TAUBER INSTITUTE
FOR GLOBAL OPERATIONS
UNIVERSITY OF MICHIGAN

MICHIGAN ROSS // MICHIGAN ENGINEERING

TEAM PROJECT SHOWCASE AND SCHOLARSHIP COMPETITION



Welcome

2019 Spotlight!

The Tauber Institute for Global Operations completed another year of actionbased team projects worldwide. In this past academic year 2018-2019, 49 students participated in 21 team projects, featuring 16 sponsoring companies from a wide range of industries, including aerospace, internet commerce, high tech, healthcare, automotive, energy and retail. Tauber was pleased to strengthen relationships with fifteen returning sponsors -AIP Canam Group, Amazon, Boeing, Dell, Dow, DTE Energy, Ford, General Electric, General Motors, Microsoft, PepsiCo, Pfizer, Stanley Black & Decker, Stoneridge, and Target - and excited to form a new partnership with Brose. As part of a comprehensive training program, students participated in facility tours and leadership and teamwork training modules leading up to their projects. As a result, 98% of students were employed, including 58% of students accepting full-time positions with Team Project sponsors or Industry Advisory Board member companies.

This book documents student teams' regional and global impact with executive summaries describing the challenge, method, and results from each sponsored project. The depth and breadth of our students' projects reflect the demands faced by operations in an ever-changing world. We hope these executive summaries will provide insight into the University of Michigan's strong global reputation and partnerships with leading companies, who know that our students can be called upon to solve some of their most challenging problems.



Damian Bell



Larry Seiford



Ray Muscat

Best Regards,

Dania Bei

Damian Beil Ford Motor Company Co-Director and Professor of Technology and Operations Ross School of Business

Larry Seiford Goff Smith Co-Director and Professor of Industrial & Operations Engineering College of Engineering

Ly Man

Ray Muscat Industry Director Tauber Institute for Global Operations



September 13, 2019



Welcome to the University of Michigan for the 26th Spotlight! Team Project Showcase and Scholarship Competition with the Tauber Institute for Global Operations. The Tauber Institute continues to reach new heights and create new opportunities for our students and industry partners. As a public university, we are proud to devote our strengths in research and education in service of society. By bringing together our talented students

from the College of Engineering and Ross School of Business, the Tauber Institute hones their abilities as creative and analytical thinkers and provides essential professional experience as they develop solutions for large-scale operational challenges at some of the world's leading companies.

The results are impressive – and further evidence of the strength of a Michigan education. In the last year alone, Tauber Team Projects identified more than three hundred million dollars in potential savings reported by sponsoring company calculations.

I deeply appreciate the generosity and vision of our friend and dedicated alumnus Joel D. Tauber and our partners' ongoing willingness to engage in important collaborations that make lives better. Together, we are unleashing the ingenuity and intellectual power of our students, while further demonstrating that the best solutions to big problems are never produced in isolation.

I hope you will enjoy learning more about the incredible experiences and ideas shared by our students. We are proud of the work they have done to tackle complex, evolving challenges and look forward to seeing what they accomplish next.

Sincerely,

Mark S. Schlissel University of Michigan President

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About the Tauber Institute

Industry identified a need. The University of Michigan responded.

It all began when a gathering of business advisors identified a key category of employees missing from their organizations: trained professionals who understand both the business and engineering aspects of manufacturing.

As a result of that discussion, the University of Michigan's Ross School of Business and College of Engineering formed a new cross-unit collaboration. Named for benefactor and U-M alumnus Joel Tauber, the Tauber Institute was born — and immediately began to innovate.

Faculty in the two schools created new courses to deliver an integrated education addressing the challenges of modern manufacturing, with an emphasis on leadership skills.

The Tauber Institute sought every opportunity to immerse students in real-world experiences — leading to the development of Tauber team projects and the annual *Spotlight!* event, where students compete for academic scholarships through their presentations about work at top companies across the U.S. and around the world.

The Tauber Institute has enjoyed many accolades — most recently receiving the UPS George D. Smith Prize for effective education in the fields of operations research, management science, and analytics. But a truer measure of Tauber's success is that 99 percent of graduates quickly secure employment, making an immediate impact in their respective companies, and rising to positions of authority.



Building careers on a foundation of strength



U-M's Tauber Institute for Global Operations is known for empowering leaders to solve operations and technology challenges through multi-disciplinary, action-oriented education and global industry partnerships. Top companies from around the world recognize that hiring a Tauber recruit is a wise investment in the future, as these young leaders come armed with skills and abilities that transcend any single discipline.

Companies and organizations from around the globe have discovered that teaming up with the Tauber Institute has tangible results when it comes to finding solutions to big problems. The relationship begins when teams made up of students representing both engineering and business are selected to work on 14-week team projects designed to tackle operations and manufacturing problems. The teams work side-by-side with company managers to provide real solutions that can ultimately save millions of dollars.

For a variety of reasons, these projects sometimes require more than 14 weeks to complete, and thus, teammates are often hired on to finish the work they began. And in other instances, their outstanding performance on the team project was enough to lead to their hiring. Today, many of these Tauber Fellows are transferring their skills and abilities to benefit a myriad of different departments within their respective companies.

Building careers on a foundation of strength

During the summer of 2016, **David Sachs**, (Master of Engineering in Manufacturing '16), was part of a three-person team tasked with utilizing smart factory deployment for lean transformation of Stanley Black & Decker's CribMaster inventory management solution. The teams' 14-weeks of work resulted in recommendations that ended with CribMaster being awarded a multi-million dollar contract with a customer in aviation. The team also estimated that the solution could deliver more than \$100M in annual revenue. Needless to say, Stanley took notice of this and offered David Sachs a job following the project.

Today, Sachs is North America Commercial Data Lead at STANLEY Engineered Fastening in Troy, Mich. "It was always my plan to come back. The leadership team from my project helped connect me to the leadership group in the automotive division, who were interested in having me join. While I would not be working on the same project, Stanley had an excellent internal leadership development program that I had been recruited for while working on the project. I was also given the opportunity to rotate between different sites and departments to help broaden my understanding of Stanley," he said.

Sachs has the ability to move from function to function and perform. Having worked in operations, engineering and sales roles, he strives to bring the consistency and data-focus developed while at the Tauber Institute and the analytical skills of two engineering degrees, to his work today. He said his goal is to make work more efficient and less confusing.

"The most critical skills I still use from Tauber all have to do with presenting. I spend a good portion of my job either updating people or trying to convince them of something, so the extra techniques like wording, body language, and speaking style I got from Tauber have been a huge help. In addition, basic skills like value stream mapping are amazing for defining the context of a problem and understanding the impacts downstream," Sachs said.

He works on the commercial team now, and his understanding of operations has been incredibly useful. In many companies, operations are process and efficiency minded. Tauber prepared him to excel by teaching core concepts that pertain to the business/financial side of the company, as well as how to make things run better. "I've done very well by being able to translate business process techniques to our commercial team," he said.

"My current role was very difficult in the beginning and forced me to learn about many topics very quickly, as I was looked at as the local expert. But it made me stronger, taught me about the commercial side of the business, and helped me to develop a broader tool set that makes me more useful for Stanley. What's next for me is probably a role in commercial excellence within Stanley, where I can help to improve profitability, efficiency, and consistency," Sachs concluded.

Stella Bi (MSCM '13), is currently the Global Commodity Manager at BorgWarner Inc. Her relationship with the Auburn Hills, Mich.-based company began as a student with her 2013 team project at BorgWarner Thermal Systems. The project, Implementation Plan and Business Case for End-To-End Traceability, resulted in an overall savings of \$850,000 over 5 years by reducing overall plant scrap.

Today, she leads the development of processes from order to delivery designed and utilized to move materials and deliver products to customers globally as Global Commodity



Manager. It was her goal to be hired following her team project six years ago, but she said she was not sure it would happen.

"BorgWarner is an international company with great product leadership in the market. The leaders that I worked with or met along the way have always been very approachable. I never felt the normal bureaucratic situations that other big companies might have," she said.

Those leaders saw something in Bi and she was indeed hired following her team project. She has been able to shift her focus, however, to an area that she's well prepared to tackle. "I moved from Thermal Systems to another division and function more related to MSCM – Supply Chain Management. Here I apply insights and understanding of all aspects that drive different supply chain strategies, using statistical tools. These are skills I obtained from my Tauber and MSCM program, and are what I apply in my current work," she said.

Her previous experience in Asia, Europe and the United States also give her a unique perspective on global Supply Chain operations from infrastructure, operations, costing/pricing, and project management points of view. Not one to rest on her laurels, Bi has the desire to seek an even broader view of supply chain management. "Before coming to study MSCM at Ross School of Business, I had longtime experience in Logistics Operations and Engineering. However, I did not have experience with purchasing and supply chain planning, or commodity strategy. After I graduated, I had my OPT project with BorgWarner where I immediately applied the analytical skills of supply chain planning. Now in my current job I am using all these skills that I gained while with Tauber and the MSCM experience. And I'm always eager to learn more," she said.

The transition from student team member to engineering team leader went very smoothly for Baran Kocal (MSCM '10) Affordability and Systems Engineering Leader at Boeing Commercial Aircraft division. Baran was confident in his employment prospects in general, but having his team project go so well improved that confidence. "I had a chance to communicate my career priorities to Boeing and get valuable insights from Boeing teams. I got hired into a leadership rotation program that recruits exclusively from Tauber and MIT LGO programs. I have done challenging rotations in high priority programs and was well supported by leadership across the company. So, the impact I have made and the good alignment between my background and the positions I took allowed me to expand my responsibilities and span across the company," he said.

Baran had aerospace experience before his Tauber stint, so he was able to hit the ground running and apply Tauber-taught methods and philosophies right away. "Specifically, supply chain analytics was the first learning area that I applied to my work at Boeing, where

Building careers on a foundation of strength

I performed inventory analysis and developed cost models for services business using Monte Carlo simulations. The quantitative and analytical nature of Tauber was key to making improvements in the roles I took, which are as diverse as supply chain, quality, engineering, manufacturing, etc. Just to give few examples, inventory optimization, lean manufacturing, variability control, and supply chain analytics stand out as the ones that I used relatively more frequently. I use skills I learned pretty regularly, whether I am developing strategy or guiding my teams to use them in tackling hard problems."

He continued, "I greatly value the skills and experience Tauber offers, together with Ross action-based learning. There is perfect alignment with Boeing's strategic focus on operations and Tauber graduates fit in nicely with strong technical backgrounds, ability to learn very quickly, and adapt to variety of conditions without detriment to performance.

Tauber graduates also have great people skills, which is very important for Boeing, where roles are very cross-functional and require significant collaboration and teaming up with many groups and functions. There has been ever-increasing focus on operations and production systems, which gets more and more technical every day. I have looked for Tauber graduates in my operations and engineering leadership assignments due to the valuable combination of strong technical and people skills with valuable operations experience."

Martha Neubauer (EGL BSE-Chem/ MSE-IOE '16), Product Development Manufacturing Engineer at Boeing, said that if not for Tauber, she would never have realized she had a passion for aerospace. "My background as a chemical engineer helped me land my Tauber project at Boeing, since the project involved materials technology, but then it was my Tauber project experience that helped me get hired full-time into Boeing's Engineering Career Foundation Program. I think the interview team was impressed that my Tauber team was able to make a large impact over a short period of time." Additionally, a soft skill that Tauber taught her was how to handle ambiguity, which she said she uses every day in Product Development. "I have also found it tremendously helpful to have a high level understanding of strategic sourcing and lean optimization to place my work in the broader business context and enable me to make the best decisions for the company."

Though she can't pinpoint it to one learning, she said she gained the most during her Tauber project through working with MBA teammate, Kelsea Ballantyne. "Since I was just coming out of college, getting to work with someone with diverse experiences helped me transition from student to change agent at a large corporation. I'm fortunate that Kelsea returned to Boeing, too, and can still be a friend and mentor!"





Nikki Haven (EGL BSE/MSE-IOE '15), recalls that the most significant accomplishment of her Tauber team project at Amazon was delivering tangible results for the company. "My teammate and I didn't just leave our managers with a bunch of recommendations for how to improve processes - we implemented process improvements until we achieved the results we set out to achieve, and we left the leadership team with a complete toolkit to maintain the results."

Her background was unique in the context of Amazon's Pathways program - a program built for MBA candidates that had work experience. As an EGL, Haven had technical capabilities matched with business acumen, but no fulltime work experience. Delivering impactful results during her team project, in addition to the breadth of knowledge from her Tauber education, convinced the management team and recruiters that she had the complete skill set needed to continue to deliver as a full-time employee.

Today, as Senior Program Manager in Operations Integration at Amazon, Haven calls on the soft skills she learned from both Tauber and Ross, along with the technical skills gained in IOE. "The most memorable experience I had in Tauber (aside from the team project itself) was Timothy Koegel's presentation on speaking skills. I will forever be conscious of avoiding presenting with dinosaur hands and being the ring-leader!"

Haven's colleague at Amazon and fellow Tauber alum, Senior Product Manager Lauren Fitzpatrick (EGL BSE/MSE-IOE '16), says that dealing with ambiguity is the most important skill she gained through her experience at Tauber. "To be able to be put in a totally new environment and figure out how to break down the issue to more manageable pieces and add some structure, it's truthfully a learned skill. Additionally, the cross functional groups that the program forms for our Tauber projects forces us outside of our comfort zones and to think more critically about team dynamics. I find myself using the team dynamics principles from the team project handouts whenever I'm kicking off a new project at work. I look forward in time and see how the different personalities might fit within the greater project and how to bring those skills out to propel the project forward quicker."

Fitzpatrick said that the depth and breadth of Tauber team projects were more intriguing than typical summer internships. "I think the projects through Tauber have more depth, and interviewers at the company were looking for a new perspective on solving Amazonian problems rather than trying to decipher if we were the right fit. Also, the pairing of engineering and business was always a talking point in my interview loops - it was a great combination of knowing tech skills but having the business savvy to do something with that knowledge. Especially at Amazon, having that tech background and the warehouse knowledge (from all the site visits and tours we did through Tauber) was a huge plus," she said.

Building careers on a foundation of strength

Also, Fitzpatrick calls out the immense U-M and Tauber network as a big plus for her career. "Not only did I have friends to connect to when moving to a new city, but also, professionally there's a connection. I reached out to a handful of alums who were a few years ahead of me when I got to Seattle, they all were giving me professional advice, helping me decide if there were other jobs that might suit me better, and also go to happy hours with. It was a great professional sounding board with people who had similar drive and questioned everything around them where I could think critically about my career. I think it definitely impacted the leader I am today - having had opportunity to present and discuss your project ideas with a wide audience and potential employers at *Spotlight!* is nerve-wracking, but it goes to show that you are qualified and can handle more than you expected. That confidence and support system gives you a great base to jump from when it comes to professional development. It's a unique skill that is often overlooked but Tauber definitely helped me build professional confidence."

Leaders and best

And the stories of Tauber team members going on to be hired at their sponsoring team project companies goes on and on. For example, Kelsea Ballantyne, MBA/MS-Environment and Sustainability, '16, is currently Boeing's Head of Manufacturing Standardized Work for the 777. Just four years ago in 2015, she was a member of one of three Boeing teams participating in the Spotlight! Competition, showcasing her work on the Carbon Fiber Recycling Strategy Team. Her team's work resulted in the ability for Boeing to achieve revenues of \$5.4M NPV over ten years and will eventually achieve the team's zero waste-to-landfill initiative. The skills she gained while at Tauber, including lean process design and sustainability focus, translated well to the role she currently holds.

Eva Xia, MBA '17, was hired by Microsoft following her Tauber's team success on a project called Partner Incentives for Accrual Process Improvement. While working at their Redmond, Washington headquarters, Xia and her team used advanced analytics, identified challenges and implemented solutions that were anticipated to result in more than \$310K in labor savings annually. The project success, which was estimated to save an additional \$35M per year in accuracy improvements, was one of the components Microsoft no doubt considered when hiring Xia as a Senior Finance Manager.

These and many other Tauber alumni are making a difference around the globe – some beginning right on the heels of their 14-week team projects with the companies and sponsors who believed in them from the start. By taking skills learned in their classrooms and project workrooms to the front lines of operations with leading businesses, Tauber-trained individuals are able to apply their knowledge across many varied departments and disciplines. Often, the Tauber team projects are just the beginning of important long-term and mutually beneficial professional relationships.



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Tauber year in review

We showcased the next generation of operations leaders.

Inventive solutions for tough operations challenges took center stage at the Tauber Institute for Global Operations' **2018** *Spotlight!* **Team Project Showcase and Scholarship Competition**.

The 2018 Tauber Team Projects resulted in **\$564.4 million in** savings according to sponsoring company calculations, an average of **\$28 million per project over three years**.

Five team project sponsors received longevity awards recognizing their commitment to the Tauber Institute's mission through their team project partnerships: Ford Motor Company (20 years), General Motors Company (20 years), Cummins Inc. (10 years), Dow DuPont (10 years), and Pepsico (5 years).

The annual *Spotlight!* event is a competitive presentation of operations solutions developed by Tauber Institute student teams during their 14-week team projects at top companies across the U.S. and around the world. A panel of distinguished judges from diverse industries selects the first, second, and third prize winners.





First Place: 2018 Team Boeing 787

Yatri Patel (EGL BSE-ME & MSE-IOE) & Kartik Raju (MBA)

Second Place: 2018 Team Boeing 777X

Andrew Davis (MBA), Colin McNally (MBA), & Cameron Stitt (EGL BSE-CHE & MSE-CHE)

Third Place: 2018 Team PepsiCo

Steven Oranges (MBA) & Tom Walkinshaw (EGL BSE-ME & ME-ESE)

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We made an impact in our community.

The annual Tauber **Community Service Day** brings together Tauber Institute students, alumni, faculty, and industry representatives who volunteer their expertise to provide operations solutions for community organizations. "It's easy for small businesses to be focused on the day to day operations and to be consumed by it, "remarked Tauber Institute volunteer Juan Alfaro (MBA '20), "but helping them to focus on a global view of where they're headed, and what they need to think about as they get there is really great."

This year, Tauber Institute volunteers partnered with the Detroit Area Pre-College Engineering Program and with Argus Farm Stop in Ann Arbor.



SPOTLIGHT! 2019

Year in Review

We assessed operations across industries.

Tauber Institute's facility tours expose students to operations and manufacturing processes practiced by a wide variety of organizations. Tauber students learn to perform a rapid audit of the state of an operation, judge the relative leanness of operations, prioritize targets of opportunity for improvement, and develop an action plan to facilitate improvement. This academic year, students assessed operations at Accenture 4.0, Amazon DET1, Arbor Brewing Company, Delta Airlines, Ford Dearborn Truck Plant, Ford Michigan Assembly Plant, Google, LLamasoft, Shinola, Sunset Greenhouse, UPS, and Zingerman's Mail Order facilities.





We analyzed operations around the world.

Tauber students spent Spring break on a **Tauber International Trek** to examine operations in Italy – specifically facilities in Bologna, Florence, and Milan. Students engaged in behind-the-scenes examinations of continuous improvement initiatives, new technological developments, and workforce best practices at the 4 Madonne dell'Emilia Dairy, Barilla, BorgWarner, Dolce & Gabbana, Ducati Motorcycles, Ferrari, Lamborghini, and Whirlpool. Students also explored operations at the Fashion Technology Accelerator, whose mission is to foster digital and technology innovation in fashion, luxury and retail industries.

To view a short video about the international trek: >



TAUBER INSTITUTE FOR GLOBAL OPERATIONS

We brought together thought leaders in industry and academia.

Thought leaders gathered at the Tauber Institute's 12th annual **Global Operations Conference** to discuss *Operations in a Digital Age*. Experts from leading industries shared insights on the topics of Digitization, Internet of Things, Sustainability, and Big Data. Featured speakers included LLamasoft Co-Founder and Chief Strategy Officer Toby Brzoznowski, Microsoft Corporate Vice President of Worldwide Operations Mary Ellen Smith, and McKinsey Partner in Detroit Russell Hensley. Sponsors included Amazon, BorgWarner GE, Microsoft, Nike, and PwC.

PwC and Strategy& sponsored the annual **Global Operations Case Competition** to challenge and reward students with an interest in forward-thinking operations solutions. Students on the six finalist teams presented their case solutions at the conference. Congratulations to our hometown "Team Aster" who received first place.

Faculty moderated robust panel discussions on *Digitizing Operations: From Manufacturing to Services, Unlocking the Power of IoT, Sustainability in the Digital Age,* and *Decision-Making in a Big Data World,* featuring leaders from AlixPartners, Amazon, American Industrial Partners, Boeing, Dell, Deloitte, Dow, General Electric, General Motors, Mainsheet OP, Microsoft, Motivate, Nits Solutions, and Steelcase.



Year in Review

We created new products and thrived in the marketplace.

For more than 25 years, the **Integrated Product Development** course has brought together students and faculty members from different disciplines for an innovative product design competition. It has been featured on CNN and written up in the New York Times, Wall Street Journal, and Businessweek.

The multidisciplinary course is managed by the Tauber Institute, and in 2018-19 was taught jointly by faculty members Eric Svaan of the Ross School of Business and Stephanie Tharp of the Stamps School of Art & Design.

This year, University of Michigan offered Integrated Product Development in both the Fall and Winter semesters, allowing 12 teams of students from the Stamps School of Art & Design, College of Engineering, School of Information, and Ross School of Business to work together to develop market research, new product concepts, technical solutions, production processes, pricing, inventory, and advertising. Each semester culminated in a trade show where student teams demonstrated their new products to potential consumers in a competitive marketplace.

Fall 2018 Product Challenge: One-handed convenience product. Students designed and produced a product or tool to be used one-handed to perform routine daily tasks that otherwise would require two hands.

Winter 2019 Product Challenge: Technology for pre-teens to improve physical and mental health maintenance and outcomes. Winter semester student teams also competed for the inaugural Murphy Prize, an annual award of \$5000 in scholarship funds established in memory of Michigan alumna



Sarah S. Murphy. A panel of industry experts selected the team whose business plan best met the assigned criteria, brought something new to the field, and had the greatest chance of commercialization. Congratulations to Team "Groovie" who impressed the judges with their exceptional product development outreach efforts! The team worked directly with preteens through classroom visits while creating a wearable goal setting device that uses avatars to motivate kids to reach their next milestone.

Check out the IPD team product videos here >



TAUBER INSTITUTE FOR GLOBAL OPERATIONS



SPOTLIGHT! 2019

Year in Review

We learned directly from experienced leaders.

The **Tauber Leadership Speaker Series** is a student-organized initiative to bring high-level executives to the University of Michigan to share insights with students about their careers, the qualities leaders need to succeed in today's global economy, and the tangible steps students can take to achieve excellence in their own career paths.

This year the series featured Eckhart Inc. President and CEO Andy Storm on Empowering Mind & Machine: How Industry 4.0 Will Reinvent Life as We Know It.





We translated operations theory to professional practice.

Published by the Tauber Institute, **Rate Lean: Fast** gives busy professionals the skills needed to accurately evaluate operations efficiency from observations made during a brief plant tour. It describes in detail how to plan a tour, rate an operation, and envision an ideal lean plant based on the concepts of the Toyota Production System.

Tauber Executive-in-Residence Emeritus R. Eugene Goodson first described his Rapid Plant Assessment process in 2002 for the Harvard Business Review. More than 1,000 plant tours and assessments later, Goodson applied the accumulated data to create Rate Lean: Fast, combining clear, direct instruction with numerous photographs, illustrations, and examples drawn from his extensive experience in industry, government, and academia.

Rate Lean: Fast is available for purchase through Amazon here >



We celebrated a quarter century of cultivating operations innovation.

The past year marked the **25th Anniversary of the Tauber Institute for Global Operations**. In commemoration of the anniversary, benefactor Joel Tauber donated \$1.75M to endow additional student scholarships, and the Tauber Alumni Network raised an additional \$25,000 to sustain and increase annual Tauber Alumni Scholarship awards. At a celebratory gathering of University of Michigan leaders, faculty, industry partners, alumni, and students, Tauber Institute leaders honored the contributions of eleven dedicated faculty advisors from the University of Michigan's Ross School of Business and College of Engineering who have provided expert guidance for over two hundred Tauber team projects.



We supported our students' passions.

The Tauber Institute awards **co-curricular funding grants** that allow institute students to pursue unique academic and professional development opportunities. This academic year, the institute helped Sarah Ting (MBA '20) to attend the OCO-3 Falcon 9 Launch, and Michael Barnes (MBA '19) to attend the AfroTech 2018 Conference in San Francisco, "a groundbreaking, revolutionary experience for Black techies, startups and entrepreneurs."



Read about Michael Barnes' experience here >



"AfroTech was equally informative as well as inspiring. It is my hope that I will be speaking and leading a workshop at AfroTech in the near future." – Michael Barnes

"I worked for NASA's Jet Propulsion Laboratory on the Orbiting Carbon Observatory 3 (OCO-3) mission.... I was lucky enough to be invited back to join the team to watch it find its new home on the International Space Station." – Sarah Ting

Read Sarah Ting's blog here >





We recognized and promoted operations excellence.

A panel of Tauber Institute business and engineering faculty selected the **50th annual TIME Dealer of the Year Award** finalists from each of the four National Automobile Dealer Association regions, and also the national award winner. In appreciation, TIME and Ally have established an annual scholarship at the Tauber Institute in the name of TIME, Ally, NADA, and the Dealer of the Year nominees.

The TIME Dealer of the Year Award is considered the most prestigious honor a new car dealer can receive, with fifty-one new car dealers - out of more than 16,000 dealers nationwide - nominated for the award. Tauber Institute faculty evaluated competitors on the business practices in their dealerships and on their contributions to their community.

Congratulations to the 2019 TIME Dealer of the Year, John Alfirevich of Apple Chevrolet in Tinley Park, IL.



Design thinking

We transform product development through design thinking.

The Integrated Product Development (IPD) course thoroughly incorporates **Design Thinking** principles and practice. "In each term, student teams develop products responsive to the design challenge we assign to them," said Svaan. "We require them to go through the steps of user observation and interviewing, brainstorming, prototyping, review and repeat throughout the term."

Each team must work through the process of market research, concept generation and selection, technical development, production process design, physical prototyping, digital making, product engineering, pricing, inventory stocking and advertising. Teams must design, build and compete with a real, fully functional, customer-ready product, while building a business model to support its realization and market entry.

Ever since the IPD course began, the students have used Design Thinking throughout this process to create viable products. Design Thinking is a discipline that uses the designer's sensibility and methods to match people's needs with what is technologically feasible and what a viable business strategy can convert into customer value and market opportunity.



It produces innovation powered by a thorough understanding, through direct observation, of what people want and need in their lives and what they like or dislike about the way particular products are made, packaged, marketed, sold and supported.

"Design Thinking invokes a process of collaborative creation involving users of a product, process or technology with the goal of reaching a deep understanding of their desires and needs, so as to design and realize new products that meet the needs and satisfy the desires," said Svaan.

Design Thinking is a human-centered, creative, iterative and practical approach to innovation. It aims to find the best ideas and ultimate solutions, incorporating an attitude of empathy, integrative thinking, optimism, experimentalism and collaboration. Three major steps are involved. The first is inspiration, examining the circumstances that motivate the search for solutions. It is followed by ideation, the process of generating, developing and testing ideas that may lead to solutions. The final step is implementation, the charting of a path to market.

In May, Svaan and Tharp's IPD course was one of five faculty projects honored with the 11th annual Provost's Teaching Innovation Prize for their innovative approach to improving student learning.

"Students report to us that IPD is a major plus factor in their job searches," said Svaan. "The Design Thinking (DT)/IPD skill set is in very high demand as firms grapple with the velocity of social, technical and economic changes. The DT approach is the one I'd pick to face and manage innovation pretty much anywhere in life."



Tauber alumni make a lasting impact

The Tauber Institute philosophy reverberates across industry though our dynamic community of alumni. Our alumni make a positive impact on the practice of operations worldwide, and they also give back to the next generation of Tauber students. Last year's 25/25 Alumni Campaign endowed – and doubled – the annual Tauber Alumni Scholarship award! Not only do our alumni provide financial support, but they routinely offer insightful advice and student mentorship, and become some of our strongest team project champions. Their invaluable contributions to the Tauber experience ensure that we continue to be the Leaders&Best in the field of Operations.



"There is no substitute for participating in real-world problem solving of this manner and magnitude in the function in which you plan to build a career." Makura Compton, MBA '19



"From autonomous cars to cleantech, there has never been a greater need to integrate innovative engineering with world class business principles to develop ideas that can change the world... I have had unrestricted access to not only thought leaders in both engineering and business but also exclusive opportunities through the Tauber Institute." Maaz Khalid, MBA '18 & MSE-IOE '18 Global Supply Program Manager, Google Inc.



"I think one of the best things about the Tauber Program is the crossdiscipline environment it brought. As an engineer, I loved having the opportunity to take classes in the business school alongside MBA students. I felt it was a nice complement to the technical engineering education I was receiving. I always knew that I didn't want to be a subject matter expert in a very specific engineering field, so getting that broader education through the Tauber Program aligned perfectly with what I wanted to do when I entered the work force. The Tauber project was a great opportunity to get that cross-disciplined perspective in an operations environment. I loved getting paired with an MBA student and another engineering student to go and solve a high level problem for an Aerospace and Defense company." Meghan Lujan, EGL BSE-AERO/MSE-IOE '12 Program Management, Lockheed Martin



"My Tauber project helped me learn to deal with ambiguity and navigating a large, complex organization... I've relied on the experience many times since to help me scope and execute difficult projects." Steven LaForest, EGL BSE-ME/MSE-IOE '08 Plant Director, Reyes Coca-Cola Bottling



"Even in an industry where there's a reputation of solitary 'hacking all night,' I've only ever worked across teams not far from the sizes we utilized in grad school. Solo 'hero work' is, in my experience, the very rare exception."

Brian Forster, BSE-ME '98, MSE-IOE '04 & MBA '04 Technical Program Manager, Amazon

Over a quarter century of action learning and operations innovation

Sporting an ear-to-ear grin, Tauber Institute benefactor Joel Tauber deplaned at Boeing Field under a cloudless sky this summer, eager to meet with Seattle area alumni from the institute that bears his name. Joel loves connecting with "the fresh face of manufacturing" he sees in the community created by the Tauber Institute, over 1400 alumni making a positive impact in operations all around the globe.

Joel Tauber grew up in Detroit, MI and received his B.A., M.B.A. and J.D. from the University of Michigan. He was then invited to take over a manufacturing business, where realization set in: "I had to develop my own training program, because what I learned at business school didn't prepare me to understand the whole organization. I worked with people in various parts of the organization - on the business side and on the manufacturing side - and I came to realize that a comprehensive approach was a crucial and much more effective way of preparing for this kind of business."



Joel's insights led to the creation of the Michigan Joint Manufacturing Initiative (MJMI) in 1993 to address the acute

shortage of broadly trained professionals who understand both the engineering and business aspects of manufacturing. In this innovative program, comprehensive academic preparation was paired



with real world experience as small teams of business and engineering students worked together to solve substantive operations challenges at sponsoring firms. Joel believed in the model so much that he made a \$5 million pledge to ensure the efforts were sustainable, and the university renamed the program in his honor.

In commemoration of the Tauber Institute's 25th anniversary, Joel renewed his financial commitment with a pledge of \$1.75 million for business and engineering student scholarships, and continues to be one of the institute's greatest champions. "I wanted to build up our scholarships so that anyone needing money would have the opportunity to join the program," Tauber said. "This gift reflects both my high regard for the University of Michigan, and the great success of the program."

Six of this summer's twenty-one Tauber team projects were based in the Seattle area, reflecting the simultaneous growth of multiple industries in the region. While top global companies such as Boeing have sponsored Tauber Institute projects for two decades or more, the institute strives to provide an array of opportunities based on student interests and objectives,

and is continually forming new industry partnerships.

Joel is excited about how today's students will shape the future of operations throughout industry. "Fifty years from now, we're not going to recognize what is happening in terms of digital technology, robotics, data analytics, and even innovations such as the autonomous vehicle," he says. "People who can think through how that is being done, in advance, will be the winners. Our scholars are extremely well prepared to face the issues of today. But more importantly, we encourage them to think about the issues of tomorrow."





Opening sessions of the Tauber Institute's annual Global Operations Conference are held in the Shelly and Joel Tauber Colloquium at the Ross School of Business. The student-run conference brings together leaders in industry and academia to envision the future of operations.

Tauber Industry Advisory Board

The Industry Advisory Board (IAB) ensures the Tauber Institute stays at the forefront of multidisciplinary operations and responds quickly to industry needs. Offering guidance and support consistent with the program's mission and objectives, the IAB actively assists the institute in achieving its academic and research goals through industry leadership, cooperation, feedback, and acquisition of financial support. The following industry leaders serve on the IAB:

3M Company, Doug Lane, Global Director

A.T. Kearney Inc., Doug Mehl, Partner

Amazon, Gary Gou, Vice President of North America Fulfillment Operations

American Industrial Partners, Danny Davis, Partner

American Securities, David Horing, Managing Director

Arconic, Randall Scheps, Vice President & General Manager, Alcoa Wheel Products - Americas

The Boeing Company, Ed Petkus, Vice President, Engineering for Airplane Development / IAB President

BorgWarner Inc., Scott Gallett, Vice President Marketing, Public Relations, Government Affairs, Internal Communications / IAB Vice President

Cardinal Health, Meredith Rarey, Vice President, Global Sourcing Medical Segment

Chagrin Consulting Associates, Roger Kallock, Chairman & CEO

ConAgra Brands, Inc., Craig Weiss, Vice President of Supply Chain Planning, Programs & Logistics

CPP Global, Brian Tauber, CEO

Dell Inc., Piyush Bhargava, Executive Director, Worldwide Procurement Enterprise & Packaging

The Dow Chemical Company, Jeff Tazelaar, Digital Fulfilment Center Director

DTE Energy, Sharon Pfeuffer, Director of Electric Strategies and Development

Ford Motor Company, Ron Johnson, Director, Americas Quality

General Motors Company, Daniel Grieshaber, Director, Global Manufacturing Engineering Integration

HERE Technologies, C. Kevin Harrington, Vice President, Global Customer Operations

Infosys Limited, Nitesh Bansal, Senior Vice President & Industry Head, Manufacturing

Mayo Clinic, Joe Dudas, Vice Chair, Supply Chain Management

McKinsey & Company, Russell Hensley, Partner

Microsoft Corporation, Andy Miller, Finance Director

National Center for Manufacturing Sciences, Lisa Strama, President & CEO

Pfizer Inc., Robert Noack, Senior Director, Worldwide Research & Development

Steelcase, Tom Dawson, Chief of Staff for Global Operations

Target Corporation, Preston Mosier, Senior Vice President, Global Supply Chain & Logistics Field Operations

Tauber Enterprises, Joel Tauber, President

Tesla, Sanjay Shah, Senior Vice President of Energy Operations

Whirlpool Corporation, Mae Zyjewski, Sr. Director, Global Advanced Manufacturing, GPO/IAB Vice President



Doug Lane 3M Company



Randall Scheps Arconic



Craig Weiss ConAgra Brands, Inc.



Ron Johnson Ford Motor Company



Russell Hensley McKinsey & Company



Preston Mosier Target Corporation



Doug Mehl A.T. Kearney Inc.



Ed Petkus The Boeing Company



Brian Tauber CPP Global



General Motors Company



Andy Miller Microsoft Corporation



Joel Tauber Tauber Enterprises



Gary Gou Amazon.com, Inc.



Scott Gallett BorgWarner Inc.





C. Kevin Harrington HERE Technologies



Lisa Strama National Center for Manufacturing Sciences



Sanjay Shah Tesla, Inc.



Danny Davis American Industrial Partners



Meredith Rarey Cardinal Health, Inc.



Jeff Tazelaar The Dow Chemical Company



Nitesh Bansal Infosys Limited



Robert Noack Pfizer Inc.



Mae Zyjewski Whirlpool Corporation



David Horing American Securities



Roger Kallock Chagrin Consulting Associates



Sharon Pfeuffer DTE Energy



Joe Dudas The Mayo Clinic



Tom Dawson Steelcase















Education in Action

Tauber team projects provide students with opportunities to tackle highly visible operations-related challenges at top companies. Over the summer, 49 business and engineering students worked on 21 team projects sponsored by 16 global firms.

Tauber's 2019 team project sponsors are leaders in a wide range of industries, including aerospace, internet commerce, high tech, automotive, energy, and retail. The institute is pleased to strengthen relationships with numerous returning sponsors - AIP Canam Group, Amazon, Boeing, Dell, Dow, DTE Energy, Ford, General Electric, General Motors, Microsoft, PepsiCo, Pfizer, Stanley Black & Decker, Stoneridge, and Target - and excited to begin a new partnership with Brose. With 62 locations in 23 countries, Brose develops and produces a wide range of mechatronic systems for the global automotive marketplace. Every other new vehicle worldwide is equipped with at least one Brose product.

Tauber students addressed substantive issues such as lean process design and implementation, manufacturing site strategic assessment, supply chain implementation, strategic capacity analysis, material handing redesign, new product development strategy, product complexity analysis, manufacturing process design, and machine learning and advanced analytics.

A successful project results in a significant return on a sponsoring company's investment. In 2019, the student teams worked on 21 projects, from 18 companies, and averaged \$30 million/per project savings over three years. The projected savings total \$390.3

30

MICHIGAN ROSS // MICHIGAN ENGINEERING



Operations challenges in a dynamic world

Welcome to *Spotlight!* 2019. Now, more than ever, companies are finding it difficult to keep pace with the rapid changes in the world, and are reaching out to find talented individuals to help navigate these substantive issues. Our Tauber students are up to these challenges, designing solutions to meet and solve these issues. Today, you will have the opportunity to view the amazing work our students and business



sponsors have accomplished during their Tauber Student Team projects. Congratulations to all our students, sponsors, faculty and staff on their great work!

Spotlight! 2019 encompasses 21 projects, 16 different business sponsors, 49 students, and 41 faculty members from the Ross School of Business and the College of Engineering, all working together on real world problems. These numbers represent a diverse set of industries as well, ranging from automotive to energy, consumer products to aerospace, and pharmaceuticals to retail. Tauber students traveled the world to design and implement global solutions from Seattle, Washington to Sandwich in Kent UK and Minneapolis, Minnesota to Austin, Texas.

Team project challenges included energy conservation and green energy deployment, incubating and scaling sustainable technologies, assessing the impact of deploying electronic and automated vehicles, and using artificial intelligence in factory operations. The application of big data and analytics, lean and agile methodologies, and change management protocols were a few of the tools used to define and shape the projects you will see today in their presentations.

On behalf of the Tauber Institute, thank you for participating today! All the best to our participants and welcome to all of our guests!

Man

Ray Muscat Industry Director Tauber Institute for Global Operations

CLASS PROFILE 2018 Students in eight different

Tauber Institute

degree programs participate in the Tauber Institute. Through the Tauber Institute, all students complete a rigorous joint business and engineering curriculum and participate in a Tauber Team Project.

99%

Student placement over the last three years.

58%

Accepted positions working for Team Project sponsors and/or Tauber Institute for Global Operations corporate sponsors.

50 Students 49% MBA / 51% Engineering

Graduated between August 2018 and May 2019

Cultivating thought leadership

DEGREE PROGRAMS ASSOCIATED WITH TAUBER

Tauber Institute students are admitted through either the College of Engineering or the Stephen M. Ross School of Business. They bring with them significant experience in fields such as product engineering, manufacturing, andconsulting. Most Tauber students also have undergraduate training in engineering or other technical fields. They have made a substantial commitment to careers in operations or manufacturing and pursue an education specifically designed to meet the needs of today's firms.

All Tauber students are enrolled in one of the following degree programs:

MICHIGAN ROSS

Master of Business Administration (MBA) This two-year program prepares students to accept general management leadership positions. The Tauber program includes a sequence of operations management, supply chain, and manufacturing-related engineering courses.

MICHIGAN ENGINEERING

Engineering Global Leadership Honors (EGL) This five-year honors program prepares students to enter a variety of firms as engineers, while giving them the necessary management skills to quickly assume business leadership rolesquickly. A highly valued element of this program is a cultural concentration in a global region of choice. The EGL program leads to both a BSE and a MSE.

Engineering Graduate Programs (EGP)

A graduate-level engineering degree program that, coupled with the Tauber requirements, provides intensive coursework in operations and manufacturing technologies paired with business electives courses. EGP students are pursuing MEng, MSE, PhD,or Doctor of Engineering degrees.

RECRUITING STUDENTS

The *Spotlight!* Competition is one way to introduce yourselfand your organization to our group of supremely qualifiedcandidates. Some opportunities are listed below:

- Individual interview with the student(s) of your choice.
- Permission to post job openings on the Institute's website, accessible by current students as well as our growing groupof 1,400+ alumni.
- A connection to the career centers at the Business Schooland College of Engineering and their employment events.
- Access to Tauber's Student Advisory Board, which can assistyou in developing networking opportunities such asfootball tailgates, receptions, and speaking engagements.

THE TAUBER ADVANTAGE

Team projects are just one way that Tauber students distinguish themselves from other business and engineering graduates. Tauber programs and courses also enhance their employability:

- The LeadershipAdvantageSM program of learning modules and workshops emphasizes leading and influencing an organization through collaboration, creativity, communication, and analytics.
- The Integrated Product Development course is an experiential, cross-disciplinary course that puts teams of students from Business, Engineering, Art & Design and Information in an economic competition and competitive product development environment.
- Facility tours deliver insight into operations and lean manufacturing. Students learn to perform a rapid audit of the state of an operation, judge the relative leanness of an operation, prioritize the targets of opportunity for improvements, and develop an action plan to facilitate improvements.
- The Global Operations Conference affords students the opportunity to join with leaders in industry and academia in strategizing ways to advance the practice of operations worldwide.
- The Leadership Forum allows Tauber students to learn about ethical leadership directly from current leaders in operations from top global firms.

- The Tauber Leadership Speaker Series invites high-level executives to share insights with students about their careers, the qualities needed in today's global economy for strong leadership, and tangible steps students can take to achieve excellence in their own career paths.
- Tauber students are encouraged to give back. Each year, on Community Service Day, they apply what they've learned to address operations challenges at southeast Michigan nonprofits.

Many Tauber students assume **leadership** roles in organizing the Global Operations Conference, Leadership Forum, and Tauber Leadership Speaker Series, gaining valuable experience in the complexities of event planning, and developing rapport with the seasoned executives they bring to campus. Student groups plan Tauber's Community Service Day and organize networking events, and Student Advisory Board members work closely with Tauber leadership to strive for continuous improvement in our own operations. SPOTLIGHT! 2019

TAUBER STUDENTS

AMERICAN INDUSTRIAL PARTNERS



AMAZON.COM

Jack Claucherty EGL BSE/ MSE-IOE



Almira Dogruyol EGL BSE/ MSE-IOE



Elena Stefanko EGL BSE-EE/ MSE-IOE



Fernanda Barros

Robbie Greenberg MSE-IOE

BOEING – DELIVERY



Nathan Block EGL BSE/ MSE-IOE



Michael May EGL BSE-AERO/ MSE-IOE



Alexander Mize MSE-IOE

BOEING – FABRICATION



Caleb Goldstein EGL BSE-AERO/ MSE-IOE



Jerry Maniscalco, Jr. *MBA*



Sarah Ting *MBA*

BOEING – GLOBAL



BROSE



Thomas Barlow MSE-ME



Nirav Suraiya *MBA*

Kayla Malehorn



Juan Alfaro MBA



Charles Moore EGL BSE-MS/ MSE-IOE



DELL



Dwight Brisbin EGL BSE/ MSE-CS



Sean Siry MSE-IOE



Ryan Manes *MBA*

DTE ENERGY





Graham McCarthy EGL BSE-AERO/ MSE-IOE

FORD MOTOR COMPANY



Charlie Manzoni *MBA*



Hiroki Tanaka *MBA*

GENERAL ELECTRIC COMPANY



Federico Kulyckyj EGL BSE/ MSE-CS





Jacob Siddall *MBA*

GENERAL MOTORS COMPANY



Benjamin Grogan *MBA*



Amine Moussaoui *MBA*

MICROSOFT BUSINESS



Robert Pakko EGL BSE-CS/ MSE-IOE



MICROSOFT PARTNER



Shabir Grover MM/MSE-ME



Jayden



Thao Nguyen *MBA*

MICROSOFT VEHICLE



Abby Lo MBA



Dahao Zhang MSE-IOE

PEPSICO BEVERAGES NORTH AMERICA



Cecelia Beux MBA



Christian Wire EGL BSE-CH/ MSE-IOE

PFIZER, INC. – CLINICAL



Andres Fuentes-Afflick *MBA*



Jason Ji EGL BSE-CH/ MSE-IOE

PFIZER, INC. – MATERIAL





Petra Romano-Lieber EGL BSE/ MSE-IOE

STANLEY BLACK & DECKER





Karan Shah *MSE-MEng*



STONERIDGE, INC.

Stephanie Hoglund EGL BSE/ MSE-IOE



Laura Malecky *MBA*

TARGET CORPORATION



Mercedes Alvarez MBA



David Ginsberg *MBA*



Rhea Kumar *MBA*

AMERICAN INDUSTRIAL PARTNERS - CANAM GROUP

Joist Trek: The Next Generation

STUDENT TEAM:

Jack Claucherty – EGL (BSE & MSE Industrial and Operations Engineering) Almira Dogruyol – EGL (BSE & MSE Industrial and Operations Engineering) Elena Stefanko – EGL (BSE Electrical Engineering & MSE Industrial and Operations Engineering)

PROJECT SPONSORS:

FACULTY ADVISORS:

Danny Davis – Partner, American Industrial Partners Gregory Matson – Director of Planning, Canam Joel Stanwood – Partner, American Industrial Partners W. Monroe Keyserling – College of Engineering Eric Svaan – Ross School of Business

American Industrial Partners - Canam Group (Canam) was acquired by the private equity firm American Industrial Partners in 2017. Canam is the largest fabricator of steel components in North America, specialized in designing construction solutions and fabricating customized products. The 2019 Tauber project focused on Canam's Construction Industries business segment and the facilities and processes for fabrication of steel joists for the construction of commercial buildings. The Tauber team's home base was Canam's Point of Rocks MD facility, the company's most efficient plant for the production of mid-span steel joists. The team's mission: to envision the future state for mid-span joist manufacturing, by evolving current processes to include automating various production steps. Senior management identified labor efficiency, safety and capacity improvement as the critical metrics for this future state.

After a deep dive into Canam's current state of plant configuration and existing processes in those plants, the team built a framework to evaluate costs, benefits and risks for future design alternatives, as follows.

- Investment: time-phased capital and operational costs
- Benefit Analysis: cost savings, safety, improvements in workplace quality of life, and other less tangible benefits
- **Risk Assessment**: qualitative analysis in 6 dimensions: customer, supplier, technology, product performance, safety, and market

Based on analysis using this framework and in-depth discussions with the R&D team and key stakeholders, the team proposed a course of action to realize Canam's ideal future state, resulting in the following improvements.

- Labor Efficiency: reduce the required labor to manufacture a joist by 54%
- **Safety**: eliminate the root cause of 33% of current safety incidents
- **Capacity**: increase mid-span steel joist production to 20,000 tons/year per line, up from existing levels which range from 4,000-14,000 tons/year

To support these recommendations and enable further design and future implementation work, the team developed and transferred to Canam team members several proof-of-concept models to compare the current state to future state options. These models include a cost per crane touch analysis to quantify the risks and costs associated with using cranes to move material, a flow simulation for identifying bottlenecks and quantifying WIP, and a master analysis spreadsheet with what-if capabilities to accommodate future technology changes.

In the Point of Rocks plant, projected yearly operating cost will be reduced by \$1.4M, resulting in an estimated payback period of around 4 years. These improvements will scale up when implemented across all 7 plants, netting the company upwards of \$10M in annual operating cost savings.

AMAZON.COM, INC.

Amazon Delivery Electrification

STUDENT TEAM:

Fernanda Barros – Master of Business Administration Robbie Greenberg – EGL (BSE & MSE Industrial and Operations Engineering)

PROJECT SPONSORS:

FACULTY ADVISORS:

David Kaufman – College of Engineering Brian Wu – Ross School of Business

Sam Eldersveld – Director of Inventory Planning and Research Maria Lee – Product Manager, Global Fleet and Products Ross Rachey – Director of Global Fleet and Products

In February 2019, with the announcement of Shipment Zero, **Amazon** committed to the ambitious goal of delivering 50% of its shipments with net zero carbon by 2030. Electric Vehicles (EVs) have zero tailpipe emissions, and offer operating savings of up to 65% in per mile energy costs and 47% in maintenance costs. Last Mile delivery electrification is the cleanest and most practical solution that will enable Amazon to reach this goal. Therefore, as soon as electric delivery vans are available at scale in North America, Amazon must be operationally prepared to deploy an electric fleet at scale.

EVs are a new technology in the last mile delivery world and come with range limitations, overnight charging requirements, and slightly different operating procedures. Further complicating things, EV range limitations vary given outside temperature, route topography, traffic profile, and driver behavior. Customer obsession is Amazon's number one priority, and thus the company will not deploy any technology that may hinder customer delivery experience. The 2019 Tauber team was tasked with determining holistic requirements to successfully deploy, route, and operate an EV fleet.

The Tauber team provided three main deliverables that allow Amazon to expand EV testing and deployment in 2019, while simultaneously providing a scalable product for routing a larger EV fleet. First, the team wrote Standard Operating Procedures for delivery providers and drivers to ensure EV delivery success under all foreseeable scenarios. Second, the team created a simulation model that predicts EV delivery success in North America, and implemented the process to limit EV routing to solely in-range zip codes. Third, the team provided other immediate next steps to ensure the successful integration of EV delivery vehicles in Amazon's last mile fleet, including recommendations on future deployment locations that will enhance both deliverables by increasing the size and variability of the EV operational data set.

With the 2019 Tauber Team's deliverables, Amazon will be able to immediately convert a significant share of their Internal Combustion Engine (ICE) routes to EV routes as soon as vehicles are available at scale, with 99.4% confidence in delivery success. If scalable EV delivery vans existed in North America today, the projected total cumulative tailpipe emissions reductions from this deployment model would be 3.9 million metric tons of CO₂ over the next three years. The Tauber team also identified the ideal EV battery size and efficiency profile required for electrifying a majority of Amazon's last mile routes, in support of near and long-term vehicle deployment planning.

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THE BOEING COMPANY – DELIVERY

Standardizing Decorative Paint Operations at the Everett Delivery Center

STUDENT TEAM:

Nathan Block – EGL (BSE Electrical Engineering/MSE Electrical and Computer Engineering) Michael May – EGL (BSE Aerospace Engineering/MSE Industrial and Operations Engineering) Alexander Mize – BSE & MSE Industrial and Operations Engineering

PROJECT SPONSORS:

Stephanie Wang – Operations Manager Craig Wood – Superintendent, Decorative Paint Operations

FACULTY ADVISORS:

Richard Hughes – College of Engineering Brian Talbot – Ross School of Business

The Boeing Company, a \$117B multinational corporation, is the world's largest aerospace company and leading manufacturer of commercial jetliners and defense, space, and security systems. Boeing's Commercial Airplane (BCA) unit is responsible for the design and development of airliner, transport, and refueling aircraft, and, within BCA, the Everett Delivery Center (EDC) is responsible for painting and delivering wide-body aircraft (747, 767, 777, and 787) orders.

The painting process is an opportunity to improve the flow of Boeing's widebody production and delivery schedule. To increase operational efficiency, the EDC's Decorative Paint Operations Department has started to shift towards standardizing the paint process. The Tauber team was specifically tasked to standardize the most variable decorative livery application within the paint process, where different techniques can result in drastically varied process times and quality.

To standardize the decorative livery process, the Tauber team followed a bottom-up approach, learning about the painting process through hangar observations, interviews, data analysis, and Boeing's painter skill improvement class. As a result of these experiences, the team delivered tools to standardize the decorative paint processes around best practices, which were also tailored to the stakeholders that would use them. Using Boeing-wide standardization documents, Standardized Worksheets (SWS) and Step Details, the Tauber team developed the first baseline sequence of steps needed to paint the 787 Turkish Airlines decorative livery. Further, the team created a user-friendly, automated SWS generation tool that reduces document development time by 75% and ensures consistent nomenclature across different users. Finally, the team conducted the first statistical analysis on different practices used to paint the 767 FedEx decorative livery, to help identify best practices for faster, higher quality results.

As a result of their position between management and front-line staff, the Tauber team was able to observe and report on the effectiveness of incentive programs, organizational transparency, and communication streams at the EDC. The team also provided recommendations to management on improving the EDC Decorative Paint Operations' data collection methods. This recommendation will lead to additional analysis to continue the process improvement by identifying and standardizing around best practices. The Tauber team's work on standardization, data collection and analysis, and communication between management and painters will allow the EDC Decorative Paint Operations to standardize paint operations across best practices and, consequently, increase capacity and operational cost savings.

THE BOEING COMPANY – METALS FABRICATION

4-Step Process to Influence Make/Buy Decisions

STUDENT TEAM:

Caleb Goldstein – EGL (BSE Aerospace Engineering/MSE Industrial and Operations Engineering) Jerry Maniscalco – Master of Business Administration Sarah Ting – Master of Business Administration & Master of Science in Aerospace Engineering

PROJECT SPONSORS:

FACULTY ADVISORS:

Ed Carr – Senior Manager Metals Center of Excellence Steve Neil – Fabrication 2025 Leader Stewart Thornhill – Ross School of Business Peter Washabaugh – College of Engineering

The Boeing Company, a \$101B multinational corporation, is the world's largest aerospace company. In support of Boeing's Fabrication 2025 effort, Boeing Defense, Space, & Security (BDS) along with Boeing Commercial Aviation (BCA) and Boeing Global Services (BGS) is seeking to bring Enterprise capabilities to Global Industrial Champion level performance by fully utilizing space and equipment. The Boeing Metals Fabrication Tauber team was tasked with developing data-driven improvement strategies and tactical opportunities to help BDS and the Enterprise Metals Capability set the stage for increasing value.

The team developed a four-step process that identifies opportunity for driving value across: optimal cost, supplier performance, internal capability and capacity, and strategic value. The first step utilizes a machine learning algorithm to identify opportunities between current price and optimal market cost. Second, supplier performance ratings filter based on historical part quality and delivery performance. Next, the process assesses available capacity and capabilities by each manufacturing site. Finally, a strategic value assessment accounts for internal fabrication cost, part complexity, and strategic goal alignment.

To validate the four-step process, the team performed a pilot program across multiple sites and platforms. The team identified a \$4.2M total opportunity for savings annually in the supply base by analyzing 279 metallic parts from the F/A-18 Super Hornet, P-8 Poseidon, and AH-64 Apache programs. Of these parts, 5 were selected as insourcing candidates, delivering 72% savings.

Additionally, the team quantified the impact of process implementation to BDS Metal Fabrication's transformation to Global Industrial Champion to encompass a total impact of \$49.7M.

Finally, the team created an implementation strategy that aligns with both current and future enterprisewide requirements, with three key recommendations to address current limitations. The four-step process was handed off to the BDS Design-Make-Buy focal and will be used to efficiently and effectively identify future value capture enterprise wide.

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THE BOEING COMPANY – GLOBAL SERVICES

Scaling Vertical Integration Across the Boeing Enterprise

STUDENT TEAM:

Jason Comstock – EGL (BSE & MSE Industrial and Operations Engineering) Kayla Malehorn – EGL (BSE Mechanical Engineering/MEng Systems Engineering and Design) Ryan Manes – Master of Business Administration

PROJECT SPONSORS:

FACULTY ADVISORS:

David Hahs – Insourcing Business Processes & Tools Manager Joel Raup – Insourcing Business Leader

Amy Cohn – College of Engineering Vijay Pandiarajan – Ross School of Business

The Boeing Company is the world's largest aerospace company and leading manufacturer of commercial jetliners; defense, space and security systems; and service provider of aftermarket support. Boeing Global Services (BGS) was established as a new business unit in 2017 to grow the company's presence in the aftermarket services space and is the fastest-growing segment of the company today. As part of its effort to considerably grow this business, Boeing is working to strategically increase vertical integration across the enterprise to, as the company has stated, "strengthen in-house capabilities and depth in key areas to offer better products that deliver greater value to our customers, grow our services business, and generate greater life cycle value."

In many cases, the company co-develops engineering designs for airplane parts and has allowed some suppliers to retain the intellectual property (IP) for those parts, in a strategic effort to focus on the aircraft's systems integration. Under this traditional model, suppliers could become sole-source providers of certain parts, which would give them pricing power for production and control over the aftermarket, all of which could increase customers' costs. With this in mind, Boeing is returning its focus to vertically integrate key design and manufacturing capabilities that are essential to the production and support of its airplanes in order to better control the value and quality being provided to customers.

To address this new business model for Boeing, the Tauber team has laid down a foundation for how the business could operate moving forward. The team has defined best practices, developed business cases, and provided recommendations for total lifecycle management across the enterprise in the commercial aircraft industry. The team evaluated and created additional criteria for identifying which parts to develop new IP for and created a business case for integrating parts into production as well – while ensuring compliance with all IP ownership and contracts. By integrating data from 14 different data sources, the team was able to scale the project evaluation scope by 500% and develop a multi-year roadmap for the business unit. As a result of the team's work, the BGS team is piloting its first-ever joint effort with the Boeing Commercial Airplanes (BCA) production team, which could produce millions in value each year.

BROSE

Creating A Cost Model for Capital Equipment

STUDENT TEAM:

Thomas Barlow – Master of Science Mechanical Engineering Nirav Suraiya – Master of Business Administration

PROJECT SPONSORS:

FACULTY ADVISORS:

Markus Gehrig – Manager of Production Equipment Purchasing Joseph LaRussa – Director of Industrial Engineering, Seats Division John Branch – Ross School of Business Robert Inman – College of Engineering

Brose is a family-owned and self-financed automotive supplier of mechatronics systems. The company consists of three primary divisions: Seats, Doors, and Drives, each with multiple mechanical and electronic products that service the world's largest car brands. Strong company growth has caused the Seats Division at Brose North America to feel increasing pressure to better manage its cash flow planning for capital investments in manufacturing.

The goal of this project was to create a predictive model for investment in production equipment to codify the relationship between product & process characteristics with equipment, improving upon the current heuristic-based cost estimation performed by only a few experienced employees.

The Tauber team first created a process map of activities from customer request to capital purchase. This map surfaced four primary touchpoints where cost estimation occurs, along with four main characteristics of the problem: accuracy, granularity, skill level, and data availability. To address these issues, the team built two solutions: a cost estimation tool and a new quotation template.

The cost estimation tool applied three unique models: Machine Learning, Statistical, and Similar Projects. The Machine Learning model was a Gradient Boosted Regression that iteratively built decision trees to correlate selected variables or "cost drivers" with investment cost in a given dataset. The Statistical model categorized each type of machine and assigned either an average cost for that type or a linear relationship with a cost driver. The Similar Projects model utilized a k-Nearest Neighbor Regression and a Differential Evolution algorithm to calculate a "distance" between two projects given importance weights for each cost driver. The tool used Microsoft Excel to display the user interface, Microsoft Access to store data, and Python to run the analysis.

The new quotation template replaced a long-standing norm during the purchasing process of requesting suppliers to quote a project as a single sum of design, labor, and overhead costs with an updated version that requests a specific breakdown of those costs per machine within the project. The team created a template builder to allow buyers to easily tailor the template to each project and seamlessly integrate it with the existing supplier portal system.

These two solutions, along with a detailed Product Roadmap, provided the company with a working prototype and recommended processes to improve their cost estimation accuracy, increase their information granularity, lower the barrier of skill level required to estimate cost, and ensure that past project data is readily available. These improvements will save the company 80-100 engineering & management hours and \$1.5M - \$3M in cost avoidance per project through faster quote turnaround time, fewer budgetary disputes, and better target costing for equipment.

DELL

Pollution Ink and Sustainability Improvement

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Dell, a \$90 billion company, is one of the largest technology companies in the world. Dell provides the essential infrastructure for organizations to build their digital future, transform IT and protect their information. A key part of Dell's brand strategy revolves around its sustainability initiatives. From ocean plastic to closed loop gold, Dell has built a portfolio of innovations to help address the challenges involved with moving towards a sustainable future.

An engaging and relatively new initiative, Pollution Ink, utilizes harmful PM2.5 black carbon harvested from fossil fuel emissions as pigment for ink. With growth halted at 400,000 boxes annually in India, the Tauber team was brought in to develop strategies to scale Pollution Ink. However, because scaling has proved to be a challenge on more than one sustainability project, the team was also asked to provide recommendations for improving scalability as a whole.

To develop an understanding of the issues and goals, the team conducted a knowledge download through a series of interviews throughout the company. Consolidating the findings with industry best practices and relevant literature, the team produced a framework to manage sustainability initiatives across the company. Running Pollution Ink through this framework, the team identified several key issues with the current supplier and identified an appropriate alternative. In partnership with this new supplier, the team conducted two pilots in Taipei and developed a roadmap to drastically increase scale and impact.

Through the scheduled implementation of the recommended framework, Dell will have the tools necessary to meet their ambitious 2030 corporate responsibility goals and provide solutions tailored to an increasingly sustainability centric customer base. To complement and test this framework, the team also outlined a plan to print over 40 million boxes using Pollution Ink by 2021, saving 17,000 Kg of PM2.5 from entering the ecosystem and preventing the emission of 45 tons of CO₂ annually.

DOW, INC.

Autonomous Vehicles in the Motor Carrier Industry

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Dow, Inc. is the third largest chemical manufacturing company in the world. In 2018, Dow generated \$49.7 billion in net sales across Industrial Intermediates & Infrastructure, Performance Materials & Coatings, and Packaging & Specialty Plastics. Dow spends over \$500 million on road logistics annually. The company is interested in adopting leading-edge technology and approaches to improve its supply chain. To support this effort, the Tauber team was tasked with analyzing the state of the autonomous motor carrier industry and developing an entrance strategy to adopt autonomous trucks in Dow's supply chain. Dow is interested in using this new technology to improve the safety, cost, environmental impacts, and customer experience attributes of its supply chain. Furthermore, challenges facing the trucking industry, such as the driver shortage, result in increased costs and reduced quality of service for Dow and its customers. The Tauber team demonstrates the ability of autonomous trucking technology to combat trucking industry challenges and improve supply chain attributes.

The Tauber team conducted interviews with internal stakeholders, researchers, and industry experts to gather information about Dow's supply chain, the trucking industry, and autonomous trucking technology. Based on these conversations, the Tauber team analyzed specific freight routes which were identified as potential applications for autonomy. These included movements on public roads as well as movements completely or partially on Dow sites. Next, the team engaged external experts and companies, including companies involved in the development of autonomous trucking software, to further understand the effects of the technology and to identify the potential for trials using autonomous trucks for Dow's freight.

To show the effect autonomous trucking technology will have for Dow, the team broke Dow's truck freight into long-haul and short-haul. Using this breakdown, the team partitioned Dow's truck freight into long-haul and short- haul. Using this breakdown, the team modelled the reduction in the operating cost between 2024 and 2045 that could be realized if Dow switched to on-highway automation and subsequently fully autonomous trucking. To motivate recommendations for near-term adoption of autonomy, the team performed a comparative analysis of the companies that Dow could implement autonomy with.

Based on Dow's non-hazardous freight over the past year, the team's analysis indicates that long-haul driverless- on-highway automation could result in annual savings for Dow and its shipping partners of more than \$4.4 million for just standard trailers and \$6.8 million for all trailer types including tanker trucks. For completely automated trucking applied to all inter-site movements, annual operating costs for Dow's freight could potentially be reduced by more than \$29.8 million. Associated with these savings would be reductions of Dow's annual transportation carbon footprint by approximately 4.6 million lbs of CO₂ for long-haul standard trailers, 7.3 million lbs for all trailer types, and 11.9 million lbs for full driverless trucking. In the on-site case, each scenario requires a custom solution, however the savings in a specific solution the Tauber team analyzed would result in \$1.25 million in annual savings shared with Dow's logistics providers.

These benefits, along with issues facing the trucking industry, demonstrate that autonomy is an integral part of remaining competitive in logistics. Consequently, the Tauber team recommends that Dow begin partnering with companies exploring autonomy in the very near future to best capitalize on the autonomous revolution.

DTE ENERGY

Developing A Framework for Non-Wires Alternatives Benefit-Cost Analysis

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DTE Energy (DTE) is a diversified energy company that provides electricity and natural gas utility services in Michigan and a wide range of other energy-related services throughout the United States. The corporate strategy group works to address a variety of complex issues facing the energy industry. Working with corporate strategy, the Tauber team built a benefit-cost analysis framework and model to analyze the impacts of non-wires alternatives (NWAs), an increasingly salient topic within the electric utility industry.

NWAs are technologies that delay or eliminate the need for traditional distribution or transmission investments by reducing the peak load on existing infrastructure. NWAs either reduce energy demand or provide local energy generation during times when peak load would otherwise exceed existing equipment capacity ratings. Currently, different NWAs are being piloted by DTE to determine their feasibility as a cost-effective alternative to traditional substation capacity investments. DTE's objective for this project was to create a standard method of quantifying the relevant benefits and costs of implementing NWAs beyond the deferral of capital expenditures to better evaluate potential NWA opportunities.

To create a model capable of quantifying the benefits and costs of all the NWA technologies relevant to DTE, the Tauber team benchmarked existing benefit-cost frameworks as well as NWA cost and capabilities characteristics. Further interviews with DTE subject matter experts enabled the creation of a benefit-cost analysis model specific to DTE's technology implementations. The model was used to analyze two existing substations being considered as potential NWA pilot sites. After conducting sensitivity analyses related to future NWA cost decreases and the cost of traditional capacity investments it was found that NWAs would be 70% to 350% more expensive than traditional capacity investments in all but the most favorable scenarios. Going forward, this model will lay the foundation for the benefit-cost test used in the NWA suitability analysis process.

FORD MOTOR COMPANY

AI-Enabled Allocation Plan Optimization Tool

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Ford Motor Company (Ford) is the second-largest U.S.-based, and fifth-largest global automaker, with revenue of \$156 billion in 2017. Ford has a vision for the "Factory of Tomorrow", which involves smart factories using artificial intelligence, augmented reality, and other new technologies. To help achieve this vision, Ford recently invested \$45M in support of its Advanced Manufacturing facility to help build out Ford's smart-factory capabilities in these areas.

With the introduction of each new vehicle model, engineers undertake a complex and highly-manual planning process to determine the allocation of ~10,000 worksteps and associated parts and tools to stations in the plant. This complex process involves many vehicle configurations, and the engineers must also consider multiple constraints such as ergonomics, precedence, tooling, floor space, and cycle time. Under current processes, this allocation planning and constraint-checking is done manually by large teams of engineers on a station-by-station basis. This is iterative, time-consuming, and can lead to a sub-optimal plan, as it is difficult to look at a broader set of stations simultaneously.

To improve the allocation plan and reduce the engineering planning hours required, the Tauber team created an analytics tool to recommend a feasible and optimized plan. The team studied the current allocation planning process and interviewed engineers to understand key issues faced, constraints and logic required by the tool, and ensure the tool had a user-centric design. The Tauber team also employed agile methodology, developing and testing new capabilities with key users on a weekly basis.

The solution utilizes machine-learning to analyze historical allocation plans of similar vehicles to predict the order in which worksteps should occur, predicting 80% of the worksteps within 3% of their executed position. The tool then utilizes mixed-integer programming to recommend a feasible plan that optimizes operator utilization. By implementing the tool developed by the Tauber team, Ford will benefit an estimated \$3M annually in direct savings through 7% utilization improvement resulting from improved allocation plans, as well as an estimated \$1M annually in cost-avoidance through reduction in engineering hours required. There is also additional opportunity to roll the tool out on a global scale.

GENERAL ELECTRIC COMPANY

Developing Analytics to Correct Electric Utility Network Model Errors

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General Electric Company (GE) is a leading global manufacturer and provider of industrial equipment, technology, and software. 40% of the world's electricity is managed by GE software. GE is in the process of establishing a software subsidiary which includes Grid Analytics, a newly established team developing analytics software for electric utilities. The Grid Analytics team is preparing to launch its first three analytics products: Network Connectivity, Storm Readiness, and Effective Inertia. The Tauber Team was tasked with developing the Network Connectivity product to bring release 1.0 to market while researching and beginning development on release 2.0.

The Network Connectivity product identifies and corrects errors in the network models that electric utilities rely on for operations management and planning. The error rate within utilities' network models is estimated to be 10-20%, or 15 to 30 million customers in the U.S. market. Due to manual updates made during outage restoration and grid expansion, network records are subject to errors. These errors result in operational challenges for utilities, such as deployment of crews to the wrong location during an outage response, or difficulty managing the voltage volatility caused by high penetration of distributed energy resources (DERs) which include solar panels and home battery systems.

As part of release 1.0, the Tauber Team created analytics to identify meter-transformer pair mismatches and recommend the correct connections. The team navigated erroneous records and worked with operationally-focused subject matter experts to create algorithms that leveraged distributed computing to process millions of data points. Initial recommendations were provided for a large utility with upwards of 5 million customers.

In parallel, the team conducted research for release 2.0 of the Network Connectivity product, which is intended to identify network records where transformers are incorrectly assigned to one of three phases. The Tauber Team interviewed customers to accurately define the problem statement, explored data sources available from electric utilities, and researched the competitive landscape. The team devised an analytic approach that ensured product differentiation from competitors and a significant addressable market size. The Tauber Team proceeded to collect and filter data, engineer features, and develop an unsupervised learning algorithm that identified errors and recommended corrections.

Eliminating network record errors is estimated to provide a small utility with 500k customers an operational cost savings of \$2.9MM over five years. Furthermore, GE is targeting \$15MM in sales from Network Connectivity in 2019-20.

GENERAL MOTORS COMPANY

Additive Manufacturing Network Development

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Additive Manufacturing (AM) represents an opportunity for General Motors (GM) to come closer to realizing the vision of zero crashes, zero emissions, and zero congestion by increasing manufacturing flexibility and agility, improving operational efficiency, reducing supply chain costs, and shortening lead time, all while shrinking the ecological footprint of General Motors' manufacturing facilities around the world.

In 2018, organic innovation by an ad-hoc network of volunteers across the Global Manufacturing organization yielded \$1.6 million in savings by designing and printing over 1100 different tooling solutions and assembly aids. However, great opportunity remains to move the organization from one with a siloed culture characterized by limited communication and capped innovation potential, to a collaborative enterprise that has the intellectual and machine horsepower necessary to reimagine automotive manufacturing processes. The team developed the long- term AM industrialization strategy necessary to change the manufacturing status quo while increasing value capture in three areas: cost savings and operational efficiencies, safety and ergonomic improvements, and shortened lead time to address tooling issues during launch. In an environment where a single vehicle program's tooling costs can run north of \$5 million per week during launch, time is paramount. This strategy encompasses elements of human development, network design, and hardware commonality while reaping the supply chain and capital investment benefits presented by a hub and spoke model.

Human development efforts focus on building a dedicated network of Additive Manufacturing Coordinators (AMCs) across 29 GMNA manufacturing facilities. These AMCs focus on identifying operational issues where AM provides a value-added solution and allow the organization to move upwards along the social adoption curve, transitioning from an enterprise where only distributed early adopters capture value to an enterprise full of operators leveraging this technology to transform the way manufacturing operations are executed. The team's deliverables included the candidate profile required to drive this change, and a training plan, based on industry and Department of Defense personnel development best practices, that will develop the skillset necessary to drive organizational change.

The team's network solution is the conduit of shared knowledge, designs, and innovation necessary to achieve industrialization. It sets forth a scalable manufacturing execution system that utilizes existing and planned capabilities to manage the life cycle process including; order entry, tracking, reprinting, costing, archiving, addressing bottlenecks, optimizing utilization, and improving user experience. Additionally, the team proposed a single-source hardware platform and tailored equipment packages to reduce the corrupting influence of variation across the enterprise while allowing GM to realize the disproportionate value and time savings present during vehicle launch operations (decreasing the time from problem identification to solution implementation from 4-8 weeks to 1-4 days).

This strategy contributed to the approval of a \$26 million investment in GM's Additive Industrialization Center at the Warren Technical Center, which will serve as the company's additive engine. By concentrating capital intensive industrial-level equipment at this central location where it can achieve optimal utilization rates, pairing this with a network that facilitates shared designs and enables on-demand ordering, and distributing the human capital necessary to identify and design AM enabled solutions, the team maximized the company's ability to capture the value opportunity presented by this technology.

MICROSOFT CORPORATION – BUSINESS

Alerting Platform for Globally Actionable Revenue

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Microsoft Corporation, a \$127B technology company, is the largest software maker in the world. The Microsoft Operations team is responsible for the global operations of Microsoft's Commercial, Consumer, MBS, Services, OEM, Partner, and 1st Party Device businesses, focusing on the strategy, development and execution of Microsoft's physical and digital supply chain solutions in mature and emerging markets. The team's vision is to make doing business with Microsoft easy.

The Tauber team was engaged to improve operations in the revenue recognition process, in which agreements with enterprise customers are processed. This work is undertaken by Regional Operating Centers in several facilities around the world. To address this opportunity, the team engaged with several stakeholders who work with this process in Dublin, Singapore, and Reno to learn about how the revenue recognition pipeline works, stakeholders' specific roles, and what pain points exist for them. The number of agreements that can be resolved before the close of the financial quarter has a direct impact on the company's bottom line, so it's critical that potential delays are acted upon quickly. A large barrier to preventing these delays is significant lag between when a problem is encountered and when this problem is perceived and acted upon by the right people.

To reduce these delays, the team built APGAR (Alerting Platform for Globally Actionable Revenue), which not only provides alerts to highlight the risk of delays, but is a dynamic working platform on which people can control which alerts they receive, create their own custom alerts, discuss with other team members, and gain access to detailed information through links to Dynamics and PowerBI. Additionally, the team created a tool inspired by Statistical Process Control (SPC) principles to quickly visualize the health of the agreement pipeline, deep dive on the performance of specific processes, and incentivize long time process improvement.

These tools are fully implemented and currently usable by members of this process. APGAR will help reduce revenue that is unable to be reported at the end of the quarter by allowing those involved with cases to act more quickly and gain better understanding of the status of important cases, while the SPC tool will help teams develop a shared understanding in terms of process performance so that they can effectively consider targeted improvements to aspects of the revenue recognition pipeline.

MICROSOFT CORPORATION – PARTNER

Partner Investment Strategy

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Microsoft Corporation is one of the biggest technology companies in the world which strives to enhance people's personal and professional lives by offering software, services, and hardware devices. Microsoft delivers its products/services through an extensive network of partners, as well as directly to its end customers. The partner network is a core strength of Microsoft as it plays a key role in enabling the company's products and services to reach every corner of the world.

This project falls within the One Commercial Partner division, which acts as an agent to connect with partners and helps Microsoft sell products and services. The objective of this project was to measure the impact of the Cloud Solution Provider (CSP) incentive program on Azure using incremental revenue to suggest the right rewards for usage and consumption of Microsoft products. This program involves rewarding partners for helping their customers consume Azure. Strategically, CSP incentive is important for Microsoft and has shown enormous YoY growth in terms of revenue earned. This project will help identify the dollar impact of the CSP program on Azure billed revenue to identify the right incentive rate to be set and the right partners to invest in.

To address this opportunity, the Tauber team first learned about different OCP incentive programs, licensing models, partner types, and data tools. The team also interviewed various stakeholders to identify the pain points and scanned through large number of resources to identify the right database for analysis. The team further collaborated with an internal data science team to model the problem, developed unique KPI's to quantify the impact, and applied Azure Machine Learning algorithms to determine the incremental revenue due to the incentive rate changes. This way the team was able to numerically measure the impact of the CSP incentive program and suggest recommendations.

After implementing the modelling, the team suggested three recommendations. First, it suggested a path to set the ideal value of incentive rate % for each subsidiary. Second, the team evaluated the impact of decrease in incentive rates on a partner's revenue generation capability and provided a roadmap of when and how Microsoft should decrease the incentive rates. Third, the team identified the partners with higher KPI's and found that those partners share certain characteristics.

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MICROSOFT CORPORATION – VEHICLE

Improving Overall Effectiveness of Microsoft Fleet Vehicles

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Microsoft Corporation is the world's largest software maker in terms of revenues. Microsoft Real Estates & Security (RE&S) Organization manages and drives improvements in fleet operations in the Puget Sound Region. The fleet has four functions, namely commute, facility, catering & beverages, and shipping & receiving, all of which are operated by independent vendors. RE&S aims to improve overall effectiveness of the fleet vehicles and optimize the fleet management process. Therefore, the Tauber team was tasked with evaluating the current vehicle utilizations, identifying opportunities for improvement, and providing recommendation on actions that Microsoft needs to take to efficiently manage the fleet vehicles.

The Tauber team focused on four improvement areas, in which the team analyzed the current state, envisioned the desired future state, and provided recommendations to bridge the gap.

- First, the team developed a Power BI dashboard that enabled monitoring and prioritization of vehicle replacement. The team also built a financial model that compared costs for vehicle lease versus buy to provide the most economical acquisition approach.
- Second, the team upgraded the user interface for on-demand shuttle booking which provided visibility on user travel times.
- Third, the team developed improvement plans to create synergies between functions through vehicle pooling and centralized services in fueling and maintenance.
- Fourth, the team designed an asset management framework and built a database through queries which stored vehicle data and streamlined the data collection process.

These recommendations would save RE&S a total of \$6.4M, which includes:

- OpEx savings: \$4.5M over the next three years.
- CapEx savings: \$1.9M capital savings for next vehicle replacement.
- Productivity: 36K hours in employee time savings over the next three years.

In addition, the outcome of this project will be directly integrated into the pipeline for future Microsoft fleet management process. For example, the upgraded user interface for on-demand shuttle booking would be incorporated into the Microsoft employee transportation application. Furthermore, the newly developed asset management framework would be adopted by future Microsoft asset management software.

PEPSICO BEVERAGES NORTH AMERICA

Renewable Energy Project

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PepsiCo Beverages North America (PBNA) is a division within PepsiCo with annual revenue of \$20B+. PepsiCo has publicly committed to reducing its greenhouse gas (GHG) emissions 20% in absolute terms by 2030. As its largest operating division, PBNA is looking to develop a strategic plan to procure and invest in self-generation of renewable energy to eliminate indirect (Scope 2) emissions associated with purchased electricity.

The range of supply options, together with variable regulatory settings, provides considerable complexity. A critical first step was to determine how much to invest in self-generation. Doing so would involve performing a technical and financial feasibility analysis for more than 600 sites across the U.S. and Canada. Some of the complexities to identify feasible projects include the following: physical space, roof condition, utility infrastructure, electricity rate structures, and availability of financial incentives. The process of vendor selection was equally challenging because vendors' bids were not standard. Therefore, the required due diligence to interpret and compare bids would slow progress towards PBNA's goals.

To capture these opportunities for improvement, the Tauber team performed a four-phased analytical approach. First, the team created a database to consolidate internal and external information relevant to evaluate solar projects. Next, the team developed a comprehensive model to rapidly evaluate the environmental and financial impact of potential solar projects at all PBNA locations. The model is capable of taking inputs from the database and calculating the GHG takedown and internal rate of return (IRR) of each project. Third, the team performed a refined analysis of the top 30 projects and prepared an RFP template to standardize the bidding process. Lastly, the team analyzed green power procurement options to offset the electricity usage not covered by self-generation and ranked them based on additionality, reputational risk, cost savings, financial risk, and lead time.

The model developed by the team can analyze all 600+ locations in under 30 minutes, making it possible to efficiently reevaluate all locations when economic conditions and financial incentives change. By using the model's results, the team identified 30 attractive solar projects to be installed in the next three years, representing a net present value of \$6.9MM. The projects identified will produce 22.7 GWh of renewable energy annually (equivalent to 2,183 homes' electricity use). The team also provided a plan to transition to 100% renewable electricity over the next three years by participating in utility-scale community solar programs, engaging in power purchase agreements with solar developers, and purchasing unbundled renewable energy credits. If implemented, this plan will realize additional savings of \$1.5MM annually.

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PFIZER, INC. – CLINICAL

Accelerating Molecule To Market Timelines By Maximizing Resource Utilization

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Pfizer is a leader in the biopharmaceutical industry with annual revenues of \$53 billion supporting a portfolio for oncology, immunology, and vaccines. **Pfizer** is currently addressing two industry wide disruptions: an increasing difficulty to deliver blockbuster drugs and a shift towards precision medicines for cancers and rare diseases. These shifts led to two bold initiatives by CEO Albert Bourla. The first initiative focuses on accelerated delivery of medicines to market by reducing operational cycle times across product development. The second initiative focuses on portfolio diversification, with an emphasis on delivering breakthrough therapies to meet unmet patient needs globally.

To support the accelerated delivery of a diversified portfolio, Pfizer identified an opportunity to review working practices and enhance capacity in clinical manufacturing at its Sandwich, UK facility. The project's goal was to increase batch throughput with reduced cycle times by maximizing resource utilization, thus delivering an expanded portfolio on expedited timelines.

The Tauber team focused its analysis in two primary areas: operational revamp and data utilization. In addressing the operational revamp, the team developed a series of new ways of working. The main recommendations included two technician teams for manufacture, continuous manufacture enablement, and a structured approach to fulfilling non-manufacture tasks. The team also recommended several manufacture cubicle design changes and technician training program enhancements.

To improve data utilization, the Tauber team developed a simulation tool that incorporates the facility's process flows, resource constraints, and capabilities. The simulation tool can analyze major site changes such as changing product mixes and new product capabilities, enabling data-driven decisions on potential cost-benefit changes. To improve performance visibility, the team developed 10 key performance indicators and a visual dashboard to encourage continuous improvement.

When implemented, the Tauber team's recommendations will enable a 62% annual batch throughput increase, while reducing end-to-end batch cycle times by 45% and technician working time per batch by 23%. These projections are derived from the Sandwich 2020 forecasted clinical demand and product mix. The results were confirmed by a 3-week facility-wide pilot with long-term impact validated by the simulation tool. These impacts will enable Sandwich to deliver clinical product at an accelerated pace, reducing the time to deliver new medicines to market. This supports Pfizer's industry leadership in both developing future blockbusters and meeting unmet patient needs through the development of breakthrough therapies and precision medicines.

PFIZER, INC. – MATERIAL

Optimizing Material Flow In Clinical Supply Chain

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With revenues totaling \$53.6 billion in 2018, **Pfizer Inc.** is the largest publicly traded pharmaceutical company. It is a leader in the research and development of compounds spanning therapy areas such as immunology, oncology, and rare diseases. As part of the drug development process, Pfizer conducts clinical trials to ensure maximum efficacy and usability of its products; as of July 2019, the company is engaged in more than 100 clinical trials, ranging from first-in-human testing to final registration and approval by the Food and Drug Administration (FDA).

With the ambitious goal of delivering 25 new drugs to the market by 2025, Pfizer and its Global Materials Management team (GMM) are faced with an increasing demand for a more agile and reliable supply chain. GMM is responsible for the planning, procurement, storage, and shipment of clinical materials, supporting all Pfizer research sites. To meet this demand, a new ERP system was launched in 2019, but GMM has since encountered difficulties maintaining oversight on material requests, prioritizing workstreams, and meeting communicated material lead-times. The Tauber team therefore was tasked with reviewing legacy practices and optimizing material flow.

Through value stream mapping, the team established that it took 6 weeks longer than expected to move standard replenishments through the supply chain. Even with the new system, material planners had to cross-reference data from 4 separate systems when assessing each request. In addition, the lack of an effective change management process meant that reassessments were necessary whenever customers adjusted requested quantities or use dates. This is especially significant in dynamic clinical trial environments, where more than 2,000 adjustments are made annually.

The Tauber team developed several tools to aid GMM in material coordination and operations. By leveraging SQL databases and data visualization software, the team built and piloted dashboards enabling material planners to instantly match available inventory to incoming requests, track statuses of active requests, and automatically assess customer adjustments. Furthermore, using simulation software, the team identified process bottlenecks and modeled future state scenarios, quantifying and recommending required resources for greater operational efficiency. Lastly, the team created a live warehouse space utilization dashboard to reduce material handling and improve procurement planning.

The tools developed by the team were piloted with user feedback incorporated. Between the pilot results and long-term recommendations, the team projects combined savings of 5,890 hours yearly, leading to a more streamlined supply chain, and the ability to handle a 30% increase in requests.

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STANLEY BLACK & DECKER, INC.

Mobile Robotics for Material Handling

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Nathan Dietrich – Industry 4.0 Deployment Manager North America Moses Pezarkar – Smart Factory Manufacturing Engineer (Chesterfield) Ziyan Xu – Smart Factory Manufacturing Engineer (Hopkinsville)

Stanley Engineered Fastening (SEF) is a \$2 billion division of Stanley Black & Decker, Inc. that manufactures and supplies fasteners across the industrial and automotive industries. With significant growth expected over the next five years, material movements will increase while floor space reduces. As a result, a project focused on improving SEFs operational performance via automated material movement and related Industry 4.0 solutions was developed. The goal of the project was to create a minimum of \$500,000 in annual savings across four SEF plants- Chesterfield Plastics, Chesterfield Metals, Montpelier, and Hopkinsville by recommending three to five business use-cases.

Three key current-state analyses were conducted across each site to investigate the need for mobile robotics: 1) Frequency and distance quantification of material flows 2) Time studies of roles associated with material flows 3) Value stream mapping of parts across the plant operations. From this, areas for significant efficiency improvement or cost-saving in both, material movement and packaging processes, were identified.

A total of six use cases were developed where the first five involve the application of mobile robotics for material movement, and the sixth involves the application of automated box packaging. The use cases regarding mobile robotics were discussed with several vendors. A decision matrix incorporating key criteria covering technological, operational, and financial factors was formulated to evaluate each vendor proposed technology. The sixth use case was discussed extensively with an existing vendor in further determining operational and financial feasibility.

A financial analysis was conducted to determine NPV, ROI and payback for each use case. Two methods were used to calculate annual savings realized: the total value method (maximum potential savings), and the P&L method (savings realized on P&L statement). Due to a payback period of over 2.5 years, Use Case 2 was determined as unfeasible. All other use cases have been recommended, and would generate a total annual savings of ~ \$850,000 with an NPV of \$2,900,000. If similar mobile robotic use cases were to be scaled across the 11 plants in SEF North America, they would generate a total annual savings of ~ \$3,000,000.

STONERIDGE, INC.

Refining the Stoneridge Program Launch Process

STUDENT TEAM:

Stephanie Hoglund – EGL (BSE/MSE Industrial and Operations Engineering) Laura Malecky – Master of Business Administration

PROJECT SPONSORS:

FACULTY ADVISORS:

Melissa Lindquist – Vice President of Program Management Control Devices Division Scott Skelton – Senior Program Manager Control Devices Division

Lisa Pawlik – Ross School of Business Fred Terry – College of Engineering

Stoneridge, Inc. is a leader in the worldwide automotive market headquartered in Novi, MI. They produce control devices and electronic components for commercial, passenger, and agricultural vehicles. Over the decades, Stoneridge has experienced rapid growth, in part fueled by acquisitions, with annual revenue for 2019 projected at over \$830M. The company has three business segments—Electronics, PST Electronics, and Control Devices—and employs 4,600 individuals across 25 locations in 15 countries.

As a result of rapid growth, there is significant opportunity for improvement in program launch. Recent programs have incurred significant post-launch costs and extended timelines. The Tauber team was tasked with understanding the missed opportunities in launch through analyzing two recent launches in Stoneridge's actuation and emissions product lines. It was expected that their findings would be applied to a new phase-gating launch process to ensure optimized process flow and time.

The Tauber team began their work by conducting 70 interviews with employees at Stoneridge sites in Michigan, Ohio, Massachusetts, Mexico, and Estonia. Next, the team mapped the actual and intended process flows in Sweden, using findings from a project management workshop. During these activities, the team identified documentation that would support program execution and pinpointed areas for cost saving opportunities.

Their recommendations include adjustment of organizational teams during launch, alteration of the process flow diagram, evaluation of 60 workstreams, and revision of 12 documents. Additionally, the team identified phases of excessive spend in launch and suggested four processes for improvement: increased cross-functional communication, improved supplier selection, greater product manufacturability, and concurrent engineering practices. Using secondary research and internal resources, the team determined that implementing their recommendations could result in estimated total savings of \$20M annually. The benefits of these recommendations go beyond improvement of internal processes and reduction of launch costs—they can lead to increased productivity, engagement, and satisfaction at Stoneridge, Inc.

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TARGET

Reducing Pick Cycle Time In Ship From Regional Distribution Centers

STUDENT TEAM:

Mercedes Alvarez – Master of Business Administration David Ginsberg – Master of Business Administration Rhea Kumar – Master of Business Administration

PROJECT SPONSORS:

FACULTY ADVISORS:

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Target Corporation (NYSE TGT) is an upscale discount retailer business that provides high-quality, on-trend merchandise at attractive prices, generating \$75B in revenue through online and in-store sales. Target has a vast Distribution Center network to replenish both stores and Fulfillment Centers (FC), which deliver ecommerce orders straight to guests. The Tauber team focused on SfRDCs for the purpose of this project; SfRDCs are Fulfillment Centers (FC) that are physically connected to Regional Distribution Centers (RDC).

As ecommerce sales rise by greater than 30% annually, Target's FCs are carrying more unique products to meet guest demand. In 2019, the average unique product count is expected to increase by approximately 155% in all SfRDCs. This broader assortment of products with fewer average units/item has led to a 14% increase in pick cycle time for small multi-unit orders. In this analysis, pick cycle time is defined as the time it takes to travel to, find, and place into the cart one item for a small multi-unit order.

Further analysis validated that the most time-consuming activity is the travel time between picking each item. To overcome the increase in cycle time and meet anticipated demand, travel time needs to decrease by 21%.

Currently, single-unit orders are picked separately from small multi-unit orders because single-unit orders can go straight to packing whereas the multi-unit orders have to be sorted to their respective orders after picking.

The proposed solution was to opportunistically add single-unit orders to small multi-unit order tasks, reducing the wasted motion in retrieving the orders in separate tasks. However, pilot testing revealed a much larger problem with the FC's Warehouse Management System (WMS) allocation logic for tasks. The Tauber team recommends further testing and analysis, and strategic changes to how inventory is placed in the warehouse, to ultimately save 3 seconds of travel time; this could lead to an annual savings of \$2.5M - \$3M across the FC network.

2019 Tauber Team Project Photo Contest Winner (front cover)

L to R: Elena Stefanko (EGL BSE-Electrical Engineering & MSE-Industrial & Operations Engineering), Jack Claucherty (EGL BSE/MSE-Industrial & Operations Engineering), and Almira Dogruyol (EGL BSE/MSE-Industrial & Operations Engineering)

Tauber students on-site at the Canam Group, the largest fabricator of steel components in North America. Specialized in designing construction solutions and fabricating customized products since 1961, Canam Group takes part in an average of 10,000 construction projects each year in one activity sector divided into three groups of products and services: buildings, structural steel and bridges. The Corporation operates 25 plants across North America and employs over 4,687 people in Canada, the United States, Romania and India. Since July 2017, Canam Group is a privately held company within the AIP portfolio. The student team assessed current state manufacturing processes and developed future state manufacturing. **Photo:** Almira Dogruyo



The Tauber Institute is the proud inaugural winner of the UPS George D. Smith Prize for effective and innovative preparation of students to be good practitioners of operations research, management science, or analytics.

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