

Ph.D.
Reflections on my time as a scholar

I believe that the most impactful, interesting solutions to problems occur at the intersection of art and science. This belief, coupled with the spirit of innovation and entrepreneurship in the field of packaging, played a major role in my choice to work in this discipline. I chose to work at a research intensive institution because I firmly believe in engaged scholarship. Societal issues catalyze investigations that are shared with students, stirring them to formulate further questions and seek new answers. I strive to accomplish this in my work, and take great pride in rousing curiosity in my classrooms and lab. My journey as a scholar in this field has been challenging and, at times, frustrating. However, I can say, without reservation, that the opportunity to lead a team that works to impact health outcomes and energize others to generate questions and seek answers in the same vein has also been deeply satisfying. This is my story.

My passion is to *employ a user-centered approach to package design, informed by science, with the goal of improving health outcomes* (Appendix 1, Fig. 1). To make progress in support of this, I have built a multidisciplinary program which leverages insights and methods from cognitive psychology, health risk communication, occupational therapy, biomechanics, ergonomics, nursing, gerontology, pharmacy science and medicine. My efforts generally focus on the healthcare industry, but occasionally investigate issues associated with food and beverages as well.

The world is burdened with healthcare issues that are costly both in financial and human terms (see Appendix 2). Among them are: medication errors, patient non-adherence/non-compliance, healthcare acquired infections, unintentional poisoning of children due to unsupervised ingestion of medications or household chemicals, and overweight and obese populations. Packaging is not an obvious path to ameliorating the effects of these issues, and very few people in the world have purposefully and thoughtfully used it to do so (to my knowledge, MSU is the only University to have faculty dedicated to medical packaging). The significance of the problems and the novelty of my approach combine to make this a fertile area for inquiry. I have sought to make an impact in the state of Michigan, and the rest of the world, by applying my expertise in human factors and medical packaging to enhance health. This is dramatically different from most of the work done in my discipline, which tends to focus on the ability to efficiently fill, protect and distribute *products*. Additionally, the limited numbers of human factors experts in packaging tend to focus their efforts on selling products, and those in other disciplines researching health outcomes rarely use packaging as a means for improvement. As such, I am quite unique.

Working toward this vision has been, at times, disheartening and lonely. One of the first phone calls that I received after being hired was from a School of Packaging alumnus who worked for a global company that made materials used in medical packaging. His company provided a yearly scholarship to students interested in pursuing careers in medical packaging, and they were interested in converting it into a fund that could be used at the discretion of the professor that held my (new) position. He asked me to explain my vision. I excitedly introduced the idea of an interdisciplinary program that used objective measures to inform package design in ways that improved health outcomes. At that point (2002) and even today, entities involved in packaging are product-centered in their approach; decisions nucleate around ideas which enhance production efficiencies and/or product protection, and end-user needs and abilities are

largely an after-thought. There was a long pause before the gentleman indicated that the company would continue providing the money in the form of student scholarships, not supporting the research agenda that I had presented, as it was “not something that they did.” (Incidentally, “ease of use by healthcare providers” is *now* listed among the key priorities of medical design on the same company’s website.)

This type of response was, unfortunately, not limited to this conversation. My approach has often been rendered as “outside of the norm,” plaguing metrics like citation indices (my current H- Index is 5 in Scopus and Web of Science- see Form D for graphs), which reward efforts where many people are working in a similar fashion with highly cited publications. I was frequently “shoe horned” into tracks at research conferences (e.g. novel materials) because human factors work did not fit the normal standards.

I am pleased to say the world has begun to change in the time since I was initially appointed. Human package interaction is now a category that can be checked at the journal *Packaging Technology and Science* and the annual conference of the International Association of Packaging Research Institutes (IAPRI) now regularly features a “packaging and the consumer track” when submitting to the peer-review process. Although my focus on applying human factors to packaging for the sake of improved health remains unique, a cohort of researchers focused on ergonomics in packaging has begun to develop, and I have influenced its genesis.

a former student whose committee I served in my Adjunct capacity at Clemson, and , a former PhD advisee at MSU, each employ a user-centered approach to packaging (in both laboratory and classroom settings) at Clemson and California Polytechnic State University, respectively. , Director at the Association of Packaging Technology and Research and a former visiting scholar to my lab, stresses projects that focus on consumer package interactions in her work in Helsinki, Finland. I have also developed collaborations with researchers whose focus on improving health leverages more traditional disciplines (e.g. medicine, pharmacy, health sciences, gerontology, etc.). It takes time and effort to build relationships with researchers in these well-established fields and programs. They frequently use different terminology, are often pulled in multiple directions (clinical work, research and teaching) and sometimes don’t take the time to really understand how packaging could play a role in healthcare (or research).

One great opportunity to nurture these collaborations presented itself when I was appointed to a committee of national experts convened by the Gerontological Society of America (GSA) and the Consumer Healthcare Products Association (CHPA). The goal of the organizations was to “recruit a cadre of behavioral scientists with appropriate expertise to work in the critical and relatively neglected area of OTC use among older adults in order to promote safe and effective use of the same.”¹ We analyzed existing work to identify gaps in knowledge regarding OTC medication use by older adults and created a number of products intended to influence policy, funding opportunities, and the national research agenda. We conceived and hosted a conference in Washington DC¹ attended by regulators, funders, industry representatives and members of the academy; coauthored an article² in the *Gerontologist* (5 year impact factor 3.380 in Web of Science 9/29/15) and presented our findings at an Annual Meeting of the Gerontological Society of America³. An interaction model developed by my team⁴ was used to classify the state of knowledge regarding what is known (and what is needed) related to the decision making behaviors of older adults selecting OTC drugs. I was also one of three people asked to present the work at the GSA’s annual conference in New Orleans³, and to represent the panel in a press conference at the same event.

While being novel has had its lonely moments, it also advanced my scholarship significantly. Recently, the unique and diverse collaborations I've formed were honored with the 2014 Phi Kappa Phi Excellence in Interdisciplinary Scholarship Award (MSU), and the unusual niche we have carved has provided the opportunity to build a global reputation (see Figure 2). The distinctive approach has garnered invitations to exhibits, expert panels and advisory boards, as well as requests for visiting scholars and invitations to speak on international stages. An R21 proposal that I co-authored was awarded a grant from the National Institutes of Health (NIH); this was the first successful NIH effort in my Department, and possibly my field. Reviewers gave the submission an impact/priority score of 15 (percentile 2+), stating that the researchⁱⁱ, "studies are creative because they bridge multiple areas in exciting new ways; they push the field farther rather than only relying on survey and/or qualitative work...[having] great potential to systematically inform and impact pragmatic packaging and policy decisions in corporate and governmental areas." This was echoed in reviews of a manuscript submitted based on the same work (currently in early view at *Food Policy*⁵: 5 year Web of Science impact factor 2.815). A reviewer of the publication said that findings were "very policy relevant" and that conclusions drawn were "important to get published."

The research that we have conducted, and the subsequent opportunities that it has facilitated, have enabled me to speak with authority and current knowledge in my classes. I am thrilled when the sense of inquiry present in research activities permeates the classroom. Nothing pleases me more than when undergraduates from my classes become excited about our research and ask to volunteer or work in the laboratory. Undergraduate researchers play an integral role in my team, and participate in a range of scholarly activities. Several have developed their own experiments (either during their undergraduate pursuitsⁱⁱⁱ or after electing to pursue advanced degrees^{iv}), acted as coauthors in publications⁶⁻⁹ and participated at the University Undergraduate Research and Arts Forum (UURAF).

Students from my undergraduate classes have also been significantly involved in the conferences I offer which feature research conducted in my lab. Most recently (2010, 2011, 2013), these conferences have taken the form of the Healthcare Packaging Immersion Experience^v (HcPIE), a joint venture of our lab and the Learning and Assessment Center (LAC). This work exemplifies the power of engagement. All facets of the mission work synergistically to the benefit of society. Events provide a venue for research students to present their work, seed funding for future research projects, an opportunity to showcase the talents of our students (both graduate and undergraduate) as well as networking opportunities for them, a bully pulpit to catalyze change in packaging processes and designs, and a mechanism to gather stakeholder feedback regarding the relevance of our work, emerging needs of the industry and assessments of student skills. Attendees have responded with great enthusiasm, and varied actions. They have hired students involved in event preparation and content^{vi}, provided sponsorships and in-kind donations and lauded the impact the series has had on the industry. In a letter of support for our Phi Kappa Phi Excellence in Interdisciplinary Scholarship Award, _____, CEO of Rollprint Corporation, indicated that HcPIE is impacting the way business is done. "I can attest to the fact that _____ and _____ [Director, LAC] work has resulted in many lively conversations and, hopefully, more thoughtful packaging designs. They have had a very positive impact on our industry and, ultimately, this should translate to better, safer patient care."

Healthcare in the US is rapidly evolving for many reasons, but patient safety and improved health outcomes are a central focus of all efforts. As pressures related to healthcare costs catalyze moving patients from acute care facilities into ambulatory care and home care environments with

great rapidity, user centered design (designs that patients and their caregivers can manage themselves) becomes crucial. This emphasis is likely to accelerate as the support network for the aging population is diminished (see Figure 3).

When I began as an academic, I felt that there was a void in both curricular and research arenas regarding the user interface with packaging. Subsequent collaborations with the Capital Area Center for Independent Living, an organization whose mission is to keep people with disabilities living as independently as possible, affirmed this for me. Believing in the importance of this imperative, I held “Universal Package” seminars in 2004 and 2006 that drew over 125 participants from 5 different countries. The visibility of the seminars catalyzed a number of meaningful and sustained collaborations that continue to generate momentum and impact, and insights (developed for and obtained from the conferences) have been incorporated into classes in at least two departments at MSU (Packaging and Mechanical Engineering). Proceeds from the conferences funded research which was distilled to best practice recommendations for child resistant packages intended to enable access for people with limited hand function while excluding an increasingly adept population of toddlers. This research subsequently received the “Best paper award” at the 5th Cambridge Workshop on Universal Access and Assistive Technology at Cambridge University (UK, 2010).

Other articles related to our research have been featured with varied distinctions. Our article published in the *Proceedings of the National Academy of Sciences of the United States of America*⁶ (5 year citation index 10.563 according to Web of Science 9/29/15) was selected as the commentary highlight for the Psychology section of the publication¹⁰ after one reviewer remarked on its novelty. More recently (August, 2015), an invited work that I coauthored was chosen by guest editors to be highlighted on the website of the *Journal of Biomechanics* upon its publication (5 year Web of Science impact factor 3.157). Through the years, the body of work that I developed became a pathway to numerous opportunities to serve as an expert to organizations of wide-ranging types, including the academy, associations and government organizations (see Figure 2). One particularly rewarding opportunity that resulted was an invitation to serve as an expert to the US Centers for Disease Control and Prevention’s (CDC) PROTECT and PROTECT Rx Initiatives. The goal of the initiatives was (and is) to reduce the number of poisonings in children under five resulting from unintentional exposure to medication. The CDC believes these two initiatives are beginning to show national impact in the form of reduced emergency department visits.

The results that have been achieved are the product of numerous, concerted efforts undergirded by a three-pronged approach: 1. **Engineering solutions:** For example, Pediatric Exposure Limiting *Packaging* and *unit dose packaging* are being used to limit the amount of drug that can be accessed per package breach. 2. **Education:** The “Up and Away and Out of Sight” campaign <http://www.upandaway.org/> was developed and promoted by the PROTECT experts. 3. **Enforcement:** The Initiatives were instrumental in encouraging the FDA to develop a guidance regarding appropriate labeling practice for drugs¹¹ (although this was before I joined the efforts). The exclusive use of mLs and other standards regarding trailing and leading zeros has been endorsed by The American Academy of Pediatrics, the American Medical Association, the National Coordinating Council for Medication Error Reporting and Prevention, the American Pharmacists Association, The American Society of Health-System Pharmacists, and the Institute for Safe Medication Practices.

It is interesting to note that each of these efforts involves changes to *packaging and labeling*. I am proud to have been involved, and to have been invited to present my research to the many experts that attend the CDC meetings on two occasions.

Recently, I have taken a more active role in the leadership of my Department. In 2014, I was appointed the Chair of the Departmental Strategic Planning Committee. A strategic plan was developed with significant input from stakeholders and faculty. It was encompassing, considering all aspects of the mission, with requests for necessary resources and a proposal for acquiring the same. As part of this effort, my approach to teaching and learning expanded beyond my own classroom and laboratory to include analyzing and revising the curriculum and program as a whole. The committee worked to engage the faculty and external stakeholders to identify a core body of knowledge that uniquely defines the discipline of packaging. As part of this, we developed a desired set of learning objectives and outcomes and conducted a gap analysis with the existing curriculum. Desired outcomes were organized using Bloom's Revised Taxonomy to reimagine our curriculum in a way that builds from basic knowledge (i.e. University requirements, foundational prerequisites and packaging fundamentals) into higher order skills (i.e. packaging analysis/evaluation, packaging synthesis/design and a capstone experience). After seeking and synthesizing the input of those who hire our students, we proposed three curricular tracks to better align with stakeholder hiring need: Packaging Science (e.g. R&D laboratory employees), Packaging Engineering (e.g. technical and structural designers) and Packaging Value Chain Management (e.g. procurement, sales and marketing). These changes are currently working their way through University governance, but will represent a dramatic overhaul when implemented.

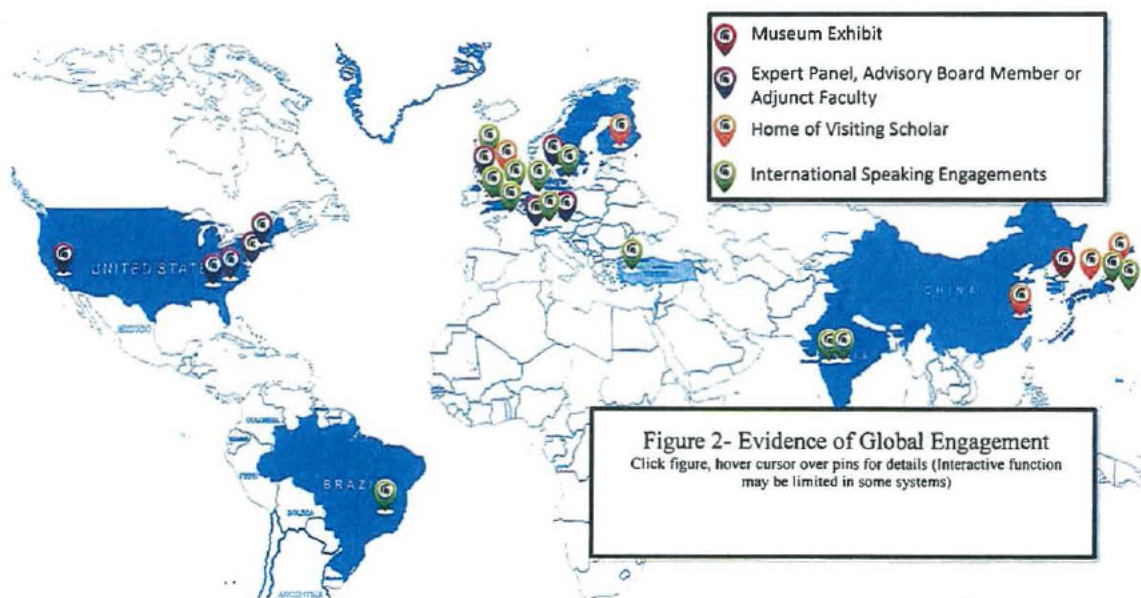
The revision of the curriculum was just a single piece of the strategic plan that was delivered, and the entire process opened my eyes to the unique challenges faced by those who lead within the academy. Largely as a result of experiences with the strategic planning efforts, I applied, and was named, one of the five MSU fellows in the Committee on Institutional Cooperation's Academic Leaders Program (CIC ALP) for the 2015-2016 cycle. I am very excited to be part of this program, which is intended to provide an intensive experience in leadership and managerial skills specific to academia. This experience will undoubtedly assist me in my new role as Associate Director of the School of Packaging, an appointment that came shortly after my time as the Chair of the Strategic Planning Process ended.

By the end of my career, I would like to say that the interdisciplinary program that I have built has reduced the prevalence of medication errors, reduced the rate of healthcare acquired infections, reduced the frequency of unintentional exposure to medication by children and reduced the number of obese and overweight individuals. These issues are vast. Even with my narrowly focused approach (packaging as a vehicle to do so), multiple, concerted efforts are required. To generate meaningful impact, I need to conduct and disseminate pointed research capable of providing information that can be leveraged by designers and policymakers; do my part to develop a cohort of scientists and industry professionals that embrace a user-centered approach to design; use the platforms that I have in research and teaching to encourage professionals in packaging (both industry and academia) to embrace a paradigm where both production/product efficiencies AND user needs are considered during the design process; and nurture the collaborations that I have developed with researchers in the healthcare and fundamental sciences in order to continue and strengthen the translational work that we have begun. I have made progress, but significant work remains. Taking a new approach to old problems is challenging, but exhilarating. I am excited to see what the future holds.

Appendix 1- Figures



Figure 1- Visual Abstraction of my Vision for Scholarship



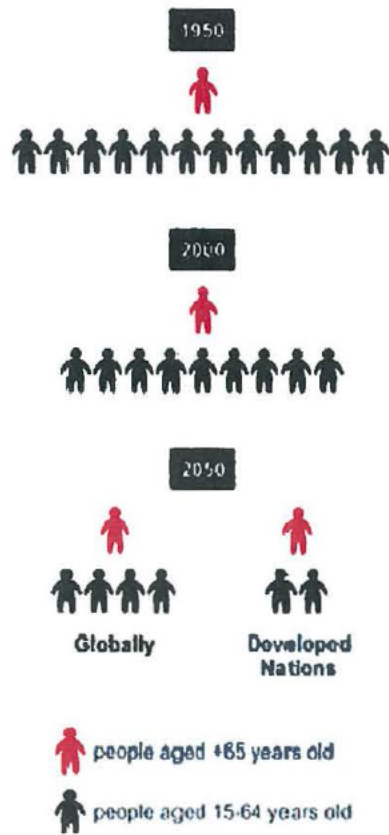


Figure 3. Shrinking support ratio; adapted from

Appendix 2- Why these issues?

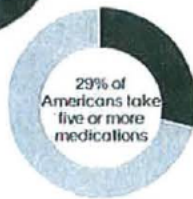
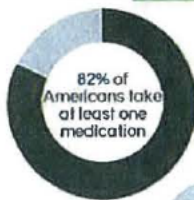
Why?

The world is burdened with healthcare issues that are costly both in financial terms and human terms.

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Adverse Drug Events (ADEs)



700,000
Annual emergency
department visits
120,000
Annual hospitalizations

Predicted to increase

- * Aging global population
- * New uses for existing medications
- * Increased use of medication for prevention
- * Increased coverage of medications
- * Development of new medications



While many factors contribute to ADEs, drug name confusion and confusion related to packaging and labeling are indicated as critical factors, yet few people purposefully study how we can do better in this regard.

Healthcare-Associated Infections

Healthcare-associated infections (HAIs), infections that were neither present nor incubating in the patient at the time of admission.



Frequency of infection is 2-3 fold higher for low to middle income countries. Device-associated infection densities are up to 13 times higher in the US.



1 in 25

patients in the US has at least one HAI on any given day

Patients with HAIs require



Increased treatment and care

More expensive therapies



Are more likely to be readmitted to the hospital



HAIs have been significantly reduced by focusing on direct contact transmissions (from a person to patient) and effective use of antimicrobials. Indirect contact transfers, transfers via an intermediate object, have fewer studies. Invasive medical devices (with packaging as an intermediate vehicle) are a potential route of contamination in need of study

Why?



Unintentional Poisoning of Children under Five



Poisoning is the fourth leading cause of unintentional death in children. Medications have surpassed household products as the predominant cause of pediatric poisoning



2 YEARS



Most commonly poisoned age

20%

The amount which Emergency Department (ED) visits rose among children younger than five between 2005-2009 due to medication overdose

70,000

children under five are brought to EDs for unintentional medication overdoses annually



Child resistant packaging has saved thousands of lives since it became required in the early 1970s, but very little innovation regarding the approach has happened in the time since. Optimized, data-driven designs are needed.

The Obesity Epidemic

CDC Estimates of obesity in US population 20 years and older



Obese (35%) Overweight (34%)
Not overweight (31%)

The obesogenic environment



Increasing Portions
Ubiquitous Foods High in Fat, Sugar and Sodium
Emphatic Promotion of these Foods

Factors related to the individual



Heredity
Activity/Lifestyle
Diet
Economic Factors
Medications/Medical Conditions
Age

The Fallout



Increased healthcare costs



Increased rates of morbidity and mortality

Obesity rates are impacted by multiple, complicated factors



Regulation of the obesogenic environment (including labeling strategies) is an important approach in reducing obesity. Regulators must have access to sound science to create informed policy.



The complex problems of the world require thoughtful, data-driven inquiry utilizing varied perspectives of expertise. There will be no singular solution for these issues. Novel thinking has the potential for impact.

References

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Endnotes

ⁱ https://www.geron.org/archives/gsawebinars/OTC_Meds_September_25_Webinar%20Final.pdf

ⁱⁱ Used objective techniques to optimize nutrition labeling regarding attention and comprehension

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^v http://www.packaging.msu.edu/industry_testing_services/hcpi

^v (both at Cardinal Health), (GlaxoSmith Kline and St. Jude Medical)