

Alex Burnap

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RESEARCH INTERESTS

Product Design, Product Management, Aesthetics and Creativity, Machine Learning, Optimization, Consumer Choice and Preference Measurement, the Interface of Marketing and Engineering

RESEARCH POSITIONS

MIT Sloan School of Management

Postdoctoral Fellow, Marketing

Sept. 2017 - Present

General Motors Corporation

Visiting Research Scientist

Sept. 2016 - Jan. 2019

University of Michigan

Postdoctoral Fellow, Mechanical Engineering

Sept. 2016 – Aug. 2017

EDUCATION

University of Michigan

Ph.D. Design Science, College of Engineering

August 2016

Dual-Degree Areas: Engineering Design & Machine Learning

Committee: [Panos Y. Papalambros](#), [Richard Gonzalez](#), [Matt Johnson-Roberson](#), [Honglak Lee](#)

M.S. Mechanical Engineering

2013

University of Illinois, Urbana-Champaign

B.S. Physics, Honors, College of Engineering

2011

MARKETING JOB MARKET PAPERS (ABSTRACTS IN APPENDIX)

Burnap, A., Hauser, J., Timoshenko, A., "[Design and Evaluation of Product Aesthetics: A Human-Machine Hybrid Approach](#)," Submitted to *Marketing Science*.

Burnap, A., and Hauser, J., "[Predicting "Design Gaps" in the Market: Deep Consumer Choice Models under Probabilistic Design Constraints](#)." In Preparation for *Frontiers of Marketing Science*.

PUBLICATIONS

Choice Modeling

Burnap A (2019) "A Technical Brief on Deep Conjoint Analysis and Interpretable Machine Learning: Visualizing Cultural Differences for New Product Development," Working Paper. Invited talk KAIST.

Burnap A, Papalambros PY (2017), "[Design Preference Prediction with Data Privacy Safeguards: A Preliminary Study](#)," *Proceedings of the 2017 International Design Engineering Technical Conferences*, Cleveland, OH, Aug. 6-Aug. 9, 2017.

Burnap A, Pan Y, Liu Y, Ren Y, Lee H, Gonzalez R, Papalambros PY (2016), "[Improving Design Preference Prediction Accuracy using Feature Learning](#)" *Journal of Mechanical Design*, 138.7: 071404.

Aesthetics and Creativity

Kang N, Burnap A, Papalambros P Y, Reed M (2018), "Influence of Automobile Seat Form and Comfort Rating on Willingness-to-Pay," *International Journal of Vehicle Design*, 75.3.

Pan Y, Burnap A, Hartley J, Gonzalez R, Papalambros PY (2017), "[Deep Design: Product Aesthetics for Heterogeneous Markets](#)," *Proceedings of 23rd SIGKDD Conference on Knowledge Discovery and Data Mining (KDD'17)*, Halifax, Nova Scotia - Canada, Aug., 2017.

Burnap A, Hartley J, Pan Y, Gonzalez R, and Papalambros PY (2016), "[Balancing Design Freedom and Brand Recognition in the Evolution of Automobile Brand Styling](#)," *Design Science Journal*, 2.9.

Burnap A, Liu Y, Pan Y, Lee H, Gonzalez R, Papalambros PY (2016), "[Estimating and Exploring the Product Form Design Space using Deep Generative Models](#)," *Proceedings of the 2016 International Design Engineering Technical Conferences*, Charlotte, NC, Aug. 21-24, 2016.

Pan Y, Burnap A, Liu Y, Lee H, Gonzalez R, Papalambros PY (2016), "[A Quantitative Model For Identifying Regions Of Design Visual Attraction And Application To Automobile Styling](#)," *Proceedings of DESIGN 2016*, Dubrovnik, Croatia, May 16-19, 2016.

Stylidis K, Burnap A, Söderberg R, Papalambros PY (2016), "[A Preliminary Study of Trends in Perceived Quality Design Attributes in the Automotive Luxury Market Segment](#)," *Proceedings of DESIGN 2016*, Dubrovnik, Croatia, May 16-19, 2016.

Burnap A, Hartley J, Pan Y, Gonzalez R, and Papalambros PY (2015), "[Balancing Design Freedom and Brand Recognition in the Evolution of Automotive Brand Styling](#)," *Proceedings of the 2015 International Design Engineering Technical Conferences*, Boston, MA, Aug. 17- 20, 2015. **Best Paper Award**

Crowdsourcing

Burnap A, Gerth R, Gonzalez R, Papalambros PY (2017), "[Identifying Experts in the Crowd for Evaluation of Engineering Designs](#)", *Journal of Engineering Design*, 10.1080 / 09544828. 2017.1316013.

Maynard A, Burnap A, and Papalambros PY, "[User-Driven Segmentation of Design Data](#)," *Proceedings of the 2017 International Conference on Engineering Design*, Vancouver, Canada, Aug. 21- 25, 2017.

Burnap A, Ren Y, Gerth R, Papazoglou G, Gonzalez R, Papalambros PY (2015), "[When Crowdsourcing Fails: A Study of Expertise on Crowdsourced Design Evaluation](#)," *Journal of Mechanical Design*, 137.3: 031101.

Burnap A, Barto C, Johnson-Roberson M, Ren Y, Gonzalez R, Papalambros PY (2015), "[Crowdsourcing for Search of Disaster Victims: A Preliminary Study for Search System Design](#)," *Proceedings of the 20th International Conference on Engineering Design*, Milan, Italy, July 27- 30, 2015.

Ren Y, Burnap A, Papalambros PY (2013), "[Quantification of Perceptual Design Attributes Using a Crowd](#)," *Proceedings of the 19th International Conference on Engineering Design*, Seoul, Korea, Aug. 19-Aug. 22, 2013.

Burnap A, Ren Y, Papalambros PY, Gonzalez R, Gerth R (2013), "[A Simulation Based Estimation of Crowd Ability and its Influence on Crowdsourced Evaluation of Design Concepts](#)," *Proceedings of the 2013 International Design Engineering Technical Conferences*, Portland, OR, Aug. 4-Aug. 7, 2013.

Gerth R, Burnap A, Papalambros PY (2012), "[Crowdsourcing: A Primer and its Implications for Systems Engineering](#)," *Proceedings of the 2012 NDIA Ground Vehicle Systems Engineering and Technology Symposium*, Troy, MI, Aug. 14-Aug. 16, 2012.

Others

Proserpio, Davide and Hauser, John R. and Liu, Xiao and Amano, Tomomichi and Burnap, Alex and Guo, Tong and Lee, Dokyun (DK) and Lewis, Randall A. and Misra, Kanishka and Schwartz, Eric M. and Timoshenko, Artem and Xu, Lilei and Yoganarasimhan, Hema, Soul and Machine (Learning) (September 16, 2019). Available at SSRN: <https://ssrn.com/abstract=3454294>.

BOOK CHAPTERS

"[Nongradient Search - Chapter 7](#)", *Principles of Optimal Design (3rd Edition)*, Papalambros, P.Y., Wilde, D. J., Cambridge University Press, 2015.

HONORS AND AWARDS

Marketing Science Institute Research Priorities Award, 2019

Distinguished Ph.D. Dissertation Award - (University Wide) - Finalist, 2016

Best Paper Award, ASME International Design Engineering Technical Conference, 2015

Best Presentation Award, 20th Automotive Research Center Conference, 2014

Outstanding Graduate Student Instructor, UM College of Engineering Towner Prize, 2014

Rackham Graduate School Research Grant, 2014

Design Science Fellowship, 2013

INCOSE Certificate of Recognition, 2012

INVITED TALKS AND OTHER PRESENTATIONS

"Design and Evaluation of Product Aesthetics: A Human-Machine Hybrid Approach"

Faculty Candidate Interviews at AMA and Flyouts, 2019

INFORMS Marketing Science, Rome, Italy. 2019

Triennial Invitational Choice Symposium, Cambridge, MD, 2019.

MIT Sloan: Marketing Seminar Series, Cambridge, MA, 2019.

Invited Talk: Design Science Seminar Series, Ann Arbor, MI, 2018.

INFORMS Marketing Science, Philadelphia, PA. 2018

"Identifying Design Gaps in the Market: Deep Choice Models with Probabilistic Design Constraints"

Triennial Invitational Choice Symposium, Cambridge, MD, 2019.

"A Technical Brief on Deep Conjoint Analysis and Interpretable Machine Learning"

Invited Talk: Korea Advanced Institute for Science and Technology (KAIST), Daejeon, 2019.

"Improving Early-Stage Marketing and Design via Probabilistic Integration of Product Lifecycle Data"

Invited Talk: National Institute of Standards and Technology (NIST), Gaithersburg, MD, 2019.

"Demand Forecasting with Time-Series and Spatial Data"

GM Advanced Analytics, General Motors Renaissance Center, Detroit, Michigan. 2017.

"Deep Learning to Predict Aesthetic Appeal"

GM Advanced Analytics, General Motors Technical Center, Warren, Michigan. 2017.

"Data-Enabled Scalable Design: Predicting Complex User-Design Systems to Design at Scale"

Faculty Candidate Job Talk, Mechanical Engineering, MIT, Cambridge, MA. 2016/17.

Faculty Candidate Job Talk, Engineering Design, Penn State, State College, PA. 2016/17.

"Analytical Target Cascading for Coordination of Large-Scale Systems Engineering Problems"

INCOSE - Michigan Chapter, Southfield, MI. 2017.

"Design Preference Elicitation: A Design Science Approach Fusing Engineering, Psychology, and Computer Science"

MIT-SUTD International Design Center, Singapore. 2016.

"Improving Conjoint Analysis with Feature Learning"

GM R&D, General Motors Technical Center, Warren, Michigan. 2016.

"Deep Learning for Design Preference Prediction"

GM Global Market Research, General Motors Technical Center, Warren, Michigan. 2016.

"Consumer Choice Prediction using Online Interactive Surveys"

Laboratoire G'enie Industriel, CentraleSup'elec, Paris, France. 2016.

"Data-Driven Design"

MENTORSHIP

Graduate

Mike Wang (MIT, now Uber)

Nan Du (MIT)

Yanxin Pan (UM, now Walmart Analytics)

Undergraduate

Ashley Lee (MIT)

Shreyan Jain (MIT)

Chunchun Wu (MIT)

Jing Lin (MIT)

Jintao Chen (MIT)

Kayo Puri (MIT)

Alex Maynard (UM, now Stanford)

Miao Zi Wee (Microsoft)

Christina Gandolfo (UM, now Herman Miller Design)

Carli Oster (UM, now Apple Design)

Giannis Papazoglou (UM, now TU Delft)

Charlie Barto (University of Michigan)

FUNDING

Marketing Science Institute , Research Priorities Funding	2019
General Motors Corporation , Research Fellowship	2017, 2018
NVIDIA Corporation , Deep Learning Research Grant	2017
Massachusetts Institute of Technology , Undergraduate Research Support (x6)	2017, 2018
Amazon , Computational Cloud Resource Grant	2018
University of Michigan , Rackham Research Grant	2015

SERVICE

INFORMS

Marketing Science 2018 - Machine Learning in Text Analysis and Design - Session Chair 2018

National Science Foundation

Grant Proposal Expert Reviewer – ED&SE – Mathematical Optimization 2019

Grant Proposal Expert Reviewer – ES&D – Mathematical Optimization 2017

Design Science Journal, Technical Coordinator 2016 - Present
Open-access journal launched to integrate product design viewpoints from engineering, marketing, arts and humanities, and philosophy.

Design Society

International Conference on Engineering Design - Scientific Committee - 2019

DESIGN Conference - Scientific Advisory Board - 2018

North American Chapter - Early Researcher Committee - 2016

International Conference on Engineering Design - Scientific Committee - 2017

American Society of Mechanical Engineers

Intl. Design Engineering Technical Conference - Data-Driven Design Session Chair - 2019

Intl. Design Engineering Technical Conference - Data-Driven Design Session Chair - 2018

Intl. Design Engineering Technical Conference - Design Decision-Making Session Chair - 2018

Intl. Design Engineering Technical Conference - Data-Driven Design Session Chair - 2017

Publication Reviewer

Journal of Mechanical Design

Journal of Engineering Design

Design Science Journal

Computer-Aided Design

Journal of Mechanical Engineering Science

International Design Engineering Technical Conference

International Conference on Engineering Design

Journal of Automotive Engineering

Industrial and Systems Engineering Transactions

American Society of Mechanical Engineers Press - ACIER Series

MEMBERSHIPS

Institute for Operations Research and the Management Sciences (INFORMS)

American Marketing Association (AMA)

American Society of Mechanical Engineers (ASME)

Design Society (DS)

REFERENCES

John Hauser

Kirin Professor of Marketing

Massachusetts Institute of Technology

hauser@mit.edu

Panos Y. Papalambros

Donald Graham Prof. of Mechanical Engineering

University of Michigan

pyp@umich.edu

Fred Feinberg

Joseph Handleman Professor of Marketing

University of Michigan

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Richard Gonzalez

SELECTED PUBLICATION ABSTRACTS

Design and Evaluation of Product Aesthetics: A Human-Machine Hybrid Approach

(with John Hauser and Artem Timoshenko)

Aesthetics are critically important to market acceptance in many product categories. In the automotive industry in particular, an improved aesthetic design can boost sales by 30% or more. Firms invest heavily in designing and testing new product aesthetics. A single automotive “theme clinic” costs between \$100,000 and \$1,000,000, and hundreds are conducted annually. We use machine learning to augment human judgment when designing and testing new product aesthetics. The model combines a probabilistic variational autoencoder (VAE) and adversarial components from generative adversarial networks (GAN), along with modeling assumptions that address managerial requirements for firm adoption. We train our model with data from an automotive partner—7,000 images evaluated by targeted consumers and 180,000 high-quality unrated images. Our model predicts well the appeal of new aesthetic designs—38% improvement relative to a baseline and substantial improvement over both conventional machine learning models and pretrained deep learning models. New automotive designs are generated in a controllable manner for the design team to consider, which we also empirically verify are appealing to consumers. These results, combining human and machine inputs for practical managerial usage, suggest that machine learning offers significant opportunity to augment aesthetic design.

Predicting “Design Gaps” in the Market: Deep Consumer Choice Models under Probabilistic Design Constraints (with John Hauser)

Predicting successful new product designs and market opportunities is fundamental goal to successfully launching and marketing new products. Both marketing and engineering have a long history of quantitative approaches to identify diverse consumer preferences to identify a “design gap.” Marketing researchers have tended to focus on market opportunities; engineering researchers on technical feasibility. A true competitive design gap is one that meets new consumer needs and is feasible to produce profitability. We use a custom deep learning approach to identify design gaps, not yet known to the firm, that are feasible, cost-effective, desired by consumers. We test our approach for the U.S. automotive market using several years of real purchase data. Not only does our approach predict consumer choices extremely well among existing products, but we are able to retroactively identify successful designs that we held out entirely from model training. Our evidence shows promise for early identification of market opportunities that are both feasible to produce and demanded by consumers.