The Impact of IT on Product Architecture and Project Outcomes

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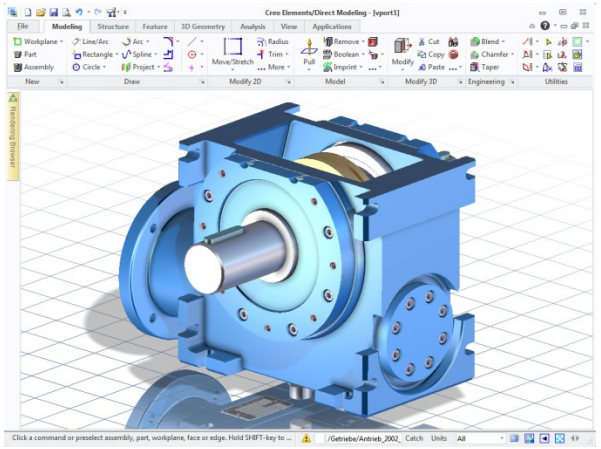
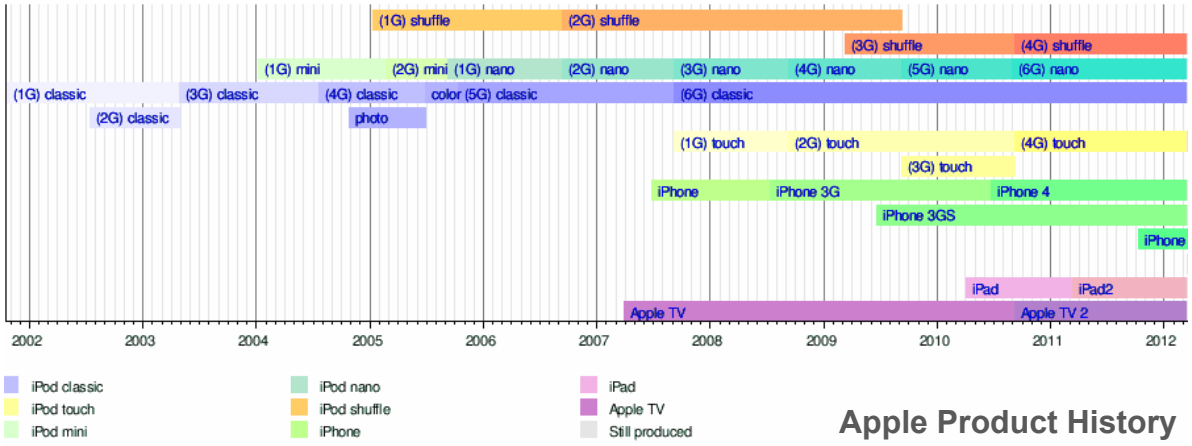
Research Motivation

How does this…



Impact this…

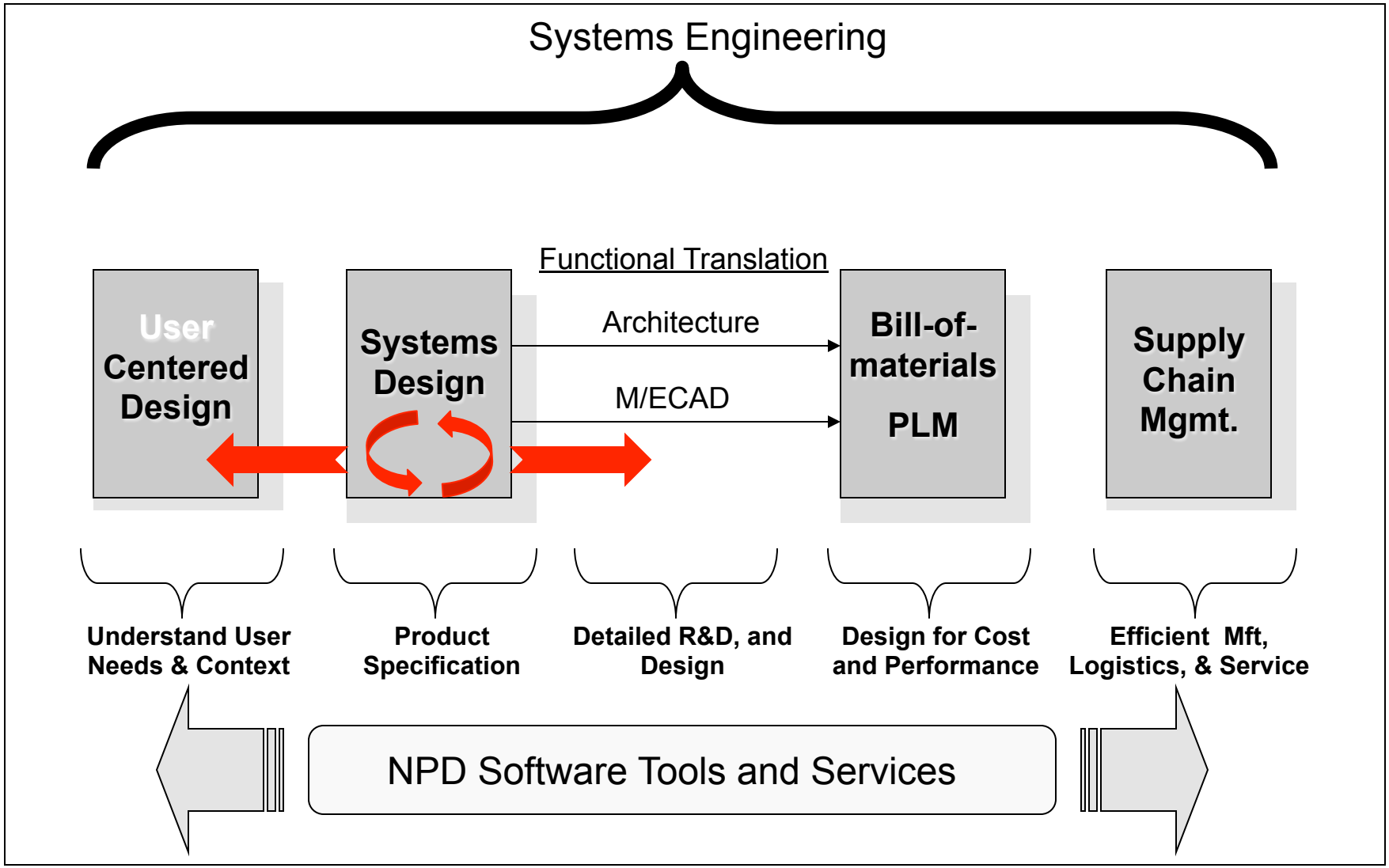


Apple Product History

Research Motivation

- Within *Systems Engineering*, *Systems Design* focuses on the planning of architecture, sub system interfaces, and the development of scalable product platforms
- The translation of customer requirements to architecture to defined platforms is a key aspect of *front-loading,* a key component of effective and efficient new product development (NPD)
- Unfortunately, many firms still struggle with the development of robust architecture and product platforms, while others, notably Apple and Honda, continue to have successful implementation generation after generation
- There is currently a lack of empirical research on the corporate NPD attributes that increase the efficiency and effectiveness of Systems Design and product architecture

Research Motivation

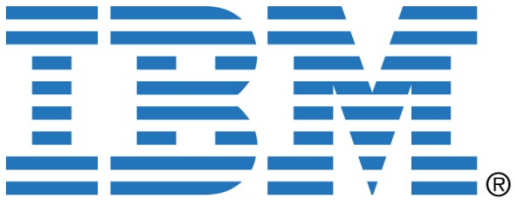


Critical Factors

- A robust product architecture allows the firm to reconfigure the architecture into new products without the loss of functionality (Shilling, 2000)
- Barczak (2009) noted the importance of NPD strategy, cross-functional teams, and the use of IT engineering tools (such as CAD) with the highest performing firms
- In this study, we are looking at, from a *project-level* perspective:
  - Team collaboration
  - Their use of digital design tools
  - Their IT infrastructure
  - Embeddedness of IT within their organization

Team Collaboration

- **Pertinent examples of the effort collaborative teams have undertaken in developing product architecture and associated product platforms include:**

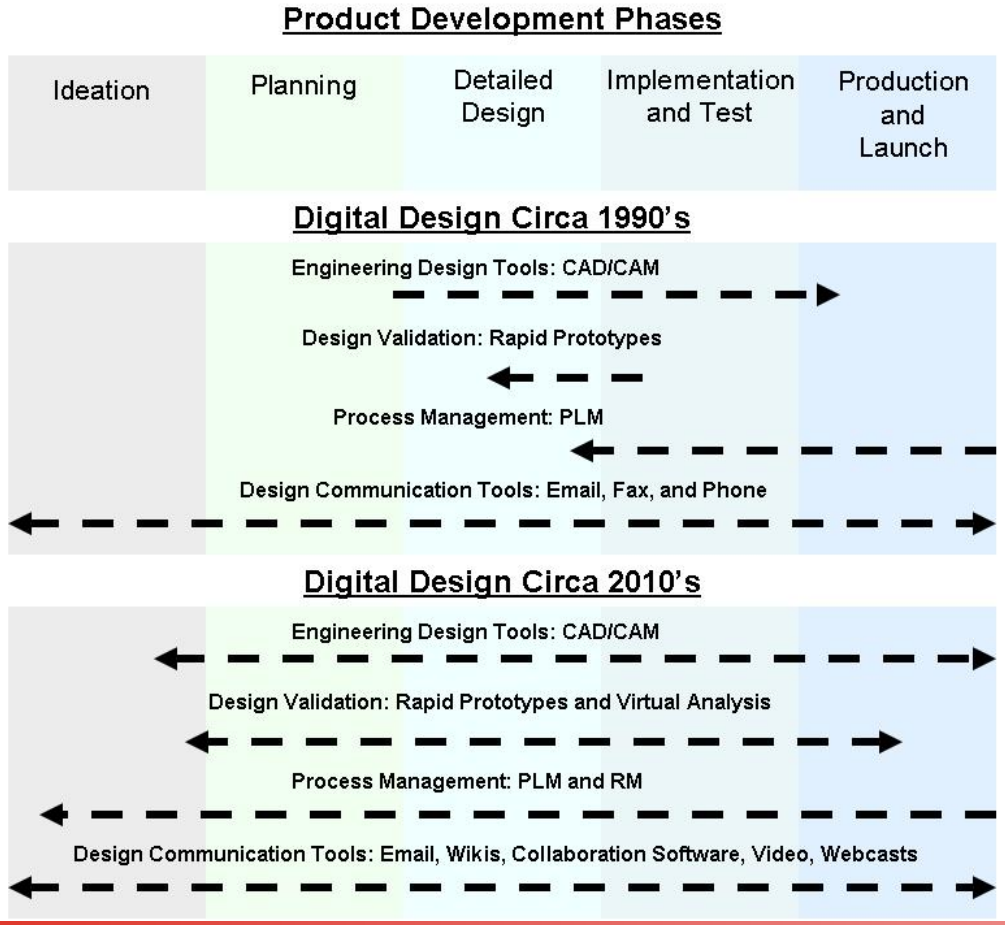


- **Team collaboration has been viewed as a critical factor in NPD since the late 1960's…**

> ***"Because the teams involved talked to each other as they began to see or anticipate the unexpected problems; they were able to mitigate them before the product testing phase of the project, resulting in considerable time and cost savings potential." Sousa, 2007.***

Digital Design and Support Tools

- **High-quality communication is essential as the functions involved in architecture design need to integrate their parts and components to ensure that the complete product works as it should.**

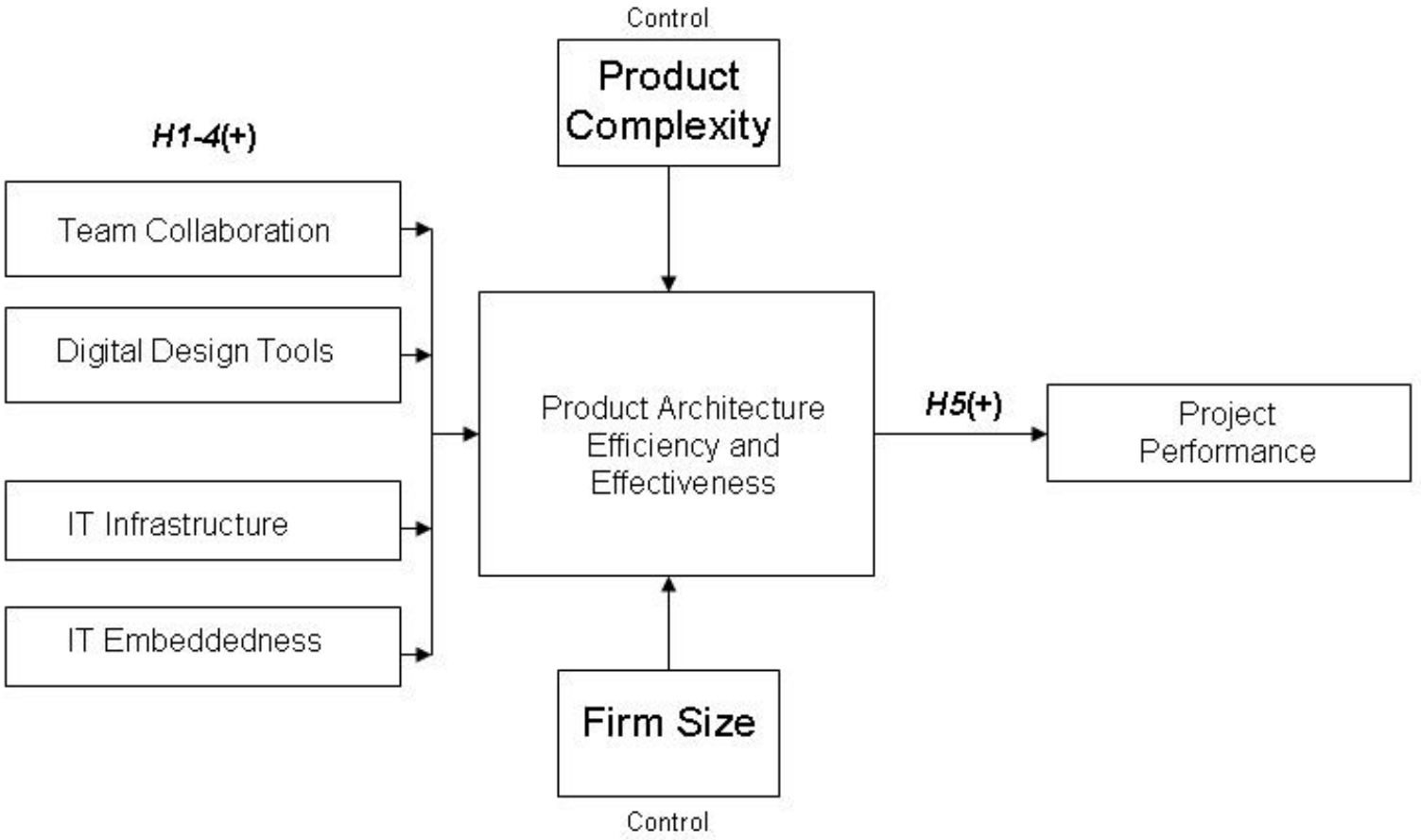


Marion et al., 2012

IT Infrastructure and Embeddedness

- IT infrastructure is defined as the computer hardware, software, and human resources necessary to support wide distribution of IT tools and includes the sophistication of the infrastructure (Sethi, Pant, and Sethi, 2003).
- Although previous research has found no relationship between IT infrastructure and IT usage (Barczak et al 2007), IT has been shown to increase product effectiveness (Boutellier et al 1998).
- We argue that a robust IT infrastructure would allow all NPD personnel to have access to the same IT tools and support structure.
- IT embeddedness is defined as the degree to which IT tools play an important part in the development of new products, in the sharing of information among project team members and in managing the interdependencies of the NPD project team (Sethi, Pant, and Sethi, 2003).

Research Model



Research Methodology

- Database of >250 multinational firms developing mechatronic products developed in conjunction with PTC
- Confidential and anonymous survey distributed
- Final sample contains 122 observations with 3 controls, 8 independent variables, and 16 dependent variables
- Basic statistics, Cronbach Alpha, Non-response bias, multicollinearity, heteroscedasticity tests were performed on the data.
- The scales are data pass all required validation requirements
- Analyses performed include regressions for OLS, Ordered Logit and Ordered Probit models, and predictive probability
- Results presented here are OLS regressions models

Sample Characteristics

- **Sample comprised of large, multinational firms**
- **Data collected on the project-level, from engineers**

Number of Employees		Location		Respondents	
0-100	12%	U.S. Only	14%	Engineering	92%
100-500	19	Multinational	86%	R&D Manager	8%
500-1,000	10				
1,000-5,000	19				
5,000-10,000	8				
>10,000	31%				

Descriptive Statistics

- **Some correlation is to be expected**
- **Variance inflation factors and heteroscedascity are non-issues**

Variables	Firm Size	Complexity	Team Collaboration	CAD and Support Tools	IT Infrastructure	IT Embeddedness	Product Architecture Effectivness	Project Performance
Product Complexity	0.357***							
Team Collaboration	0.168*	0.447***						
Digital Design Tools	0.082	0.440***	0.575***					
IT Infrastructure	0.227**	0.324***	0.489***	0.641***				
IT Embeddedness	0.209**	0.264**	0.436***	0.662***	0.702***			
Product Architecture	-0.008	0.083	0.506***	0.390***	0.479***	0.297***		
Project Performance	-0.074	0.083	0.434***	0.286***	0.290***	0.210**	0.504***	N.A.
Mean	3.88	5.04	4.85	5.08	4.90	4.69	4.16	
Standard Deviation	1.87	1.09	1.38	1.33	1.20	1.53	1.10	

*$p<.1$
**p<.05
***<.01

Results

- OLS regressions, individual independent variables

Regression Model 1

Hypothesis	Independent Variables	Efficient and Effective Product Architecture	VIF
	Firm Size (Control 1)	(0.102)*	1.243
	Product Complexity (Control 2)	0.107	1.532
H1	Team Collaboration	0.283***	1.663
H2	Digital Design Tools	(0.029)	2.579
H3	IT Infrastructure	.381***	2.318
H4	IT Embeddedness	(0.085)	2.390
	R^2	0.363	
	Adj. R^2	0.329	
	F-value	10.9	
	df	121	
	N	122	
	*p<.1		
	**p<.05		
	***<.01		

Regression Model 2

	Independent Variable	Project Performance	VIF
H5	Efficient and Effective Product Architecture	0.569***	1.110
	R^2	0.261	
	Adj. R^2	0.242	
	F-value	13.91	
	df	121	
	N	122	
	*p<.1		
	**p<.05		
	***<.01		

Results

- Negative relationship between firm size and an effective and efficient architecture
- Increased team collaboration has a substantial, positive impact on the development of efficient and effective product architecture (0.283, $p<.01$)
- A firms IT infrastructure has a strong, positive relationship with an efficient and effective product architecture (0.381, $p<.01$)
- Digital design and support tools and embeddedness of IT within the organization had no significant, positive impact on efficient and effective product architecture
- Efficient and effective product architecture has a positive impact on project outcomes in obtaining performance objectives (0.569, $p<.01$), showing strong support for *H5*

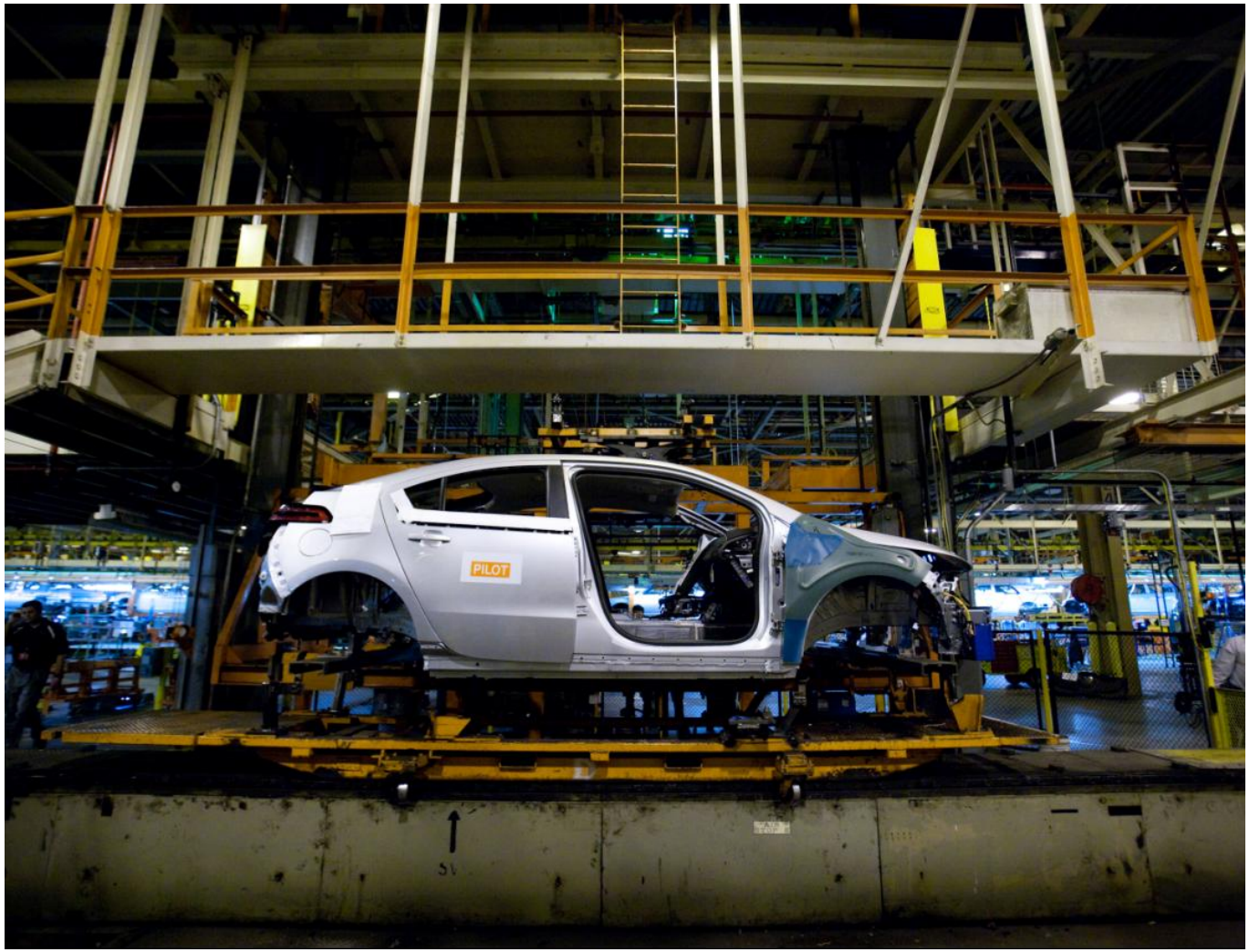
Discussion

- Firms that are smaller, with highly collaborative teams, and a robust IT infrastructure have better architecture and better project outcomes
- Digital design and support tools per se did not have an impact on architecture or outcomes
- i.e. the *'road'* and *'driver interaction'* is more important than *'the car you drive'*
- Teams can use face-to-face meetings, and traditional methods of communication (phone, email, etc.). It's just important that they speak with one another!
- Focusing on architecture is a key aspect of front-loading, and firms that focus on this, have better performance to objectives

Future Research and Trends

- Continued study of project-level engineering activities and digital design tool usage by phase
- Improvements in ease-of-use and capability of tools
- Better understanding of knowledge management best practices
- Focus on up-front modeling / planning and digital tools
- Impact of open innovation on product development in each phase
- Customization of software suites and capabilities for different corporate infrastructure needs (SMEs versus large multi-national firms)
- The balance between fuzziness and precision at the front-end

Discussion



Thank you!

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