MANAGING DIGITAL TRANSFORMATION

Per Andersson, Staffan Movin,
Magnus Mähring, Robin Teigland,
and Karl Wennberg (eds.)

Managing Digital Transformation

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Karyn McGettigan, Language Editor

SSE INSTITUTE FOR RESEARCH

Address:
Stockholm School of Economics Institute for Research (SIR)
Box 6501, SE-113 83 Stockholm, Sweden
Visiting address: Sveavägen 65, Stockholm City
Phone: +46(0)8-736 90 00
www.hhs.se/en/Research/Institutes/institute-for-research/
publications@hhs.se

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STIFTELSEN MARKNADSTEKNISKT CENTRUM

In his central role at the Wallenberg Foundations,
Peter Wallenberg Jr has furthered a broad range of important research
and research-led education initiatives at the Stockholm School of Economics
(SSE) and its Institute for Research (SIR). This indispensable work has also
helped create a fertile ground for research on digital innovation and
transformation: a phenomenon currently experienced, shaped, and
managed in and between organisations and throughout society.

This is the topic of this book, which we dedicate to him.

Contents

Acknowledgements 10
Introduction 12

Digitalization: Different Perspectives

1. Strategic Challenges of Digital Innovation and Transformation 17
Per Andersson and Christopher Rosenqvist

2. Reaping Value From Digitalization in Swedish Manufacturing Firms: Untapped Opportunities? 41
Magnus Mähring, Karl Wennberg, and Robert Demir

3. Digital Platforms: A Critical Review of the Core Concepts 65
Henrik Glimstedt

The Digital Customer

4. Catering to the Digital Consumer: From Multichannel to Omnichannel Retailing 97
Sara Rosengren, Fredrik Lange, Mikael Hernant, and Angelica Blom

5. Digital Trace Data: Which Data Should we Collect and What Should we do Once we Have it? 115
Claire Ingram Bogusz

6. Managing Digital Media Investments 133
Erik Modig and Martin Söndergaard

Re-Organisation in Order to Bridge the Gap to Digital Customers

7. Digitalization of Professional Services: The Case of Value Creation in Virtual Law Firms 155
Tale Skjølsvik, Karl Joachim Breunig, and Frida Pemer

8. Robotisation of Accounting in Multi-National Companies: Early Challenges and Links to Strategy 175
Martin Carlsson-Wall and Torkel Strömsten

9. Uncertainty and Complexity in Predictions From Big Data: Why Managerial Heuristics Will Survive Datafication 189
Gustav Almqvist

10. Explaining the Behaviour of News Consumption 203
Adam Åbonde

11. Digital Transformation Supporting Public Service Innovation: Business Model Challenges and Sustainable Development Opportunities 217
Per Andersson and Lars-Gunnar Mattsson

Business Models and Ecosystems

12. The Role and Potential of IoT in Different Ecosystems 243
Jan Markendahl, Stefan Lundberg, and Staffan Movin

13. Digitalization, Collective Intelligence, and Entrepreneurship in the Care Sector 265
Erik Lakomaa

14. AgTech and the City: The Case of Vertical Farming and Shaping a Market for Urban-Produced Food 281
Maria J. Bustamante

Future Outlook

15. Future Outlook on Digitalization 301
Robin Teigland, Claire Ingram Bogusz, and Anna Felländer

About the Authors 333
An Assortment of Our Latest Publications 341

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Every year since 1992, the Stockholm School of Economics Institute for Research (SIR) has published an Annual Research Anthology, and this year SIR is publishing the book in cooperation with MTC (Stiftelsen Marknadstekniskt Centrum). The purpose of the SIR Annual Research publication is to enable managers and practitioners better understand and address strategically important challenges by showcasing SSE research on a selected topic of importance for both business and society.

This year's book, *Managing Digital Transformation,* features authors from academic areas across SSE together with representatives outside the institution. The book's eighteen chapters show the strength and breadth of SSE's research within the area of digitalization and reflect the importance that SSE places upon closely linking research to practice and on investigating the leadership challenges and their implications in order to support value creation in society.

Participating in the many ongoing research projects at SSE and the multitude of aspects of digital transformation addressed in the various chapters has been very rewarding for the editors. We would like to thank all the authors for their hard work and cooperation throughout the project. In finalising this book, we have relied upon the expert work of Karyn McGettigan for language editing, Petra Lundin for layout and graphic design, and Marie Wahlström for digital access to the book. We are, indeed, most grateful for their excellent and diligent work.

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Stockholm, January 2018
Per Andersson, Staffan Movin, Magnus Mähring, Robin Teigland, Karl Wennberg

Introduction

One of the hottest research topics lately is digitalization. Many research projects are focusing upon different perspectives. Gone are the days when digitalization or business implications of ICT were just about increasing efficiency. Instead, the ripple effect of digital development can now be felt wider and deeper than ever before. The way in which business is conducted and how it creates value, as well as how corporations can become more efficient and sustainable, are all implications of digitalization. Adapting to new demands and taking advantage of the plethora of possibilities, however, is not always easy.

Managing digitalization and the transformation of business always involves new challenges. The novelty and complexity of the digital age has led to an increased academic interest in the area of digital transformation and a call from companies that seek support in this process.

We take a look at digitalization from the perspective of business research. This creates a better understanding of the challenges that today's businesses are facing. We believe this anthology will serve as a tool to help businesses better understand the force that is digitalization and support these corporations in their digital transformation.

The idea behind this anthology grew as Marknadstekniskt Centrum was taking part in several interesting research projects. Companies were asking MTC to facilitate contact with scholars and supply them with academic insight. Vinnova came on board, by supporting the project *Progressiv digital utveckling förutsättningar för framgång (Progressive Digital Development: Pre-Requisites for Success)* of which this book is a part: its aim to stimulate business to become more progressive in digital change. At last, this book and the website www.digitalchange.com have become a reality.

This joint venture between Marknadstekniskt Centrum and The Stockholm School of Economics Institute for Research follows the SIR tradition of publishing an annual yearbook to showcase its vital research contributions. The book begins with an overview of digitalization, then moves to understanding the new digital customer, and ends by exploring re-organisational effects, business models, and ecosystems. We hope this year's anthology will be useful for managers by facilitating their digitalization processes.

PART 1: DIGITALIZATION – DIFFERENT PERSPECTIVES

The role of digital technology in business and society is rapidly shifting from being a driver of marginal efficiency to an enabler of fundamental innovation and disruption in many industrial sectors, such as media, information and communication industries, and many more. The economic, societal, and business implications of digitalization are contested and raise serious questions about the wider impact of digital transformation. Digitalization affects all private and public operations, as well as the internal and external workings of any operation. Digitalization is the major driving force behind sweeping large-scale transformations in a multitude of industries. Part 1 includes various perspectives on digitalization and digital transformation.

PART 2: THE NEW DIGITAL CUSTOMER

Digitalization has resulted in more user-centric business and user-centric systems. The changing behaviour of the digital consumer/customer is discussed here as it connects to new forms of customer involvement and engagement, as well as analysis models of what creates customer value in this digital context.

PART 3: THE RE-ORGANISATION IN ORDER TO CONNECT WITH THE DIGITAL CUSTOMER

How can companies connect with digitalized consumers and non-digitalized customers? This is a central issue in managing digital transformation, as it draws attention to the emerging intra-organisational, marketing, and customer interaction challenges associated with digitalization: for both the consumer and the supplier. Another aspect of this is the internal handling of new forms of organizational ambidexterity; that is to say, companies and organizations engaged in digitalization processes often require an internal re-organisation in order to handle the demands that digitalization brings, and to explore new digital opportunities while promoting their existing business and operations.

PART 4: BUSINESS MODELS AND ECOSYSTEMS

How do companies change, adapt, and innovate their business models? Given that digitalization leads to a convergence of previously unconnected or loosely connected markets, the digitalizing company and organisation is analysed in its systemic and dynamic context. This part draws attention to business models and business model innovation. Incumbent firms need to adapt and change business models while competing with digital start-ups based upon new scalable business models, accessible ventures, and rapid processes of intermediating. These chapters discuss completely new co-operative business models: processes that need to be developed as companies shift from products to digitally based services.

The Ecosystem places digitalizing organisations and companies into their broader and systemic context. This includes discussions on digital disruption, industrial convergence processes, and shifting patterns of competition and cooperation. Digital technologies cause markets to converge in many new and sometimes unexpected ways. The result is the emergence of new roles and market positions of technical platforms.

Staffan Movin, Stiftelsen Marknadstekniskt Centrum

Digital Platforms: A Critical Review of the Core Concepts

HENRIK GLIMSTEDT

The Inverted Smile

Remember the *smile*?

Comments on the economics of computer manufacturing in 'new economy' in the 1990s often referred to a U-shaped curve, which illustrated the uneven distribution of profitability between the different kinds of actors in the personal computer industry. Both manufacturers of branded personal computers and the manufacturers of PC clones operated in the shadows of two specialized component suppliers: Microsoft and Intel. These two businesses organizations provided most of the value added, whilst they also captured the lion's share of the profit pool. Hardware components and software applications lived somewhere in between those two polar positions, depending upon degree commoditization.

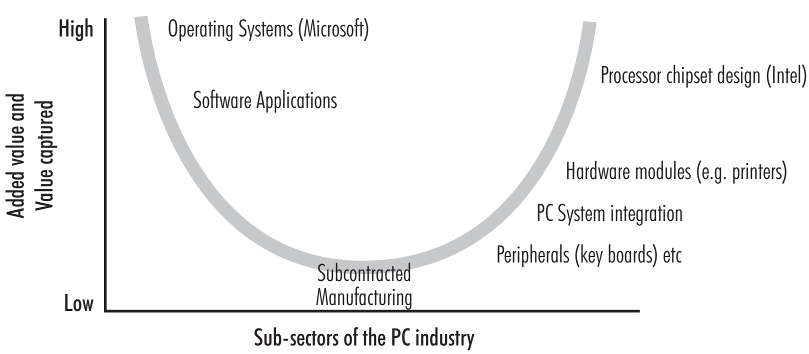

Figure 3.1. Wintel: The Smile Shaped Curve

Recent developments in the contemporary digital economy have turned the concept of the smile into a less useful template. In particular, system integrating device manufacturers have risen from rags to riches; successful device integrator manufacturers, such as Apple, sees profit margins far superior to those of even the more component suppliers. The economic value of operating systems – once the stellar performers of the digital economy – seems to have eroded definitively, especially since Google released its free of charge open source OS for mobile devices[1]. How about software applications? What about software? The growth in terms of software output has been staggering since the smartphone revolution, especially in the app markets that Apple and Google/Android have organized. Apple likes to talk about its AppStore, in terms of a booming business. A little more than 0.7 billion customers/users can now choose from 2.1 million different apps, accounting for 100 billion accumulated downloads (Reisinger, 2017). While growth, in terms of output of software, is striking. The independent software developer's revenue figures tell us a different story. Game apps, with market leading Clash of Clans, absorb 85% of the profit pool. For most developers, the App Store resembles a lottery: for every hit like Candy Crush, hundreds or even thousands of apps languish in obscurity. In 2016, Apple paid approximately $50 billion to app developers (Perez, 2016), indicating that app developers offer a substantial part of all apps for free or at very low cost (e.g. $1). Forbes already flagged in 2013 that no less than 55% of all for-profit apps failed to even fetch $1,000 in revenue; only a fraction of the more successful app development companies reporting revenues above $5000 per month, thus, concluding that "a hard-working developer on iOS will eventually be able to get a new car, while Android and Microsoft developers will be forced into the used car market, if they plan to take those earnings on the road."(Louis, 2013) As for hardware, the sector suffers from exposure to concentrated demand: for example, Apple and Samsung. Steep investments in the latest sub-22 nanometre technologies must also be made at prohibiting costs to all who remain viable as suppliers. Leading chip vendors, such as Qualcomm and Broadcom, respond in the same fashion as low margin contract manufacturers have done for decades: mergers in search of control of even greater production

1 According to numbers released officially by Redmond, Windows mobile operating system dropped from a 1.2 per cent market share at the end of 2015 to a new low of 0.3 per cent by the end of Microsoft's third financial quarter in 2016. Those numbers show that the business of selling operating systems as a standalone product for profit is dead.

volumes to amortize sky-rocking manufacturing costs for the latest generations of chip technologies. According to Handel Jones, a semi-conductor industry analyst, only five companies are making sufficient investments to support leading edge manufacturing capabilities today: down from nearly 20 a decade ago. Lesser chip vendors either make their exit, or stick with older generations of processor node technologies: that is to say, >32nm. Whereas software and hardware companies find themselves entangled in intensive competition and "price taking", the major platform companies capture the largest chunk of the profit pool of the digital economy. Tech strategist Wos Ahmed[2] (2016) writes: "Today, the consumer captures a lot of end use value. The functions in my iPhone are a testament to this. Nearly all the economic value goes to Apple: from the application processor through to retail, apps, and services. Foxconn earns low single-digit operating profit margins and the rest of the value system – vendors of IP, semiconductors and display panels, etc. – fights over the rest."

In 2016, the top 15 public platform-based companies represented no less than US$2.6 trillion of the world market capitalization. Some platforms are household names: such as Microsoft, Amazon, Apple, Google, and Alibaba. Others have emerged more recently or hail from parts of the world that get less attention: such as ARM (Great Britain), Rakuten (Japan), Delivery Hero (Germany), Naspers (South Africa), Flipkart (India), or Javago (Nigeria). Thus, a new general orthodoxy has emerged as a "strategy of last resort" for tech companies. Writing for Accenture, the global advisory, Lacy, Hagenmueller, and Ising (2016) offered the following view to prospective customers:

"Players across industry clusters are entering existing platforms or collaborating to build new products, services, and customer experiences on enabling platforms. Or businesses are expanding into other industries by using existing platforms–or creating their own. Previously 'independent' products and service suppliers are now part of one large competitive set. This leads to a new landscape where former competitors are now working closely together, and former collaborators become competitors. And while this expanded competitive circle may seem a threat, it is also an opportunity."

Observations of value creation and value capture in platform economies bring business strategies to the forefront, as well as governance of networks and industry architecture. The billion-dollar question concerns whether the

2 https://www.linkedin.com/pulse/business-semiconductor-part-one-what-happened-woz-ahmed/

actions in which a firm takes may, indeed, shape the industry architecture: with the intent to skew to their advantage capacity for capturing value from innovations along the value chain.

Executives, consultants, and academics are armed with showcase examples ranging from personal computers in the 1990s to the contemporary case of Uber. They push hard to support the idea that modular platform will change industrial architecture, bringing massive productivity gains, and even contribute to the collapse of old established incumbents. In the late 1990s and early 2000, a widely believed notion was that modular platforms would change the architecture of the global automotive industry: shifting the capacity for innovation from incumbents' OEMs to "first tier mega-suppliers", thus, servicing the OEMs with modules the way that Microsoft and Intel innovated on behalf of HP and other manufacturers of personal computers[3]. More recently, loud voices including those at PwC, Accenture, McKinsey & Co, and KPMG (the list is long) all advocate that "open platform banking" collectively organized by ecosystems of innovative FinTech companies, or some version thereof, will disrupt the giant incumbents. And, as the argument runs, that will be the end of banking as we know it (e.g. deJong, Little and Gagliardi, 2016). The numbers are certainly suggestive. Europe anticipates banking regulations that require incumbent banks to share proprietary data through open "application interfaces"[4]. Uncertain if they have the right ideas for open platform banking and financial innovation, incumbent banks and investors congregate around the new generation of FinTech start-ups. Global venture investment in FinTech grew by 11%: up to $17.4 billion in 2016; it is the first time China – with its $7.7 billion of investment in FinTech – outpaced the US with its $6.2 billion. Ant Financial, formerly Alipay and a subsidiary of Alibaba, led 2016 with a whopping $4.3 billion venture round: the largest in FinTech's venture history (Wintermeyer, 2017). Yet, the jury for open platform banking is still out, leaving us to question whether investments in open

3 According to a Bain & Company report by Donovan (1999), "The new giant suppliers will quickly move to designing vehicle systems that can be 'standardized' within and across OEMs–in other words, used in multiple models of an OEM and eventually by multiple OEMs." According to some academics, autos would mirror IT: "Chrysler has played the role of the Compaq of the automotive industry. Chrysler's strategy allows suppliers–even Ford's and GM's internal suppliers–to strengthen their capability to develop whole automotive subsystems, thereby, pushing the entire structure of the industry from vertical toward horizontal (Fine, 1998, p. 62)."

4 Regulation PSD2 in the European Union, and Open Banking Standard in the United Kingdom.

platform banking will be as futile as the billion dollars invested in automotive modular mega-suppliers around the new Millennium.

Emergence: The Basic Enabling Technologies and Definitions

In a sense, today's digital platforms are just the more complicated cousins of two 19th-century innovations: the self-playing piano and Joseph Marie Jacquard's famous silk loom from 1801. Both innovations separated pre-programmed instructions (punctuated paper music rolls and silk patterns stored in sets of punch cards) and the machinery execution that, in turn, enabled the formation of rudimentary ecosystems of composers and silk pattern designers[5]. Modern platforms, of course, support more elaborate forms of integrations. Generally speaking, we define this by comprising three elements: a core technology that serves as a foundation, additional modular technologies that integrate or connect with this core, and the interfaces in-between (Baldwin and Woodard, 2008; Tiwana, Konsynski and Bush, 2010). According to the loosest possible depictions, the term "digital platform" simply points to a set of online digital arrangements whose algorithms serve to organize and structure economic and social activity (Kenney and Zysman, 2016). The core technology is typically formed around a specific standard (for example, GSM, VHS, and Ethernet) or the arrangement of standards compiled into an operating system: such as Microsoft Windows (David, 1985; Farrell and Saloner, 1985; Cusumano, Mylonadis and Rosenbloom, 1992; Besen and Farrell, 1994; Von Burg, 2001) Especially in business, these arrangements also point to a set of digital frameworks for social and marketplace interactions. Therefore, platforms tend to build upon the formation of digital ecosystems. In sharp contrast to the sequential and linear notion of value creation of Porter's infamous value chain model (Porter, 1985), the general thrust in later conceptualizations of value creation has revolved around the idea of horizontal linkages and concurrent co-specialization between independent value network participants or "value constellations" and "value co-creation" as famously proposed

5 Joseph Marie Jacquard's loom was indeed the first binary information processor. At any given point, the thread in a woven fabric can be in one of two states or positions: on the face of the fabric or on the back. Pattern cards were punched or cut according to the required fabric design. A hole in the card signified that the thread would appear on the face of the fabric, while a blank meant that the end would be left down and appear on the back of the fabric. The Jacquard head was used on the weaving loom or machine for raising and lowering the warp threads to form desired patterns based upon the lifting plan or program embedded in the cards. Thus, the Jacquard mechanism set the stage for modern day binary information processing.

by (Normann and Ramirez, 1993; Vargo and Lusch, 2004). Indeed, a substantive subset of the literature proposes platforms as the coordinating artefact that a hub firm uses or the services, tools, and technologies that other members of the ecosystem can use to enhance their own performance (Gawer and Cusumano, 2002; Iansiti and Levien, 2002, 2004b, 2004a; Li, 2009)[6], [7].

Product Platforms: Internal and Supply Chain Platforms

Product development researchers generally see modular product platforms as the final answer to the question of how to develop and offer a greater variety of products to different market segments at a reduced cost. Their thinking starts with Herbert A. Simon's theory about hierarchies of interdependent problem having dynamics that are approximately independent to those of other subsystems (Simon, 1965). Herbert Simon famously said: "Every problem-solving effort must begin with creating a representation for the problem" and "solving a problem simply means representing it so as to make the solution transparent" (Simon, 1996: pp. 108 and 132). In other words, good representations can help to illuminate important dimensions of a problem. Simon's basic inclination was to differentiate between two approaches to solving problems in complex systems:

- *Integral systems* where the sub-system are tied together through a large number of technical interconnections with un-specified 'interface rules' for how different sub-systems work together, and
- *Modularized* systems where sub-systems are decomposed and tied together through a reduced number of technical interconnections with clearly defined interfaces between the different sub-systems.

6 As Jansen and Cusumano (2012) point out, the field of digital ecosystems is evolving. Originally, the concept of ecosystem was applied to study how traditional monolithic software service-oriented software architectures evolved into collaborative architectures: processes in which innovation by autonomous agents, self-organization, and sustainability were the main topics, More recently, this previous application of the concepts has faded into the background, giving way to a more strategic definition. Increasingly, the term digital ecosystem is being used as strategic behavior in digital business ecosystems.

7 The comparison to biological and natural ecosystem is easily made, but analogies only stretch so far. The main difference between digital and natural ecosystems is that biological ecosystems are mainly studied to observe influences from external factors, whereas software ecosystem dynamics are mainly analysed with the aim of growth and success. Software ecosystems are also made up of participants harboring intentionality, whereas the beings in a biological ecosystem have no means to consciously be part of the ecosystem. The largest difference between participants in software ecosystems and those in natural ecosystems, however, is that participants can consciously decide to exit the ecosystem or even destroy it in software ecosystems.

Simon suggested that problem solving in integral systems will be always cumbersome and time consuming because modifications to one part of the system may result in deleterious side effects elsewhere in the system. By contrast, Simon's research suggested that modularization of complex systems into nearly independent modules allow engineers to modify and improve subsystems independently, with limited unintended side-effects in other parts of the system. Hence, the idea about modular problem solving and the re-use of modules in ever-increasing ranges of product configurations to meet diversified demand is simple and powerful. Wheelwright and Clark (1992) famously introduced the concept of product platforms to describe a framework "for new products that meet the core customer requirement, but are designed for *easy modification* into derivative products through addition, substitution or removal of features" (p 73). Apart from the reduction in complexity (Simon, 1965; Parnas, 1972), the advantages of modular product platforms involve *economies of substitution* (Garud, Jain and Kumaraswamy, 2002), *enhanced customer flexibility* (Baldwin and Clark, 2000), and *organizational agility* in responding to changing environmental conditions (Galunic and Eisenhardt, 2001). Moreover, many have argued that modularity increases innovation (Baldwin and Clark, 2000). Because many firms are involved in the design and production of a modular system, there are more opportunities for innovation as there are potential innovators. Further, several firms are involved in the design and production of a product; its modules increase competition which, in turn, also spurs experimentation and innovation. Not only are there more potential experimenters who face increased competition; the costs of experimentation are also lower, given the fact they are split among multiple firms. Thus, modularity results in an elevated rate of trial-and-error experimentation, and in increased competition and innovation on the module-level (Langlois and Robertson, 1992).

Within the discussion on internal product platforms – particularly in research on the development of product platforms in machine tools, consumer electronics, and the automotive industry – product platforms have been defined by its degree of modularity. Most definitions of product platform focus upon re-using and sharing common elements – or use-cases – across complex products. The focus has been placed, to a large extent, on four dimensions: architecture, platform, modules and design rules (Ulrich 1994; Baldwin & Clark, 2000).

• *Platform:* The collection of bundled technological [physical] assets that are shared by a set of related products.

• *Architecture:* The [abstract] scheme by which the functions of a product is allocated to physical components, also defined as *modules*.

• *Module:* A unit whose internal structural elements are powerfully and integrally connected among themselves and relatively weakly connected elements in other modules.

• *Design Rules [or interfaces]:* The principles that govern the relationship between modules.

The general established criteria are that a platform embodies certain constraints or design rules, in terms of interfaces (or crossing points) between components; these govern the relationship between components. At these points, the interdependencies between components are defined by the interfaces, whilst other forms of interdependencies are ruled out by the design rules Therefore, internal product platforms refer the to modularization of complex system in which the platform itself remains stable, while modules are encouraged to vary in a cross-section or over time. The most stable element in a platform is the interfaces that control the mediation and point of interactions between modules. In turn, this defines the degree of modularity.

This product-oriented definition emphasises commonality of the systematic re-use of components across different products within a product family, which allow economies of scope in production to occur. Hence, the systematic creation and harnessing of economies of scope and mass-customization in innovation can be seen as one fundamental principle of platform-based new product development. Led by these inclinations, empirical studies within the product engineering studies have identified that these kinds of economies of scope can occur in a variety of industrial contexts (such as semi-conductors, machine tools, commercial aircraft manufacturing, automotive manufacturing, aerospace engine manufacturing, and consumer electronics). Expanding the focus from internal product platforms, such as Black & Decker's successful operation of its much-discussed internal platform for consumer electrical hand tools, empirical research has also documented how manufacturing platforms were increasingly being shared across firms within supply chains. (Helper and Sako, 1995; Helper, MacDuffie and Sabel, 2000; Brusoni, Prencipe and Pavitt, 2001;

Sturgeon, 2002; Zirpoli and Caputo, 2002; Becker and Zirpoli, 2003; Doran, 2003; Berger, 2005; Brusoni, 2005; Huang, Zhang and Liang, 2005; Park et al., 2009; Sako, 2009; MacDuffie, 2013; Jacobides, MacDuffie and Tae, 2016).

Industry Ecosystem Platforms (Product Innovating and Transactional)

Parallel to the evolution of platform thinking in product engineering, various scholars and industry observers began to discuss the networking of personal computing technologies' "industry-wide platforms" for information technology; these include Michael Bourrus & John Zysman (1997); William Lazonick (Lazonick, 2005, 2009); and, Michael Cusumano & Anna Gawer (2002). Zysman and Bourrus, coined the phrase *Wintelism*, to describe the rise of a new industry platform, competing against the vertically integrated computer manufacturers. The aforementioned research originally drew upon insights from business history on how the policies and processes (e.g. anti-trust) led to the raise of independent software companies a new generation of merchant chip manufacturers, epitomized as *the Fairchildren*. Eventually, this new generation American tech firms experienced the rise of Japan's successful semi-conductor manufacturers, which fiercely competed upon both price and quality in the late 1970s and early 1980s. This cut-throat context in semiconductor technologies, such as memory chips, lead tech firms in Silicon Valley-based pioneers to more advanced technologies in personal computing, which they identified as way of diversifying into new and less competitive segments. Hardware specialists such as Intel, however, lacked the competence to develop and market complex consumer electronics products. While the initial attempts to diversify into computers and other consumer products failed (for example, calculators), Intel and other Silicon Valley tech firms purified their specialisation strategies. They particularly embraced the idea of platforms linked together with sophisticated and less advanced components, thus, according principles of "open-but-owned" systems of standards[8]. The making of a new Wintelist era enabled a dramatic shift in the character of electronics production, moving away from

8 Key product standards under Wintelism, especially the interface specifications that permit inter-operability with the operating system or system hardware, are owned as intellectual property, yet are made available to others who produce complementary or competing components, systems or software products. Hence, the systems are "open-but-owned". The relevant technical standards are licensed rather than published, with either the universe of licensees, the degree of documentation of the technical specifications, or the permissible uses restricted in some fashion.

the dominance of vertically-integrated organizations that were built upon a closed-proprietary standard over to a decentralized value chain that both collaborated and competed within platforms, such as the PC.

More recently, platforms have been found to operate within even larger networks of firms that are not necessarily linked through buyer–supplier relationships. This is also known as “innovation ecosystems” (Adner and Kapoor, 2010; Nambisan and Sawhney, 2011) or “ecologies of complex innovation” (Dougherty and Dunne, 2011). *Such industry platforms* are then defined as ‘ …a building block, providing an essential function to a technological system, which acts as a foundation upon which other firms, loosely organized in an innovation ecosystem, can develop complementary products, technologies, or services (Tee and Gawer, 2009).

At the end of 2016, four of the top five public firms by market capitalization used platform business models. An open platform business model offers distinct economic advantages since it allows a firm to harness external innovation as a complement to internal innovation (Chesbrough, 2003a). While prevalent in information intensive industries such as search (Google), operating systems (Microsoft), and video games (Sony), open platforms have emerged in aerospace (Lockheed Martin), food spices (McCormick), T-shirts (Threadless), 3-D printing (MakerBot), and shoes (Nike). Thus, industry platforms are mainly viewed by a research hub or a central point of control within a technology-based business system (Gawer and Cusumano, 2002, 2008; Huang et al., 2013). Cusumano (2010) has argued that that an industry platform differs from product platforms in two ways:

- While similar to an internal product platform in that it provides a common foundation or technological system that a firm can reuse in different product variations, the industry platform defines a more or less “open” technological system whose components are likely to come from different companies (or maybe different departments of the same firm), which we call “complementors.”
- The industry platform has relatively little value to users without these complementary products or services.

As an example, Cusumano maintains that the Wintel PC or a smartphone are just “boxes with relatively little or no value without software development tools and applications or wireless telephony and Internet services” (ibid, p.

33). The company that makes the platform is unlikely to have the resources or capabilities to provide all the useful applications and services that make platforms such as the PC or the smartphone so compelling for users.

Hence, in order to allow their technology to become an industry wide platform, companies generally must have a strategy to open their technology to complementors and create economic incentives (such as free or low licensing fees, or financial subsidies) for other firms to join the same "ecosystem" and adopt the platform technology as their own. A third key point is that, as various authors have noted, the critical distinguishing feature of an industry platform and ecosystem is the creation of *network effects*. These are the powerful feedback loops, which also are referred to as *demand-side economies of scale* (Katz and Shapiro, 1986), that can grow at geometrically increasing rates as adoption of the platform and the complements rise.

Central to industry platforms, by the way of summary, appear to be the combined logics of platform leverage and architectural openness. As its most basic definition, platform leverage refers to a process of generating value and market impact that is disproportionally larger than the input required in other types of value chains: for example, integral (non-modular) architectures. In the area of strategic management, platform leverage is directly linked to the organization's sustainable competitive advantage. Following Thomas, Autio and Gann (2014):

- *Production leverage* is based upon the (re) use of a collection of assets and the interfaces and standards that enable sharing these to drive economies of both scale and scope. In the case of product families, the reuse of production assets and product components helps to realize both scale and scope economies through reduced manufacturing costs and improved design quality, such as better product architecture.

- *Innovation leverage* is similarly based upon the (re) use of a collection of assets and the interfaces and standards that enable sharing. However, instead of sharing to achieve economies of scale and scope, the goal is to drive economies of innovation and complementarity and, hence, facilitate the creation of new goods and services. When the product family is extended to supply chains and the platform system is decoupled from the focal firm, potential innovation benefits also emerge in the form of component innovation, enhanced by the distribution of self-interested decision making across the ecosystem among competing complements.

• *Transaction leverage,* in contrast, is based upon the manipulation of the market pricing mechanism and market access, which drives transaction efficiency and reduces search costs in the exchange of goods and services. In the same manner as a conventional market intermediary, a platform ecosystem extracts the surplus value generated by leveraging its position as a value hub linking multiple sides of the market. In this sense, the platform ecosystem leverages its position within industry architecture to benefit from the economies of transactions and search.

Given the critical importance of complements and network effects, the key ways of defining industry platforms revolve around concepts of degree of *platform openness* and the *governance of complements*. Before discussing the theme of governance, we will briefly touch upon the economics of platforms, combining demand-sided economies of scale (or network externalities) with forceful lock-in effects.

Value Capture in Digital Platform Ecosystem

Demand-side economics of scale is widely held as constituting the driving force of digital platforms. Researchers have developed an explicit platform theory to explain how, despite interdependence in technologies and complementary assets, some technology firms can control an industry's value chain and capture a disproportionate share of the total value. This draws primarily upon the literature on technological standards (David, 1985; Katz and Shapiro, 1985; Besen and Farrell, 1994), network economics (Katz and Shapiro, 1985; David and Bunn, 1988) (David Bunn, 1988; Katz & Shapiro, 1985 and 1994) and multi-sided markets (Evans, 2003b, 2003a; Rochet and Tirole, 2003; Evans and Schmalensee, 2010). As many have observed, a first key point is the critical distinguishing feature of an industry platform and ecosystem is the creation of critical mass and network effects: for example, (e.g. Molina, Bremer and Eversheim, 2001; Evans and Schmalensee, 2010; Prasarnphanich and Wagner, 2011). These are positive feedback loops that can grow at geometrically increasing rates as adoption of the platform and the complements rise. Thus, the network effects can be very powerful.

TWO-SIDED-MARKETS

Digital platforms serve as integrators and bottlenecks in two-sided markets (Roson, 2005; Hagiu and Hałaburda, 2014). They can take many guises and provide infrastructure and rules that facilitate the two groups' transactions. In some cases, platforms rely upon physical products, as with consumers' credit cards and merchants' authorization terminals. In other cases, they are places that provide services, such as shopping malls or websites: Monster, eBay, and so on. Two-sided networks differ from other offerings in a fundamental way. Value moves from left to right in the traditional value chain,: cost is to the left of the company; revenue is on the right. Since the platform in two-sided networks has a distinct group of users on either side, cost and revenue are both found on the left and on the right: for example, as is the case of Google Search, which is subsidized by revenues from the advertising business: Google Ad.). In this case, the perspective shift goes from supply-side economics to demand-side of economics.

In two-sided markets, the number of agents on the other side determines the value that an agent derives from joining a platform: that is to say, the cross-group network effects. Examples include payment systems such as PayPal or Visa, videogame systems such as PlayStation 3 and Xbox 360, smartphone platforms similar to Apple's iPhone or Google's Android, and so on. According to Parker and van Alstyne (2005), two-sided markets require the interaction of three groups of actors: a group of technology buyers, a group of sellers, and an intermediation "platform", which creates tools or mechanisms for helping both parties strike a deal[9]. It works like this: a company quickly enters a new market and attracts customers, and those customers attract more customers, and so on. In turn, the first mover experiences explosive growth and assumes a dominant market position while earning wonderful profits. The most important aspects of the network effect are that the more external adopters in the ecosystem that create or use complementary innovations, the more valuable the platform (and the complements) become. This dynamic, driven by direct or indirect network effects or both, encourages more users to

9 More precisely, according to Rochet and Tirole (2006, pp. 664-665)"*a market is two-sided if the platform can affect the volume of the transactions by charging more to one side of the market and reducing the price paid by the other side… The market is one-sided if end-users negotiate away the actual allocation of the burden; it is also one-sided in the presence of asymmetric information between the buyer and the seller, if the transaction between buyer and seller involves a price determined through bargaining or monopoly"*.

adopt the platform, more complementors to enter the ecosystem, more users to adopt the platform and the complements, almost ad infinitum.

NETWORK EFFECTS: DIRECT AND INDIRECT

Economists developed the theory of network effects in the 1980s, and burnished it in the 1990s. Business gurus, entrepreneurs, and the tech media cherished it as one of the guiding lights of the new economy. Two concepts are central here: critical mass and "indirect" network effects; it is widely recognized that sufficient value from the use of products such as the telephone, fax machine, or other networked services is closely associated with 'critical mass' (Rohlfs, 1974). Without such a critical mass (defined as "a minimum network size that can be sustained in equilibrium") users will not receive sufficient value, and growth will not continue (Oren and Smith, 1981; Economides and Himmelberg, 1995).

Strong direct network effects builds upon the number of users. A telephone becomes more valuable to an individual as the total number of telephone users increases. Following the received wisdom of *Metcalf's Law,* the value of a platform is attributable to the size of the network: that is to say, the number of nodes (Gilder, 1993; Metcalfe, 2013)[10]. Companies or platforms compete through creating "bandwagon" among the users that make the outsiders to those bandwagons experience a loss of value, and even an extra cost of remaining outsiders. Therefore, network industries often involve 'tipping' at a certain point at which the joint existence of two incompatible products may be unstable, with the possible consequence that a single product and standard will dominate. Given the idea that the numbers of nodes – that is to say, complements and users – determine the value of a network, economists see markets with strong network effects as being prone to a "winner-takes-it-all-outcome" (Katz and Shapiro, 1985; Boschma and Lambooy, 1999).

Strong indirect network effects arise when critical mass of complementary products – for example, hardware and software – enable users to receive sufficient value from the use of the networked technology. As the variety of avail-

10 Research in industrial economics introduced the concept of network externalities (popularized as Metcalf's Law) to describe a situation in which "the utility that a user derives from consumption of the good increases with the number of other agents consuming the good" (Katz & Shapiro, 1985: 424). The "number of other agents consuming the good," often referred to as total network size, is defined in a straightforward way: "The network size is simply the total number of consumers owning units of hardware that are compatible with the individual's unit" (Katz & Shapiro, 1992: 59)

able DVDs increases, a DVD player becomes more valuable through indirect network effects, and this variety increases as the total number of DVD users increases. A major stream in the literature on indirect network effects demonstrates how the value of ownership of core products – for example, phones, VHS and DVD players, game consoles, and other networking technologies – increases with the number of complement products. Standardisation, therefore, is a likely outcome (Gandal, Kende and Rob, 2000; Dranove and Gandal, 2003; Gandal, Salant and Waverman, 2003; Rohlfs, 2003; Clements and Ohashi, 2005). Theory also suggests that such effects should drive faster market growth due to the bandwagon effects (Shapiro and Varian, 1998; Rohlfs, 2003). Shapiro and Varian (1999) first attributed network externalities to positive feedback and then suggested that "if a technology is on a roll…positive feedback translates into rapid growth: Success feeds on itself" (p 176).

Research also point to the opposite effect of slowing growth in what is sometimes labelled "excess inertia" (Srinivasan, Lilien and Rangaswamy, 2004; Goldenberg, Libai and Muller, 2010; Peres, Muller and Mahajan, 2010). Early in the product life cycle, most consumers see little utility in the product, as there are few adopters; therefore, they may take a "wait-and-see" approach until there are more adopters. Hence, diffusion early on may be very slow and occur among the few consumers that see enough utility in the product even without adoption on the part of other consumers. Therefore, the process may be characterized by a combination of excess inertia and excess momentum: that is to say, slow growth followed by a surge (Rogers, 2003).

Managing the Degrees of Openness

Governance of platforms and strategizing within platforms gradually becomes relevant for companies that are trying to establish themselves in the digital economy. Decentralization of value chains is not without its ambiguities. First, the building of decentralized value chains for a more or less permanent innovation economy invites free riding and opportunism, thus, raising questions about governance of management of networks. (Piore and Sabel, 1984; Jarillo, 1988; Dyer and Singh, 1998). The central dilemma of growth lies in reconciling the demands of learning with the demands of monitoring (Sabel, 1994). In this view, there is a contradiction between openness to attract and coordinate learning for innovative product or services with the control over value capture and the distribution of the gains from the collaboration within the ecosystem. Here, it is easier to write contracts between partners within the ecosystem that cover contingencies associated with transactions between them when the market conditions are stable and economies of scale are, thus, predictable. Innovations undermine stability because they disrupt the regularity of markets. Hence, the dilemma is that learning and innovation within the ecosystem undermines the stability that is normally required for value capture and monitoring insofar as each transacting party in the collaboration fear possible hold-ups: that investments will not be matched and the terms of value capture from the investments remain uncertain.

With concepts such as *system integrators* (Hobday, Davies and Prencipe, 2005), *architectural capabilities* (Henderson and Clark, 1990; Galunic and Eisenhardt, 2001; Roy and McEvily, 2004; Jacobides and Winter, 2005; Jacobides, Knudsen and Augier, 2006; Baldwin, 2015; Jacobides, MacDuffie and Tae, 2016), *architectural knowledge control* (Henderson and Clark, 1990) and *platform leadership* (Gawer and Cusumano, 2002, 2014), *iterative pragmatic collaboration* (Helper, MacDuffie and Sabel, 2000; Gilson, Sabel and Scott, 2009) research tries to describe that decisive capacity to coordinate collaborative knowledge creation and simultaneously manage value capture.

Gawer and Cusumano (2002, 2008) argued that the main problem of platform leaders[11] can be identified in two key features of contemporary platforms: the increasing interdependency of products and services and the increasing ability to innovate by more actors, especially in the high-tech sectors. The combined effect of these two elements determines that the evolution and improvement of one element in the product/service/organisation of the platform is complementary and interdependent to the development of all other elements. Furthermore, they focus upon how firms can drive industry innovation and "architect" or influence competition through four particular "platform levers":

- *Firm scope:* The choice of which activities to perform in-house versus what to leave to other firms. In particular, this decision is about whether

11 Iansiti and Levien (2004) also differentiate between two types of platform leaders: "keystone" and "dominator" leaders. In particular, the keystone leader has developed capabilities from which to benefit and, at the same time, generate significant externalities within the platform in order to sustain the collective performance. Keystone leaders strike a productive balance value appropriation and value sharing between platform's partners. By sharp contrast, the "dominator" leaders integrate vertically and horizontally this in a predatory way, seeking to appropriate most of the value produced by the network.

the platform leader should make at least some of its own complements in-house.

• *Technology design and intellectual property:* This refers to what functionality or features to include in the platform, whether the platform should be modular, and to what degree and at what price the platform interfaces should be open to outside complementors.

• *External relationships with complementors:* This is the process by which the platform leader manages complementors, and encourages them to contribute to a vibrant ecosystem.

• *Internal organization:* This regards the way and the extent to which platform leaders should use their organizational structure and internal processes to give assurances to external complementors that they are genuinely working for the overall good of the ecosystem. This last lever often requires the platform leader to create a neutral group inside the company, with no direct profit-and-loss responsibility, as well as a Chinese Wall between the platform developers and other groups that are potentially competing with their own complementary products or services.

Gawer's and Cusomano's highly influential book has created a bandwagon of related research, converging on a general theory on platform leadership. Essentially, there is a general agreement on the critical role of establishing an "optimal degree of openness", which ensures wide ecosystem participation and positive network externalities, while still leaving the control of the core element of the platform firmly in the hand of the platform leader in order to ensure the disproportionate distribution of value captured. First, the literature indicates that platform owners face a key challenge in designing the structure of their platform, such that they maintain ownership and control over the critical elements that deliver value. For example, platform owners must determine the optimal "openness" of the platform in terms of interoperability, disclosure of IP, and collaboration with complementors that will spur innovation and network effects (Chesbrough, 2003a; West and Gallagher, 2006; Parker and Alstyne, 2008). Secondly, the firm must balance these requirements with the need to maintain control of the platform in a way that allows it to capture value in a sustainable fashion (Boudreau, 2010; Eaton et al., 2015). This tension is present in strategies for day-to-day governance, which include determining the boundaries of innovation and value capture by the platform owner and complementors (Eaton, 2012; Tilson, Sorensen and Lyytinen, 2012; Ghazawneh and Henfridsson, 2013), as well as pricing and other revenue generation strategies for each side of the market (Rochet and Tirole, 2003).

Research on "industry architecture" takes a more structured approach to the analysis of platform governance. Jacobides, Knudsen and Augier (2006) say firms attempt to strategically develop architectural competencies to determine the firm's vertical and horizontal specialization, as well as influence the institutions that shape markets. Thus, researchers explore how firms shape and redefine the strategies and templates that determine "who does what" in a sector, because they appreciate that this will affect "who takes what" (Jacobides, Knudsen and Augier, 2006). Departing from a structural view on agency, the industry architecture literature suggests that a platform firm can intentionally construct the value network in such a way as to create barriers of entry for its own position, while increasing competition in other nodes around its network location, thereby positioning itself as the "bottleneck" or "control points", which is defined as the location in the platform that extracts most value while locking-in customers most forcefully (For a revew, see: Ballon et al., 2008).

In the PC industry and other related sectors, the OS and application layer have famously been the locus for value capture (for example, Microsoft)[12]; with the advent of the Internet, however, the recent opportunities for control and profitable growth have migrated upward, away from the operating system layer and into the software application layer, which is higher in the IT stack (for example, Google's search function and other online applications[13]).

12 Though most persons attribute Microsoft's dominance to its control of the Window's OS, equally, or perhaps more important, is the Microsoft Office productivity suite, which is the consumers' connection to Microsoft and is likely more important for the mindshare lock-in than the desirability of Windows. More precisely, each new improved generation of Microsoft Office package also involves up-graded file formats (e.g. docx for Word). Once users start upgrading –they might be universities, large companies, parts of the government, or public institution—all users with older versions will find that sharing and opening of the new files will be more complicated (for example, they might save in older formats with a loss of functions and formats) unless they also upgrade to the latest version of MS Office. In that sense, Microsoft's position in the computing depends upon the proprietary file format rather than the operating system.

13 As Jonathan Murray, Microsoft Worldwide CTO, revealed in a private conversation with the present author, Microsoft's concern of course is that large public sector customers start pressing for support of widely recognized non-proprietary formats, such as XML for Excel, which would reduce the pressure on up-grading and increase the capability between MS products and free software offered by, say, Google as cloud services.

Research on Android shows that Google's launch of its open source operating system diluted the existing OS-based bottlenecks in general – particularly, Microsoft's position – whilst also generating a shift in the locus of control points. Pon, Seppälä and Kenney (2014) demonstrate, based upon case studies of evolution of control points and gate keeper roles in Google's Android, Amazon and Xiaomi, that Amazon and Xiaomi have built new bottlenecks by designing complementary services on top of Google free OS to create new bottlenecks and find ways to lock-in customers. Google's open source OS allowed Amazon and Xiaomi to tap into Google's massive installed base and offer a significant short-cut, meaning they could forego the massive investments in attracting users into a two-sided market and, instead, allow them to focus their resources upon providing value-adding services for two-sided markets. Amazon builds its own versions of Android application interfaces to offer unique services that other Android-powered platforms cannot match. In this fashion, Amazon extends, for example, its popular AWS cloud services into its line of Kindle and Fire-tablets, thus, creating strong incentives for developers to focus upon Kindle and Fire-tablet applications while locking in customers at the other end of this two-sided market. Pon, Seppälä, and Kenney (2014) follow this same logic by also revealing that Google responded by raising the bar for mobile OEMs that seek to implement Android without adding Google Mobile Service apps: for example, Maps, Gmail, Google Drive, Calendar, and Search. Thus, Google quietly adds the highest value-adding innovations to a proprietary version known as "certified" Android. Mobile phone OEMs that aim to offer its own version of added-value services on top of the open source Android will find the "bare" open source OS becomes less and less competent compared to the certified version, thus, increasingly demanding more and more resources to turning the open source version into a competitive offering.

General Caveats

In this chapter, I attempt to provide a first impression of some of the more central ideas that guide our understanding of the evolution of the digital economy. These generalizations must, however, be taken at face value – at least partially. Some of the cornerstones – particularly, advantages from modularity in design and production, and network effects, may be weaker than often agreed. As for management implications, the consequences might be significant. If the digital platforms strongholds of monopoly power are weaker than presumed, the chances of dethroning digital platforms in various sectors of the economy are not as bleak as we may think.

NETWORK EFFECTS: HOW STRONG IS EXPLANATORY POWER?

First, the existing conceptualisations of network effects do not fully explain observable market outcomes, especially when it comes to technology adoption. If consumers would have based their decision on network size, it could be hard to explain market outcomes in wireless standards. Take cellular standards as an example: by the early 1990s, the AMPS systems ranked, by far, as the most successful standard in the world. By 1991, wireless operators in 21 countries had adopted AMPS, accounting for approximately 75% of the world subscribers (Garrard, 1998). Even if AMPS originally outnumbered European standards in terms of connected phones, the European GSM standard gained traction in the 1990s and the first decade into the millennium. Two decades later, the GSM family of standards (GSM, UMTS, LTE) became the dominant global standard.

In a similar way, we must also ask how well does network theory really explain why Symbian and Blackberry did not win against iOS and Android in the race for dominance in smartphone operating. By 2009 – that is to say, two years after Apple's introduction of iPhone and Google's decision to offer Android for free – Symbian's global market share was at 60%, whereas the second network in terms of size (RIM/Blackberry) had captured 20% of the global market through its dominating position in the US market. At 60% dominance, the market should have tipped in the favour of Symbian. Yet, Android and iOS stormed in. If the number of nodes determines the value of a network, then Google's Android arm, or Samsung's mobile phone business, would be valued higher by investors than Apple's. What is noteworthy is that Apple's 75% market share of the global MP3-player fell apart the moment entrants such as Nokia, Samsung, and Sony-Ericsson entered the music platforms with music phones, even though their initial platforms lacked the strong network externalities, such as Apple's iTunes services, which connected the music industry to Apple's platform product. Similarly, in videogames, several competing platforms fight for dominance; however, smaller players still hold strong in profitable pockets of the market. The deviations from predicted outcome are significant in all cases. What anomalies such as these suggest is that other factors in network externalities theories besides network effects are at play. Network effects might, indeed, explain market outcomes *cetris paribus*. But then again, how often is everything equal in the innovative platform economies?

THE LIMITATIONS OF MODULARITY

Closely related to the above, we need to also treat the concept of modularity with analytical care, which explains the seamless integration of positive network externalities (or complements) into the platform environment. Following Simon's notion of nearly decomposable systems, modularity has been a key concept in system design as well as in the discussion on the rise of highly specialized supplier networks. Modularity allows firms to apparently respond more quickly and flexibly to shifts in product markets since modular architecture reduces the cost of providing a greater variety of product and services because the standardisation of interfaces drastically reduces the volume of information required for inter-firm coordination. Since the modules themselves can serve many purposes, they can be produced in high volume and combined to yield a variety of customized goods matched to differentiated consumer demand (Langlois, 2004). In modularity literature, the implicit assumption is that supply-chain can be 'virtualised'. Langlois (2003) introduced the concept of the "vanishing hand" to illustrate how platform technologies, such personal computers and stereo equipment systems, emerged as a consequence of perfectly modularised product architectures under the liberalisation *slash* globalisation of trade and manufacturing in the 1980s and 1990s.

The stabilisation of technical interface standards, however, constitutes a two-edged sword (Glimstedt, 2001; Chesbrough, 2003b; Sabel and Zeitlin, 2004). Some standardisation is obviously necessary to allow specialists to focus upon the complex subsystems in which they have distinctive capabilities. Too much standardisation, however, can just as obviously become a barrier to systematic innovation, thus, locking component manufacturers into a potentially obsolete product architecture. Excessive commitment to a particular product architecture and accompanying interface standards can, thus, lead to a *modularity trap,* with the following two associated risks: loss of innovative capacity and loss of product distinction.

Henry Chesbrough writes: "Within the firm, the focus on developing products to compete within the standard eventually erodes the amount of system-level knowledge. While focused firms are effective in linking to the established architecture, they lack the knowledge to envision how to connect to a new architecture. Within the industry, the collection of focused competitors that modularity enthusiasts celebrate . . . now lack the collective knowledge of how to evolve the system. They may also lack the ability to take collective action, necessary to coordinate a shift from one system of highly interconnected parts to a new system of connections" (Chesbrough, 2003b, p 181)

The far-reaching delegation of modules' R&D diminishes organisation's absorptive capacities (Cohen and Levinthal, 1990), with firms losing their ability to evolve their product and to innovate (Hobday, Davies and Prencipe, 2005).

If architects of a product no longer control inter-module interactions and no longer understand the technological and functional opportunities offered by module-related innovations, they will be unable to design radically new architectures. The product will then freeze in its current state, which will weaken the manufacturer who has taken the outsourcing decision, thus, affecting its ability to make radical innovations: especially in comparison to more integrated competitors. For these very reasons, firms in most industries seek to avoid risky and irreversible commitments to a single product architecture and technical specifications.

While having embraced the concept of *modular mega suppliers* in the 1990s, major automotive OEMs backed away from modularisation as a key path for the creation and capture of value. Automotive executives feared that modularisation and outsourcing to 1st tier (mega) suppliers would lead to the *hollowing out* of OEMs, that is shifting the capacity to innovate from OEMs to the suppliers (MacDuffie, 2013; Jacobides, MacDuffie and Tae, 2016). Takeishi (2002)has also shown that the quality of suppliers' developments depends strongly upon the degree of carmakers' technological prowess, notably when it regards architectural knowledge. Carmakers that have substantially reduced the scope of their ancillary (non-core) competencies are less successful in innovation terms than carmakers that have maintained and continue to achieve significant learning regarding detailed module architecture. Managers and technology strategists in the automotive sectors understand the problem: "It is naive to believe you can integrate a system without having in-depth and detailed knowledge of the components that are going to affect the performance of the whole car. Managing each system performance does not, in fact, automatically result in effective system integration. The performance is the ultimate objective, not systems... We realised you cannot integrate the performance of components you know very little about... if you have never designed a component or a system it will be very difficult to understand the subtle interactions with the rest of vehicle" (FIAT Director of Vehicle Concept and Integration: 2006, quoted in (Becker and Zirpoli, 2011)[14].

While reporting on modular networks in the electronics industry, Timothy Sturgeon (2002) acknowledges that "as contractors seek new sources of revenue by providing additional inputs to lead firm design and business processes, and new circuit-board assembly technologies appear on the scene, such as those for boards with optical components, the hand-off of design specifications is becoming more complex and less standardized, making it harder for lead firms to switch and share suppliers," while requiring "closer collaboration in the realm of product design". Thus, Sturgeon also concedes contract manufacturing of modular design accounted in 2000 for just 13 per cent of the global market for circuit-board and product level electronics (Sturgeon, 2002). Concerning loss product distinction through far-reaching modularity, Joakim Ingers, a smart phone veteran and Apple's expert witness in Samsung versus Apple over patent rights, noted:

"Any entrepreneur can hire a team of 10 engineers to create a new smart phone based on standard modules, such as Qualcomm Snapdragon [hardware platform] and Android [operating system] and a slew of other standards components. In a year so, it would actually work. But it would be a very mediocre device without features that make it stand out in the competition. As such, it would compete in Asia's rock-bottom division of mediocre white-box phones, catching minimal attention and minimal revenues per sold phone."

14 Statements of this kind echo the insight from research on system integration in complex systems: that is to say, "firms need to know more than they make" (Brusoni, 2001). Task and knowledge boundaries will not always coincide (Takeishi, 2001). Firms that have historically integrated the components of a complex product risk a competency trap if, from outsourcing, they lose their systems integration capability (Zirpoli and Becker, 2011). Thus, firms that no longer produce certain components may still need to retain the knowledge of how to make them; as Brusoni et al. (2001) had it, such firms need to "know more than they make". Indeed, given risks of imitation from modularity (Pil and Cohen, 2006), firms may benefit from preserving the interdependencies of a near decomposable product design– even when more decomposition is possible– to maintain the tacit knowledge associated with managing those interdependencies (Ethiraj and Levinthal, 2004).

Conclusion

There is widespread consensus among management consultants on digital platforms with a new pillar of profitable growth or even a fourth industrial revolution. These ideas are trickling down into business schools and into buzzword-driven academic business research. While citing more or less fanciful examples of digital platforms to illustrate the potential for innovative value creation concerning value capture, the literature tends to be less distinct, or even conceptually misleading.

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