### 2016 HPC Spring Meeting

**Friday, April 22, 2016**  
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>
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</thead>
<tbody>
<tr>
<td>8:45 a.m. – 9:00 a.m.</td>
<td>Check-in/Continental Breakfast</td>
</tr>
</tbody>
</table>
| 9:00 a.m. – 10:30 a.m. (90 mins) | **Bioworks: Its Connection to Biologistics & Packaging**  
Brandon Wellford, Bioworks  
**Solar ColdBox**  
Nicole Smith and Michael Goodwyn, Aldelano |
| 10:30 a.m. – 10:40 a.m. | Break                                                                                    |
| 10:40 a.m. – 12:00 p.m. (80 mins) | **SweetBio Journey to FDA Clearance**  
Kayla Rodriguez, SweetBio  
**2016 TransPack Forum in Review**  
Larry Rutledge, CBU Packaging Lab |
| 12:00 noon – 1:00 p.m. | Lunch                                                                                   |
| 1:00 p.m. – 2:30 p.m. (90 mins) | **Polymer Research & Biologistics**  
Firouzeh Sabri, University of Memphis |
| 2:30 p.m. – 2:40 p.m. | Break                                                                                    |
| 2:40 p.m. – 3:40 p.m. (60 mins) | **Cold Chain Packaging R&D Projects @ CBU**  
Pong Malasri, Christian Brothers University |

Campus Map: [http://www.cbu.edu/assets/2091/cbumap2015.pdf](http://www.cbu.edu/assets/2091/cbumap2015.pdf)

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**Active Members**  
Bayer Consumer Care, Evergreen Packaging, FedEx, GlaxoSmithKline, Medtronic, Memphis Bioworks, MicroPort Orthopedics, Olympus Surgical Technologies America, Plastic Ingenuity, Smith & Nephew, SweetBio, Thaddeus Medical Systems, The Pallet Factory, Wright Medical, WS Packaging
Meeting Sponsors

The University of Memphis
(http://www.memphis.edu/)

Memphis Bioworks
(http://www.memphisbioworks.org/)

Aldelano Corporation
(http://solarcoldbox.com/)

SweetBio
(http://www.sweetbio.com)

Christian Brothers University
(http://www.cbu.edu)

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Registered Participants

1. Baker, Chad
   Christian Brothers University
2. Behles, Cody
   University of Memphis
3. Bonner, April
   Christian Brothers University
4. Gadowmski, Dick
   Christian Brothers University
5. Garcia, Luis
   MicroPort Orthopedics
6. Gilman, Jay
   FedEx
7. Golias, Mihalis
   University of Memphis
8. Goodwyn, Michael
   Aldelano
9. Hare, Charlotte
   Christian Brothers University
10. Housewirth, Jade
    Christian Brothers University
11. Ivey, Stephanie
    University of Memphis
12. Johns, Georgina
    Christian Brothers University
13. Le, Phillip
    Bayer Consumer Care
14. Lin, Louie
    Christian Brothers University
15. Loving, Benjamin
    Christian Brothers University
16. Malasri, Pong
    Christian Brothers University
17. Mishra, Sabya
    University of Memphis
18. Moats, Bob
    Christian Brothers University
19. Nguyen, Ngan Kim
    Christian Brothers University
20. Nobes, Geoff
    Evergreen Packaging
21. Phaneuf, Rob
    MicroPort Orthopedics
22. Pourhashemi, Ali
    Christian Brothers University
23. Ray, Asit
    Christian Brothers University
24. Rodriguez, Kayla
    SweetBio
25. Russell, Stephen
    Christian Brothers University
26. Rutledge, Larry
    Christian Brothers University
27. Sabri, Firouzeh
    University of Memphis
28. Savage, Sammurelle
    Christian Brothers University
29. Shannon, John
    Viskase Companies
30. Smith, Nicole
    Aldelano
31. Thomas, Erica
    Christian Brothers University
32. Vazquez, Juan
    Christian Brothers University
33. Wadlington, Clark
    Christian Brothers University
34. Wellford, Brandon
    Memphis Bioworks
35. Yeasin, Mohammed
    University of Memphis
36. Zheng, Zhihong
    Christian Brothers University
37. Zhou, Yongquan
    FedEx

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ABSTRACTS
Bioworks: Its Connection to Biologistics & Packaging

Brandon Wellford

Abstract: Memphis Bioworks is the Mid-South’s go-to organization for creating companies, jobs and investments. A visionary community leader, Memphis Bioworks has a well-established record of sparking new levels of economic vitality by investing in entrepreneurs, building state-of-the-art labs and facilities, and training the next generation of workers. Bioworks was created in 2001 as part of a citywide effort to foster economic growth by building on Memphis’ strengths and bioscience potential in the medical, agricultural and logistics fields. The organization is a 501(c)(3) non-profit organization funded through philanthropic contributions, corporate support, and state and federal grants. In addition to the work of the Foundation, Bioworks executes its mission through a family of organizations created to fulfill economic development needs in the community.

With Memphis being America’s Distribution Hub, the local community has a vast amount of talent and assets related to logistics and specifically packaging. It is important that Memphis is recognized for these capabilities and that we are a center for new ideas and companies related to logistics and packaging. In May, Bioworks will start a second cohort of logistics companies that are focused in these areas:

- Cross-border E-Commerce solutions
- First- and last-mile delivery solutions
- Fleet efficiency
- Data-driven supply chain management, including predictive analytics
- Payment systems
- Location and contextual-based services
- Internet of Things
- Autonomous vehicles
- Robotics
- Sensors
- Smart packaging

Through a competitive application process, up to six companies will be selected for the 2016 cohort and will receive $50,000 in initial seed capital. In return for an equity stake, each participating company will receive a $25,000 investment to work on developing the initial product and business model from Innova, a Memphis-based venture capital firm that has invested in more than 60 early-stage companies and co-founded the ZeroTo510 Medical Device Accelerator with Memphis Bioworks, as well as a $25,000 match from EPIcenter.

1 CFO, Memphis Bioworks, 20 S. Dudley, Suite 900, Memphis, TN 38103, bwellford@memphisbioworks.org
During the 15-week accelerator, entrepreneurs go through an intense, mentorship-focused program that includes classroom activity, hands-on exercises and rigorous business-building curriculum. The companies spend the bulk of their time on market validation, refining their business models, and proofs-of-concept. Post-acceleration programming will be available to help teams continue to develop and grow their startup companies. At the end of the program, each team presents its business to investors, business leaders and community supporters at Memphis Demo Day.

**Keywords:** Economic Growth; Startup; Medical Device; Biologistics

**Presenter:**

Brandon Wellford has served as the Chief Financial Officer and Director of Real Estate for the Memphis Bioworks Foundation since 2004. He is responsible for the financial and real estate functions for the Foundation including about 20 for-profit and non-profit organizations sponsored by Memphis Bioworks. Mr. Wellford managed the demolition of the 1.3 million square foot hospital facility in the Medical center which has led to the construction and renovation of 305,000 square feet of laboratory/office space with more than $140 million in investment.

Prior to working at Memphis Bioworks, Mr. Wellford worked for 22 years for real estate development companies in Little Rock, Ark, Tucson, AZ, and Washington, D.C. He is a Certified Public Accountant (inactive) and holds a Bachelor of Science in Business Administration degree from the University of Tennessee at Martin and graduated from Christian Brothers High School. He was born in Memphis and was raised on a farm in Cordova.
Solar ColdBox

Nicole Smith\textsuperscript{1} and Michael Goodwyn\textsuperscript{2}

Abstract: In developing nations, 40\% of food is wasted post-harvest due to lack of a sufficient cold infrastructure. It is estimated that by 2025, 1.8 billion people around the world will live in “extreme water scarcity”.

Aldelano Solar Cold Chain Solutions\textsuperscript{TM} has addressed these needs with innovative, life-saving technology. The Aldelano Solar ColdBox\textsuperscript{TM} is a fully off-grid, solar powered cold storage system which delivers both freezing and refrigeration storage solutions with temperatures ranging from -10° to 55° Fahrenheit. The Aldelano Solar WaterMaker\textsuperscript{TM} and IceMaker\textsuperscript{TM} literally produce water and ice by pulling the moisture from the air and purifying it for consumption. All are off-grid solutions powered through solar energy.

Aldelano will share our direction for introducing these new products to industry and developing markets, as well as provide a glimpse into some of our exiting new projects.

Keywords: Post harvest waste; water scarcity; off-grid; solar; refrigeration; cold storage; water

Presenters: Nicole Smith - Nicole Smith is a 25 year industry professional and the C.O.O. of Aldelano Corporation. Nicole has overseen the startup and operations of dozens of production operations, working closely with Fortune 500 clients. Oversees the development of the Solar ColdBox line of products and continues to lead in the advancement and improvement of these products.

Michael Goodwin - Michael Goodwyn is a certified Electrical Engineer with 6 years of Navy training. He has a background in carpentry and mechanics as well as production and operations management. Michael is the Lead Engineer and Operations Manager for the ColdBox project and the brains behind much of the innovative technology.
SweetBio Journey to FDA Clearance

Kayla Rodriguez

Abstract: How does a startup company know how to commercialize a product? SweetBio co-founder, Kayla Rodriguez, will first present on how SweetBio created and utilized a roadmap to identify and understand puzzle pieces necessary to achieve FDA 510(k) clearance. Additionally, thinking outside “the box” with respect to research and relationship building has given SweetBio an advantage. Even though there are several industry standards for FDA clearance, Kayla will provide insights into how SweetBio asked potential customers about what packaging they want, what claims would entice them to purchase their product, and how this has dictated SweetBio’s FDA 510(k) Clearance pathway.

Keywords: FDA 510(k); Startup

Presenter:

Kayla Rodriguez – Kayla earned her MBA in 2014 from Hult International in San Francisco, CA and New York City, NY. Her forward thinking business mindset is unique and her overall knowledge of business development, marketing, operations, organizational effectiveness, and front-end web development in Fortune 40 experience made her a fit for the COO role at SweetBio. She is responsible for operational efficiency, manufacturing, quality and logistics.

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1 Co-Founder and COO, SweetBio, 20 Dudley Street, Suite 900, Memphis, TN38103, kayla@sweetbiotech.com
2016 TransPack Forum in Review

Larry Rutledge

Abstract: CBU’s Package Test Lab Services strives for continuous improvement through attendance at ISTA technical forums and other educational platforms focusing on latest trends in transport packaging. This year’s attendance at the 2016 Transport Packaging Forum provided a balance of interesting case studies, research and innovative packaging solutions presented by experts from Asia-Pacific, Europe, North America and South America. This short presentation at CBU’s spring HPC meeting will share key points and takeaway’s from this year’s forum.

Keywords: ISTA TransPack Forum, Healthcare packaging consortium, Distribution Packaging, Package Testing

Presenter:

Larry Rutledge is the Manager of CBU’s ISTA certified Packaging lab. A former packaging manager at FedEx for 18 years, his experience covers every aspect of distribution packaging. He served as a past member of the ISTA Board of Directors, named the recipient of the 2010 ISTA prestigious "R. David LeButt Memorial" Award, and is currently a member of IoPP. He can be reached at lrutledg@cbu.edu

1 Christian Brothers University Packaging Lab, 650 East Parkway South, Memphis, TN 38104, lrutledge2@bellsouth.net
Polymer Research & Biologistics

Firouzeh Sabri

Abstract: Aerogels are currently the best and lightest solid insulating material known. This presentation will cover the materials research that is ongoing in the Sabri research group. The presentation will give an overview of aerogels and composite materials made with aerogels and their relevance to cold chain storage and biologistics.

Keywords: Polymers, sensors, aerogels, thin films, biologistics

Presenter:

Firouzeh Sabri – Firouzeh Sabri is an Associate Professor of Physics and Materials Science at the University of Memphis. She established the Bio, Nano, and Space Materials Laboratory in 2007. Her research involves experimental materials physics with an emphasis on aerogels and elastomeric polymers. She has been funded for her materials research nationally and regionally and is the recipient of the 2008 APS Hildred Blewett award for women in Physics.

1 Associate Professor, Physics Department, University of Memphis, 219 Manning Hall, Memphis, TN 38152, fsabri@memphis.edu
Cold Chain Packaging R&D Projects @ CBU

Siripong Malasri

Abstract: This presentation will cover two recent projects at CBU related to cold chain packaging:

- **Temperature Sensitive Label**
  
  Performance of a commercially available temperature sensitive label was investigated. These labels were designed to detect temperature within the range of 100F to 150F. Several materials were used with these labels, i.e., corrugated card board, plastic, wood, aluminum, fiber glass, plastic, and Styrofoam. Effect of base materials and heating durations will be discussed.

- **In-House Developed Low-Cost Temperature/Humidity Chamber**
  
  A low-cost temperature/humidity chamber was developed. Its performance was evaluated using a portable data recorder. The chamber construction and performance evaluation will be discussed.

In addition to the above two studies, the CBU Packaging Lab plans to pursue ISTA thermal lab certification. Requirements for the certification will also be presented.

**Keywords:** Cold Chain Packaging; Temperature Sensitive Label; Temperature/Humidity Chamber; ISTA Certified Thermal Lab

**Presenter:**

Siripong Malasri – Dr. Malasri is currently Dean of Engineering and Director of the Healthcare Packaging Consortium, Christian Brothers University. He is an ISTA CPLP (Professional Level) and a registered professional engineer in Tennessee. His research interests include artificial intelligence applications and packaging.

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1 Director, Healthcare Packaging Consortium, Christian Brothers University, 650 East Parkway South, Memphis, TN 38104, pong@cbu.edu
SLIDES
Memphis Bioworks Mission

To be the Mid-South’s go-to organization for creating bioscience businesses, jobs, and investments that expand the economic vitality of our community.
The Bioworks Approach

Bioworks identifies and fills strategic gaps in the bioscience ecosystem by building on local assets

Education
Commercialization
Patient Data Management
Real Estate Development
Pre-Clinical Research Labs
Start-Up Formation
Opportunity!!!
Policy & Advocacy
Non-Traditional Financing
Start-Up Incubation
Real Estate Development
Workforce Development
Agricultural Innovation

Time-Honored Innovation

1999 2001 2003 2005 2007 2009 2011 2013 2015

Battelle
MBF
INNOVA
TriMetis

Medical Device Accelerator
EPlcenter
Entrepreneurial Acceleration

- Chairman’s Circle initiative
- Front door for entrepreneurial activity in Memphis
- 54 companies accelerated or incubated
- 78 local jobs created
- ZeroTo510 Accelerator named a top 25 accelerator in the U.S. two years running
- Launched logistics innovation accelerator sponsored by FedEx
- SBA Startup in a Day seed funding

- Agritech business acceleration program
- Supported by TN Department of Agriculture
- Included as part of the Governor’s Rural Challenge
- Kicked off July, 2015
- 5-Year, $10M program to:
  - Serve 200 entrepreneurs
  - Build 100 new companies
  - Create 2,000 high-wage jobs

Funding Enterprise Growth

- Invested $19.7M in 61 companies
  - Leveraged over $70M in follow-on funding
  - 263 jobs in portfolio companies
  - $38.4M in portfolio company annual revenue
- Raising AgriTech Fund under USDA RBIC designation
  - Allows for farm credit investment
  - Provides CRA credit to banks upon investment
Thaddeus Medical

Protecting biomedical specimens & products with the world’s first smart medical cooler.

- Platform technology for biomedical shipment temperature control
- Provides temperature profile during shipping
- Replaces antiquated & imprecise coolers and ice packs
- $300M in vaccines lost in 2014 according to the CDC
- Graduate of EPIcenter’s inaugural logistics accelerator
- Steve Scully, MD, PhD - Founder

Tradelanes

Key Partners

- End-to-end supply chain management
- Web-based platform that connects all supply chain actors in a single platform
- Order entry with real-time quotes and ability to compare shipping prices
- Allows for global trade management with electronic customs filings
- Automates onerous manual processes for small business owners
- Graduate of EPIcenter logistics accelerator
TriMetis Life Sciences

- Pre-clinical research & consultation
- Contract laboratory testing
- Laboratory access for established teams
- Biospecimen procurement
  - Over 75 access sites globally
  - Including access to Zika virus
- 26,000 sq. ft., LEED Certified facility
- AAALAC certified & GLP compliant
- Founded by Bioworks in 2011 in response to local industry needs

Biologistics Represents Opportunity

*Biologistics is a strategic opportunity for economic growth, industry, and academia*
No City Owns Biologistics … Yet …

• Numerous cities have overlapping bioscience & logistics assets
• None is a breakout biologistics leader
• Must harness both public & private sectors while leveraging academia

Biologistics Cluster Collaboration

• Established Industry
  • Problem identification
  • Product validation for innovators
  • Customer discovery for new ventures
  • Become customers
  • Acquire new ventures
  • Accelerator sponsorships
  • Investment capital

• Academia
  • Cutting edge research
  • Collaborative agenda with industry
  • Flexible tech transfer policies & practices

• Entrepreneurial Ecosystem
  • Access to industry pain points
  • Access to academic research & patents
  • Proactively solving problems

• Local Government
  • Funding for key activities
  • Incentives for business relocation
Biologistics as Dealflow Opportunity

- Four-tiered investment strategy
- Leverages local assets
- Creates a “Biologistics front door”
- Recruits small to medium bioscience companies to Memphis
- Coordinates local assets to respond to industry needs
- Promotes the brand domestically & internationally
- Working to build consensus on strategy with EDGE’s Brookings Steering Committee

Vaxent – StreptAnova®

- Group A streptococcus vaccine
  - Primary cause of strep throat, rheumatic fever, & necrotizing fasciitis
- Currently in Phase 1 clinical trials in adults
  - Ultimate target is pre-school aged children
- 616M global cases of strep throat each year
- 517K Strep A related deaths annually
- Developed by Dr. Jim Dale at UTHSC
## Ariste Medical

- Aggressive Reduction of Infection, Stenosis, and Thrombotic Events
- Proprietary coating for surgical implants
- Reduces complications
  - Infection
  - Scar Tissue
  - Clotting
- Technology developed at UTHSC by Lisa Jennings, Ph.D., & Tim Fabian, M.D.
- First application will be an anti-microbial drug eluting hernia mesh
  - 1,000,000 procedures annually
  - MRSA infection is the leading cause of infection which leads to re-operation

### Hernia Mesh Inhibition Testing

**MRSA – 7 Days**

<table>
<thead>
<tr>
<th>Control</th>
<th>Ariste</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control Mesh</td>
<td>Ariste Mesh</td>
</tr>
</tbody>
</table>

## Restore Medical

- Patented surgical instrument sterilization tray
- Keeps ringed instruments upright & open
- Addresses a market with 20,000,000 procedures annually

### Simple, Clean, Efficient

- **90°**
  - Optimal angle for cleaning. The tray ensures consistency and maximum exposure to water and cleaning agents.
- **99.99%**
  - Percent reduction of bioburden on ring-handed instruments in third party validation studies.
- **60%**
  - Up to 60% time saved in processing ring-handed instruments.
Q & A

LEAD. INNOVATE. GENERATE RESULTS.
Cold Chain Packaging R&D Projects @ CBU

Siripong Malasri
Healthcare Packaging Consortium
Christian Brothers University
650 East Parkway South, Memphis, TN 38104, USA
pong@cbu.edu

Presentation Outline

- Temperature Sensitive Label
- In-House Developed Low-Cost Temperature/Humidity Chamber
- ISTA Certified Thermal Lab
Temperature Sensitive Label

Reversible Label

- Self-adhesive
- Clear, easy-to-read in °C and °F
- Can be used for heating and cooling applications
- Returns to original state – can be used over and over
- Safe, non-toxic design
- Electrically non-conductive

RLC Series labels are ideal for monitoring temperatures of electronic parts, transformers, relays and motors. To most precisely interpret liquid crystal labels, please note color variances:

**GREEN** Bar is the Actual Temperature Reading

**BROWN** Bar is just above the Actual Temperature

**BLUE** Bar is just below the Actual Temperature Reading.


Irreversible Label

- Six Temperature Ratings on Each Label
- **6MA** - 10°F between each rating
- **6MB** - 25°F between each rating
- 1 1/4 x 3/8” Actual Size
- 1/64 x 1/8” Indicating Window

http://www.omega.com/pptst/6M_LABELS.html
Wood

Aluminum

Polyethylene terephthalate, PET or PETG

Corrugated Paper

Polystyrene Foam, PS Foam, or Styrofoam

Fiber Glass

Plastico
Envirotronics Altitude Chamber
Model EA8-2-3-AC
-90F to +350F
Up to 100000 ft altitude,
24”x24”x24” chamber size
<table>
<thead>
<tr>
<th>Material</th>
<th>Performance</th>
<th>Thermal Conductivity</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>W/(m K)</td>
</tr>
<tr>
<td>Aluminum</td>
<td>83%</td>
<td>205</td>
</tr>
<tr>
<td>PS Foam</td>
<td>78%</td>
<td>0.033</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.195</td>
</tr>
<tr>
<td></td>
<td></td>
<td>N/A</td>
</tr>
<tr>
<td>Plastico</td>
<td>67%</td>
<td>0.05</td>
</tr>
<tr>
<td>Corrugated Paper</td>
<td>39%</td>
<td>0.13</td>
</tr>
</tbody>
</table>

http://www.engineeringtoolbox.com/thermal-conductivity-d_429.html
https://en.wikipedia.org/wiki/Polyethylene_terephthalate
https://en.wikipedia.org/wiki/Polystyrene
Conclusions

• Using temperature sensitive labels with caution. Only 51% correct if “Black” is considered “Activation” while only 71% if “Grey” is included.
• Considering “Grey” as activation gives a better indicator
• Need further study

Observations

• Longer duration yields less accuracy in “Black only” cases, i.e. 67% (10 mins) to 35% (20 mins)
• More accurate with super-high thermal conductivity, i.e., Aluminum

In-House Developed Low-Cost Temperature/Humidity Chamber
Set Temp = 90°F, Set RH = 75%

Avg Temp = 88.74°F, Avg RH = 78.73%
Set Temp = 80°F, Set RH = 70%
Avg Temp = 82.15°F, Avg RH = 73.73%

Set Temp = 75°F, Set RH = 75%
Avg Temp = 77.08°F, Avg RH = 71.23%
Set Temp = 75°F, Set RH = 60%
Avg Temp = 77.94°F, Avg RH = 65.76%

Set Temp = 73°F, Set RH = 50%
Avg Temp = 75.83°F, Avg RH = 55.42%
<table>
<thead>
<tr>
<th>Set</th>
<th>Actual</th>
<th>% Error (Avg &amp; Set)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Temp (F)</td>
<td>RH (%)</td>
</tr>
<tr>
<td>90</td>
<td>88.74</td>
<td>67.36-85.87 = 18.51</td>
</tr>
<tr>
<td>80</td>
<td>82.15</td>
<td>68.07-79.41 = 11.34</td>
</tr>
<tr>
<td>75</td>
<td>77.08</td>
<td>64.66-76.19 = 11.53</td>
</tr>
<tr>
<td>75</td>
<td>77.94</td>
<td>50.12-72.16 = 22.14</td>
</tr>
<tr>
<td>73</td>
<td>75.83</td>
<td>49.92-60.28 = 10.36</td>
</tr>
</tbody>
</table>

Setting for Dog Food Project

Set: Temp = 85F, RH = 75%
Actual Average: Temp = 85.12F, RH 74.43%
<table>
<thead>
<tr>
<th>Set</th>
<th>Actual</th>
<th>% Error (Avg &amp; Set)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Temp (F)</td>
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<td>75</td>
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<td>75</td>
<td>60</td>
<td>77.94</td>
</tr>
<tr>
<td>73</td>
<td>50</td>
<td>75.83</td>
</tr>
<tr>
<td></td>
<td>Walmart</td>
<td>85.12</td>
</tr>
</tbody>
</table>
Set Temp = 85°F, Set RH = 75%
Avg Temp = 87.25°F, Avg RH = 75.49%

<table>
<thead>
<tr>
<th>Set</th>
<th>Actual</th>
<th>% Error (Avg &amp; Set)</th>
</tr>
</thead>
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<tr>
<td></td>
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<td>77.08</td>
<td>64.66</td>
</tr>
<tr>
<td>75</td>
<td>77.94</td>
<td>59.12</td>
</tr>
<tr>
<td>73</td>
<td>75.83</td>
<td>54.92</td>
</tr>
</tbody>
</table>

| Walmart | 85 | 75 | 85.12 | 65.48 - 81.10 = 15.62 | 74.43 | 0.14 | 0.76 |
| CSZ     | 85 | 75 | 87.25 | 69.57 - 78.51 = 8.94  | 75.49 | 2.65 | 0.65 |
Conclusions

• Temperature control results using space heater in tent chamber (Error: Range 0.14% to 3.92%, Average = 2.47%) and CSZ chamber (Error: 2.65%) are comparable.
• Humidity control results using humidifier in tent chamber (Error: Range 0.76% to 10.84%, Average = 6.09%) have error significantly over using humidifier in CSZ chamber (Error: 0.65%).

Future Work

• Build a chamber from plywood with PS Foam insulation using same heater and a more sensitive humidifier.
• Add a de-humidifier if lower RH than ambient RH is needed.
ISTA Certified Thermal Lab

**ISTA 7E + Standard 20 =**
The First Global Method for Standardizing the Establishment of Insulated Shipping Container Performance

**FIND A LAB**

Cryopak (Edison, NJ, USA)
gh Package and Product Testing & Consulting (Fairfield, OH, USA)
Lifoam (Huntington Beach, CA, USA)
SGS Consumer and Retail (Fairfield, NJ, USA)

Next Entry: Christian Brothers University

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<table>
<thead>
<tr>
<th>Task</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acquisition of Standard 20</td>
<td>$10,000</td>
</tr>
<tr>
<td>Registration for CTP Level I Technician (2 @ $425)</td>
<td>$850</td>
</tr>
<tr>
<td>Registration for CTP Level I Technician (1 @ $425)</td>
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<td>Registration for CTP Level II Technician (2 @ $450)</td>
<td>$900</td>
</tr>
<tr>
<td>Application for Lab Certification Pre-Audit</td>
<td>$500</td>
</tr>
<tr>
<td>Application for Lab Certification Audit</td>
<td>$2,500</td>
</tr>
<tr>
<td>Auditor Travel Expenses</td>
<td>$2,000</td>
</tr>
<tr>
<td><strong>CBU Certified Thermal Lab Designation</strong></td>
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</tr>
<tr>
<td>Completion of Benilde Hall Expansion</td>
<td>$400,000</td>
</tr>
<tr>
<td>Acquisition of a New Temperature Chamber</td>
<td>$70,000</td>
</tr>
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