</td>
<td>241</td>
<td>112</td>
<td>311</td>
</tr>
<tr>
<td>Avg</td>
<td>252</td>
<td>109</td>
<td>341</td>
</tr>
<tr>
<td>SD</td>
<td>23</td>
<td>8</td>
<td>22</td>
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<tr>
<td>SD (% Avg)</td>
<td>9.24</td>
<td>7.55</td>
<td>6.57</td>
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<tr>
<td>BCT (lb) = 200</td>
<td>122</td>
<td>258</td>
<td>158</td>
</tr>
<tr>
<td>U (in) = 12</td>
<td>20</td>
<td>28</td>
<td></td>
</tr>
<tr>
<td>Side/Top (Actual) = 0.43</td>
<td>0.32</td>
<td>0.24</td>
<td></td>
</tr>
<tr>
<td>Side/Top (BCT) = 0.61</td>
<td>0.61</td>
<td>0.61</td>
<td></td>
</tr>
</tbody>
</table>

\[
BCT = 5.876 \times ECT \times \sqrt{U \times d}
\]
**Effect of Volume on Box Strength (Cube)**

<table>
<thead>
<tr>
<th>Volume (in^3)</th>
<th>3&quot;X3&quot;X3&quot;</th>
<th>5&quot;X5&quot;X5&quot;</th>
<th>7&quot;X7&quot;X7&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actual Max Load</td>
<td>252</td>
<td>341</td>
<td>513</td>
</tr>
<tr>
<td>BCT</td>
<td>200</td>
<td>258</td>
<td>305</td>
</tr>
</tbody>
</table>

**Volume Effect, 200# Single Wall - Cube Boxes, Top Loading**

**Effect of Volume on Box Strength (Same Height)**

<table>
<thead>
<tr>
<th>Volume (in^3)</th>
<th>4&quot;X4&quot;X12&quot;</th>
<th>5&quot;X5&quot;X12&quot;</th>
<th>6&quot;X6&quot;X12&quot;</th>
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</thead>
<tbody>
<tr>
<td>Avg (lb)</td>
<td>295</td>
<td>309</td>
<td>478</td>
</tr>
<tr>
<td>SD (lb)</td>
<td>15</td>
<td>14</td>
<td>20</td>
</tr>
<tr>
<td>SD (% of Avg)</td>
<td>4.98</td>
<td>4.48</td>
<td>4.13</td>
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<tr>
<td>BCT (lb)</td>
<td>231</td>
<td>258</td>
<td>282</td>
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</table>

**Volume Effect, 200# Single Wall - Same Height, Top Loading**
# Effect of Box Height (5"x5" footprint, 200# Single Wall)

<table>
<thead>
<tr>
<th>Height (in)</th>
<th>5</th>
<th>10</th>
<th>12</th>
<th>36</th>
<th>48</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>326</td>
<td>442</td>
<td>317</td>
<td>300</td>
<td>139</td>
</tr>
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<td>2</td>
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<td>451</td>
<td>286</td>
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<td>120</td>
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<tr>
<td>3</td>
<td>352</td>
<td>395</td>
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<td>320</td>
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<tr>
<td>4</td>
<td>331</td>
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<td>311</td>
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<td>325</td>
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</table>

Avg = 341
SD = 22
SD (% Avg) = 6.57
BCT (lb) = 258

# Conclusion

- McKee Formula does not give an accurate predicting in most cases.
- It does not consider height, which is critical to wall strength.
- More tests are needed.
FREE PACKAGING RESOURCE

http://technical.cloud-journals.com/index.php/IJAPT/index
PACKAGING CONCENTRATIONS

Bachelor of Science in Engineering Management
Master of Science in Engineering Management

- UNDERGRADUATE & GRADUATE PACKAGING CERTIFICATES
- UNDERGRADUATE PACKAGING MINOR
- CERTIFIED PACKAGE TESTING LAB
- HEALTHCARE PACKAGING CONSORTIUM
- International Journal of Advanced Packaging Technology (official journal of HPC)

www.cbu.edu/packaging
The Graduate Certificate in Packaging Engineering was designed for the engineer, scientist or technologist who must develop and produce packages that contain, protect and preserve, transport, inform, and sell a product.

**Required Courses** (Choose three from the following courses):


- **ENGM 643 Healthcare Packaging:** Introduction to the basics of materials used for healthcare packaging including materials selection. The steps used for packaging design and development and use of suitable conversion process from raw materials to packages. The considerations used for aseptic packaging and added sterilization process, if needed. Storage and distribution of final products to customers with codes imprinted on products for quick identification of source details. Finally the most important steps of scope, planning, preparation, and for receiving of FDA validation. Three credits *(Instructors: Asit Ray & Michael Tune)*

- **ENGM 644 Transport Packaging:** Transport packaging related organizations, test protocols, and testing equipment. Distribution hazards including shock, vibration, compression, and temperature/humidity. Shipping container design. Interior packaging design. Unit load design. Packaging performance testing. ISTA laboratory, package, and professional certifications. Three credits *(Instructor: Siripong Malasri)*

**Instructors:**

- **Dr. Siripong Malasri** is the Dean of the Engineering Department and Director of the Healthcare Packaging Consortium at CBU, a Registered Professional Engineer in the State of Tennessee, and an ISTA certified packaging laboratory professional. He has authored various publications related to transport packaging and currently serves as Editor-in-Chief for the *International Journal of Advanced Packaging Technology*. Dr. Malasri is also a member of Institute of Packaging Professionals, International Safe Transit Association, and TAPPI.

- **Dr. Asit Ray** is a professor of chemical engineering at CBU. He earned his Ph.D. from Lehigh University and has over 20 years of teaching/research experience at Auburn and CBU. Dr. Ray spent seven years in the polymer industry, and was four times a NASA/ASEE Summer Faculty Fellow engaging in polymer research at NASA Kennedy Space Center and Langley Research Center. He is actively engaged in laboratory research in polymeric and biomaterials and has published over fifteen refereed papers. He is a member of Institute of Packaging Professionals.
• **Michael Tune** is currently the Director of Packaging Science & Technology at Bayer Consumer Care in Memphis, Tennessee. He is responsible for the design and technical development of primary and secondary packaging systems for various over the counter pharmaceutical, cosmetic and device products. He has a B.S. in Packaging from Michigan State University, and is a Certified Packaging Professional (CPP). He has a diverse background in quality management, primary package manufacturing and consumer products. He also holds several utility and design patents in primary packaging. Michael is a member of Institute of Packaging Professionals.

• **Yongquan Zhou** is a project engineer in Packaging Design and Development at FedEx Corp. He received his B.E. in packaging engineering and M.E. in mechanical engineering from the Wuxi Institute of Light Industry in China, and his M.S. in packaging science from the Rochester Institute of Technology. Mr. Zhou is a Certified Packaging Professional (CPP) with more than 30 years of experience in the packaging industry, academic classrooms, and research and testing laboratories. Mr. Zhou serves on various IoPP, ASTM, and ISTA technical committees, and was an IoPP AmeriStar Packaging Competition judge from 1997 to 2001. He has published articles in *Packaging Technology and Engineering* and other magazines.

**Admission Requirements:**

• A complete application form (online at [http://cbu.edu/future/apply.html](http://cbu.edu/future/apply.html)) with application fee.

• One official transcript of previous academic credits from each of the colleges or universities previously attended.

• Two letters of recommendation from former teachers or immediate supervisors qualified to attest to the applicant’s preparation and ability to perform graduate study.

• Current resume.

• Personal statement describing the fit between career objectives and a master’s certificate.

• For International Students Only:
  o If English is not the native language or was not the language of instruction for a foreign applicant’s baccalaureate degree, a minimum proficiency in English equivalent to a TOEFL score of 550 (paper-based test), 231 (CBT/computer-based test), or 79 (IBT/internet-based test) must be demonstrated.
  o World Education Services (WES) Comprehensive Course-by-Course Report. This evaluation is required for those whose highest degree is from a foreign University.

**FOR MORE INFORMATION, CONTACT THE GRADUATE ENGINEERING OFFICE AT 901-321-3410 OR memp@cbu.edu.**

11/3/2014
Quality of Medical Devices Graduate Certificate

The Graduate Certificate in Quality of Medical Devices was created to meet the needs of the Medical Device industry. It expands knowledge to improve job performance and increase the opportunities for advancement in the medical device industry.

Required Courses:

- **ENGM 605. Quality Assurance**: Statistical quality control methods for products and services; design of quality control systems; control of quality control inputs. Lecture and problem solving. Three credits (*Instructor: Susan Bell*)


- **ENGM 650. Regulatory Affairs and Quality Systems**: Develop a basic understanding of regulatory affairs and quality systems related to medical devices to provide a better cross-functional working relationship and process efficiency. Three credits (*Instructors: Christine Scifert and Kimberly Strohkirch*)

- **ENGM 652. Quality Systems for the Medical Device Industry**: Develop a basic understanding of quality system requirements for medical device manufacturers based on both FDA and ISO standards. Three credits (*Instructor: Susan Bell*)

Instructors:

- **Susan Bell** is Assistant Professor in the Mechanical Engineering Technology department at Southwest Tennessee Community College. She has an ASET from Southwest, a BSET from the University of Memphis, as well as a MEM from CBU. Susan retired from Smith & Nephew in 2013 after 24 years as a Quality professional. She is a member of the American Society for Quality & holds several certifications including Certified Quality Engineer, Certified Quality Auditor, Certified Biomedical Auditor, and Certified Manager of Quality/Operational Excellence.

- **Dr. Asit Ray** is a professor of chemical engineering at CBU. He earned his Ph.D. from Lehigh University and has over 20 years of teaching/research experience at Auburn and CBU. Dr. Ray spent seven years in the polymer industry, and was four times a NASA/ASEE Summer Faculty Fellow engaging in polymer research at NASA Kennedy Space Center and Langley Research Center. He is actively engaged in laboratory research in polymeric and biomaterials and has published over fifteen refereed papers. He is a member of Institute of Packaging Professionals.

- **Christine Scifert** has been a managing partner with Memphis Regulatory Consulting, LLC for over 5 years and supports large and small medical device companies related to regulatory, quality and clinical activities. Prior to consulting, Christine spent 9 years at Medtronic Spinal and Biologics directing the regulatory department of 22 people. As Senior Director of the group, she set regulatory strategy, oversaw global submissions, developed a design control process, interfaced with FDA and notified bodies, oversaw modification and implementation of procedures to maintain regulatory compliance and performed due diligence activities for potential acquisitions. Prior to Medtronic, she performed evaluations of injury mechanisms associated with automobile collisions, slip and falls, and sport/recreation accidents. Christine received a Bachelor of Science in Physics from Hamline University and a Master of Science in Biomedical Engineering from University of Iowa. She also completed a Masters in Engineering Management from Christian Brothers University.
• **Kimberly Strohkirch**: Kim has been a managing partner with Memphis Regulatory Consulting, LLC for over 5 years and supports large and small medical device companies related to regulatory, quality and clinical activities. Prior to consulting, Kim spent 3 years at Medtronic Spinal and Biologics working on design control activities, annual reports, PMA supplements, change control, and labeling related to cervical and lumbar arthroplasty devices. She also spent two years at Cook Med Institute developing clinical protocols and managing studies for peripheral bare metal and drug-eluting stents. Engineering principles were used to develop regulatory strategy and pre-clinical testing to obtain clearances and approvals. Kim received a Bachelor of Science in Mechanical Engineering from The University of Memphis and a Masters of Science in Engineering from the department of Aeronautics and Astronautics from Purdue University. She has completed other graduate engineering courses at The University of Memphis with an emphasis in materials.

• **Yongquan Zhou** is a project engineer in Packaging Design and Development at FedEx Corp. He received his B.E. in packaging engineering and M.E. in mechanical engineering from the Wuxi Institute of Light Industry in China, and his M.S. in packaging science from the Rochester Institute of Technology. Mr. Zhou is a Certified Packaging Professional (CPP) with more than 30 years of experience in the packaging industry, academic classrooms, and research and testing laboratories. Mr. Zhou serves on various IoPP, ASTM, and ISTA technical committees, and was an IoPP AmeriStar Packaging Competition judge from 1997 to 2001. He has published articles in *Packaging Technology and Engineering* and other magazines.

**Admission Requirements:**

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• One official transcript of previous academic credits from each of the colleges or universities previously attended.

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  o World Education Services (WES) Comprehensive Course-by-Course Report. This evaluation is required for those whose highest degree is from a foreign University.

**FOR MORE INFORMATION, CONTACT THE GRADUATE ENGINEERING OFFICE AT 901-321-3410 OR MEMP@CBU.EDU.**
To better meet the needs of the engineering/technical community, CBU Graduate Engineering offers Master’s Certificates. These proficiency certificates consist of three graduate level courses taken from the MSEM curriculum and culminate in the issuing of a Technical Certificate of Completion. All of the courses in the Graduate Engineering Certificate programs apply toward the MSEM degree. Thus, you have the opportunity to get a sampling of the graduate engineering program while obtaining industry recognized certification.

**Quality of Medical Devices**

The Graduate Certificate in Quality of Medical Devices was created to meet the needs of the Medical Device industry. It expands knowledge to improve job performance and increase the opportunities for advancement in the medical device industry.

**Courses (3 from the following courses):** Quality Assurance; Regulatory Affairs and Quality Systems; Quality Systems for the Medical Device Industry; Distribution and Medical Device Packaging

**Packaging Engineering**

The Graduate Certificate in Packaging Engineering was designed for the engineer, scientist or technologist who must develop and produce packages that contain, protect and preserve, transport, inform, and sell a product.

**Required Courses (3 from the following courses):** Principles of Packaging; Distribution and Medical Device Packaging; Sustainability; Healthcare Packaging; Transport Packaging

**Information Technology**

The Graduate Certificate in Information Technology is designed for the engineer, scientist or technologist implementing or maintaining computer information systems software and hardware. This would include the design and maintenance of computer networks, databases, expert systems and artificial intelligence.

**Courses (3 from the following courses):** Knowledge Engineering; Management of Information Systems; Computer Networks & Cyber Security; Database & Big Data Management; Data Science

**Engineering Management**

The engineer, scientist, or technologist moving into a leadership or managerial role needs the latest business tools and techniques to drive their organizations to success. These tools are not normally part of a technical undergraduate curriculum.

When you are ready to move to the next level, consider a Graduate Certificate in Engineering Management from CBU.

**Courses (3 from the following courses):** Engineering Management; Engineering Financial Management and Accounting; Advanced Engineering Economy; Technical Project Management

**Innovation**

The Graduate Certificate in Innovation was created to meet the needs of innovative corporations and start-up companies. It provides knowledge needed for those who are involved with innovation.

**Courses (3 from the following courses):** Engineering Management; Entrepreneurship; Engineering Law; Database and Big Data Management
Construction Management

The Graduate Certificate in Construction Management was created to meet the needs of civil engineers, architects, and contractors. It provides knowledge needed for those who are involved with construction projects.

Courses (3 from the following courses): Construction Management; Planning and Scheduling; Construction Estimating and Cost Control; Construction Equipment and Methods; Engineering Law

Admission Requirements

- A complete application form (online at http://cbu.edu/future/apply.html) with application fee.
- One official transcript of previous academic credits from each of the colleges or universities previously attended.
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For more information, contact the Graduate Engineering Office at 901-321-3410 or memp@cbu.edu.

11/10/2014