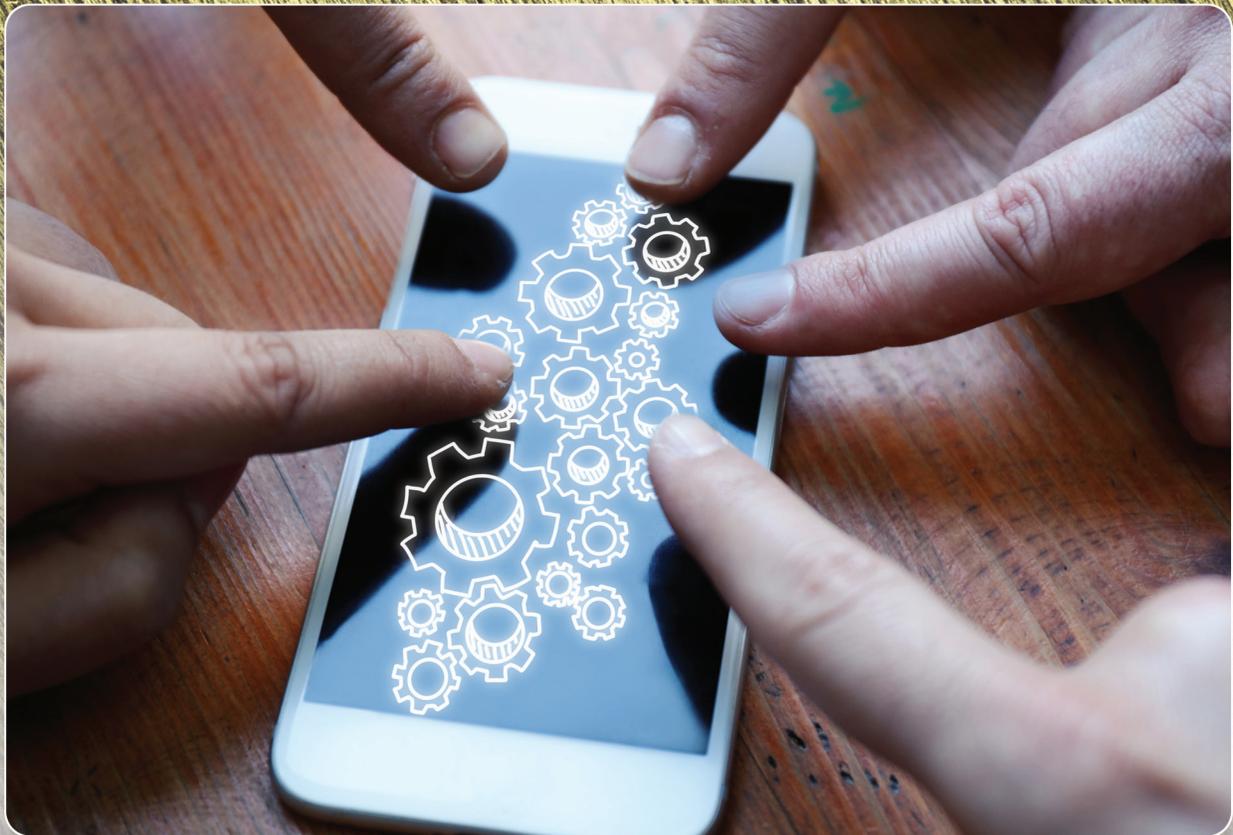


Service Industrialization, Convergence, and Digital Transformation – I



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Digital technologies have significantly changed service industries, the largest segment of the US economy. The convergence of the creation, consumption, and delivery processes of services across a range of sectors, followed by rapid industrialization, has had a powerful effect on revenues, job shares, wages, and sector structure. Uday Karmarkar explains why companies must respond to these challenges rapidly or risk being perpetual laggards.

Digital transformation is of central interest to companies in every industry. The forces driving change include new technologies, a rapidly evolving competitive environment, and the resulting need for flexibility, resilience, and continuous innovation. Leading technology providers, industry observers, and company advisors are casting this transformation as a “plug-and-play economy” or an “API economy,”¹ both terms that capture the increasingly modular nature of business and production as well as the concurrent need for flexibility and speed in reconfiguring them. The B2B (business to business) and systems landscape is moving toward the philosophy of everything as a service while many companies are outsourcing or even discarding any processes that are not their core competitive capabilities.

Many sectors producing B2C (business to consumer) goods are following suit as their products become technology enabled or smart. Among the recurring themes in the popular business press today are the network economy,² the gig economy,³ and the sharing economy.⁴ Many news stories warn of the dangers which automation and robots pose to jobs and employment. Not so long ago though, the leading concern was offshoring and job flight, threats which are actually greater than ever. Although there is a practical reality behind all of these issues, they can seem fragmented and confusing.

In fact, all of these concerns and concepts can be fruitfully viewed as facets of an overarching process of service industrialization, which consists of a common set of technology enabled process strategies which managers often implement locally and independently to make their companies more competitive. The consequences of these strategies can legitimately be called a

revolution⁵ with all that the term implies. In addition to the effect on jobs and incomes, many service sectors are being significantly disrupted while firms are driven to restructure and even reinvent themselves. The impact of this process is magnified by the size and growth of the service sector, which already dominates all the major economies in the world.

The path of industrialization starts with the information and communication technologies that are transforming the chain of service creation, processing, delivery, and consumption. The “back rooms,” or the internal working processes of companies, were industrialized over a long period starting with the advent of calculating machines, typewriters, phones, and computers. Logistics systems for information and service delivery began to develop with telecommunications and expanded with radio and TV broadcasting before evolving further with the internet and the web. This back room industrialization is now migrating to the cloud, to web services, outsourced and off-shore vendors, and software-as-a-service (SaaS). Today we are seeing a new phase in the service industrialization of the front office, the customer facing side of a company. That often involves server based platforms interfacing over the internet with personal devices to enable service access for predominantly mobile customers. We will examine the effects of industrialization on the economy, and on various business sectors and processes and their mixed consequences, which are mostly good for consumers but sometimes less so for jobs and companies.

The shift to services in the US and other developed economies has long been apparent. Services account for more than 85 percent⁶ of the US GDP. Furthermore, within the services sector, value is

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shifting from physical services to information intensive services. Information intensive product and service sectors together make up over 60 percent of the US GNP, while the share of information intensive services alone is almost 57 percent.⁷ Other developed economies, such as those of Sweden⁸ and S. Korea,⁹ show very similar patterns. One particularly visible instance of change due to industrialization is the decline of music distribution, news publishing, and other traditional content-based services. Transactional services such as retailing and financial services are also being rapidly transformed while sectors like book publishing and education are on the cusp of potentially massive disruptions. The continuing impact of these changes on back room and front office white collar workers will soon be as serious as that which we have already seen with manufacturing jobs.¹⁰ This transformation is also driving the rapid emergence and growth of new companies. Some companies which did not exist twenty to fifty years ago are already among the largest in the world in terms of market value, while some older firms that were leaders in their industries are waning.

The most recent waves of technology have created a watershed moment. Their effects include new functions and substantial changes in the economics of information

processing. But a new service revolution is not a singular event; it is the accumulated result of innumerable decentralized decisions made by managers, entrepreneurs and investors over decades. We refer to this process as service industrialization because of the extensive intersection and interaction between services and information technologies, and because the effects of new technologies on services came early and with considerable force. These massive structural effects of industrialization have had broad consequences including sector restructuring, sector disruption, and the emergence of new services. They also have powerful implications for management strategy and public policy.

Service Industrialization

Service industrialization¹¹ refers to the application of technology, often in concert with reengineered and standardized processes, intended to increase profits, quality, demand, and market share. This transformation is sometimes termed the “productization” of services,¹² and indeed the effects of industrialization often make services look a bit more like products. Nonetheless, the key defining aspects of services remain, including provision on demand, no transfer of tangible assets, infeasibility (or illegality) of reselling the service, interaction and co-production with customers, and a need to actively manage customer experience either in person or online. By understanding that industrialization does not transform services into real products, managers can gain a sharper and deeper perspective on the resulting changes in process economics, their competitive effects, and the strategic options available to them.

Service industrialization is, in many ways, analogous to the 19th century’s industrial revolution in

manufacturing. It is a true revolution¹³ in services that substantially alters the entire economy as well as affecting social conditions and the distribution of jobs, income, and wealth. Service industrialization is the set of actions and decisions facilitated by new technologies, that includes

- *Automation* of process steps and information logistics, enhancing speed and capacity;
- *Outsourcing and offshoring*, or moving some processes out of companies and dispersing them geographically inside and outside a country;
- *New service creation* often introduced by new companies which make more effective use of new and emerging technologies;
- *Service and process redesign*, in both the small and the large, sometimes radical;
- *The repositioning* of companies and restructuring of sectors;
- The creation of *new markets, exchanges*, and networks using communications which may be many to one, one to many, or many to many;
- *Online distribution and delivery* to devices along with closer engagement with individual customers and networked groups;
- *Self-service* or shifting work to consumers and *moving operations* to other stages in a chain.

Many of these approaches are similar to those which transformed manufacturing, though the last three are not. Along with the effects on profits and quality, they also tend to increase productivity, which is a fundamental driver of consequences for the total economy, and for sectors and markets. But while increased productivity is generally beneficial for the economy as a whole, some of the consequences, like increased income inequality¹⁴ and the job losses which can follow severe disruptions, are less positive.¹⁵

While physical processing advances tended towards large scale centralized production, information processing has gone towards miniaturization, mobility and dispersion across devices and geography.

The nature of the technologies which underlie service industrialization has spurred considerable changes in service process economics. During the industrial revolution, increases in processing capability were accompanied by increased need for motive power, and by economies of scale in processing facilities. By contrast, information processing resources have achieved enormous performance improvements, as captured by Moore’s Law¹⁶ about chips, but with simultaneous reductions in the power, space, and weight requirements needed for each unit of computational power, data transport, and storage capacity. These changes have been accompanied by physical miniaturization and portability. So while physical processing advances tended towards large scale centralized production, information processing has moved towards dispersion across devices and geography. There are undoubtedly still economies of scale which centralize some computing and storage resources, but mobile devices show an ever increasing capacity for computing and data storage. The advent of the Internet of Things (IoT)¹⁷ and the proliferation of microelectronic and electromechanical devices (MEMs) will accelerate this dispersion.

From an economic perspective, one effect of these new technologies is a dramatic decline in the cost of information processing and

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logistics. For information intensive businesses, both the fixed and variable costs of end-to-end processes have become small compared to their output. Entry into these markets is therefore easier and price competition more intense. Technology also affects service design. While the external look and feel of a physical product can often be copied for a price, functionality is much more difficult to reproduce. The same is not true of information intensive services which are highly vulnerable to copying, both in visible design and underlying function. Even poorly built copies can be indistinguishable from the original to customers who only see the user interface. The result is that services quickly become commoditized, similar in appearance and function, with seemingly interchangeable substitutes quickly available. Apart from look and feel, differences of localization or geographic specialization also fade, further spurring intense competition within and across market segments.

Service industrialization is now also affecting physical services that once seemed immune to technological change. The impacts on

logistics, retailing, trucking, and counter services are becoming ever more apparent. Even some manufacturing sectors have begun to see “servitization”¹⁸ and the growth of asset sharing micro-markets encourages a further shift towards services, with rentals replacing ownership. Common traditional examples of servitization include bundling warranties and repair services with products, or providing financial assistance for equipment purchases. An early example of more extreme servitization was Xerox’s strategy of leasing rather than selling their machines, and then charging the user for the number of copies made. That price discrimination and forward integration strategy was also effective in allowing customers to adopt novel and expensive equipment at low initial expenditures and low risk. Today, automotive companies are beginning to position themselves to enter the car rental and ride services market.¹⁹ Although these companies once found forward integration into rental services unattractive, it is now a preemptive defense against the looming disruption potential of changing ownership patterns for autonomous vehicles.

Convergence in Information Services

While the term convergence is overused and often too broadly and loosely applied to everything from designs to devices, it is nonetheless an important feature of information intensive services. Within those sectors, convergence determines process structure, costs, economics, and the nature of competition. Convergence is a deep phenomenon that applies to information intensive services on many levels. The most fundamental of these is digitization or *convergence in form*. Since all information, including sounds, images, and more can be conveyed as bits, all forms of information look

the same at a process level. This cannot happen with physical products where materials can at best only be partial substitutes and the actual trend is towards ever more variety.²⁰ A direct consequence is a *convergence of logistics* in that the same methods of transportation, storage, and delivery work for all kinds of digitized information. This trend means high volumes of activity for those stages, but also significant commoditization. For example, transportation of all digitized information runs through the same telecommunication channels, such as optical fiber, legacy copper lines, and radio transmission through the air using a spectrum of frequencies. Once again this is very different from material supply chains and physical service networks where storage and transportation systems vary widely across sectors and the supply chains for, say, cars and clothes will never converge.

The next direct consequence of digitization is the *convergence of processing*. The same equipment, either in centralized servers or on distributed devices, is used to process all kinds of information, alphanumeric, graphic, audio, or video, regardless of sector, source, and end use. The same resources process entertainment content, data analytics, financial services and consumer searches. This universality is now producing a convergence in hardware even at the chip level, where low cost, low power RISC (reduced instruction set computer)²¹ architectures, which use a small but optimized set of instructions, are widely used not just in mobile devices but increasingly also in servers. Similarly, graphics chips are ever more widely used because of their utility in parallel processing which applies to many tasks like searches and data processing. In effect, the logistics chains of information intensive sectors – from factories

and roads to warehouses and retail stores -- are converging into one common system.

Going further, we also see a *convergence in processes* within sectors. The production and business processes of different companies within a given sector begin to look very similar, if not the same. While there may be small differences in the processes and in the way they are implemented, there is little variation in form, cost, or performance across firms in the same sector, whether the service is content distribution, e-commerce, or retail banking. Companies within a sector thus face broad commoditization, more intense competition, and a pressure to differentiate their services somehow, and to build whatever entry barriers they can.

Finally there is a form of *convergence in use or consumption*, though this is a fuzzier pattern. Adults in the US now face screens of one kind or another for more than ten hours a day.²² A quarter of US adults describe themselves as “almost constantly” online,²³ sometimes for work and sometimes for leisure. Either way, there is no longer a clear separation between work and leisure periods. The traditional notion of how our use of different media – and therefore our exposure to advertising messaging – was divided between work and home time is blurring. People now routinely interweave their work and non-work time. As devices, work, and consumption become ever more mobile, the locations of both the workplace and leisure activities are less fixed. More important now is the size of the screen required for a given activity, which can still determine location. Much is done on a small personal screen – contributing to our isolation – while large screens may be used for professional work or social events.

Convergence also has a significant impact on the structure of

information intensive service sectors. Cloud and web services such as infrastructure as a service (IaaS), platform as a service (PaaS), unified communications as a service (UCaaS), and software as a service (SaaS) have appeared and grown rapidly. Because logistics and processing are the same across sectors, third parties find it economically viable to sell these functions as services, inviting firms to rent or lease capacity as needed rather than buying and installing it on site. IT resources move from being internally managed on-site to something which looks much like a traditional utility, and capital expenditures become operating expenses. Meanwhile consumers use these same devices, operating systems, and browsers for a range of activities. So convergence again produces intense competition for these services with many entrants and dropping prices. In this environment, the biggest firms are the most likely to survive due to the scale of their server use, their capacity for lateral expansion, the strength of their brand and presence, and their pooling economies of scale with respect to access, demand queues, task queues, and processing capacity. To differentiate themselves, suppliers will continue to bundle adjacent services and add new services at a high rate.

Vertical De-integration and Horizontal (or Lateral) Dominance in Information Services

One consequence of digital technologies and convergence is the vertical de-integration of sectors²⁴ which could also be thought of as modularization of information service process at the industry level. An immediate result of this change is the appearance of lateral or horizontal dominance, in which companies start to provide resources and services that cut across sectors at stages (such as transport) where those sectors have converged.

Consider the case of home photography,²⁵ which can be thought of as a self-provided consumer service. This sector has been digitized and industrialized in a comparatively short time (Table 1). For a century, the industry was vertically integrated and dominated by Kodak and Fuji, with Agfa Gevaert and others far behind. While both the leaders did produce cameras, the key to their dominance was film. Producing film is technically difficult and has a high startup cost. Film also tied together image capture, storage, processing, archiving, delivery, and end consumption which allowed the leading companies to completely dominate the entire chain. Once photography was digitized, however, the film

Table 1: Digitization and Vertical De-integration of the Consumer Photography Sector (2000-2020)

Process Stage	Photography (2000)	Photography (2010)	Photography (2020 and later)
Capture	Film Cameras	Digital Cameras	Mobile Devices (phones)
Storage	Film	Local Digital Storage	Cloud and Local Storage
Processing	Photo-finishing	Digital Processing	Digital, Automated
Master Copy	Photo Negative	Digital File	Digital File
Distribution	Paper Print	Electronic File	Exchanges, Networks
Archiving	Print/Negative	Local Digital Storage	Cloud and Local
Delivery	Print	Digital File, Download	On-demand Streaming
Consumption	Print	Screens	Mobile Screens

based vertical disappeared. Cameras still remained part of the chain, but their cost dropped radically and consumers turned in ever increasing numbers to using phones to take photos, and at volumes much higher than ever before. Costs are low for the camera itself and it uses no consumables. Worldwide sales of photographic film peaked before 2000, and had nearly vanished just 10 years later. The same happened with film-based cameras. Now, the extent of de-integration, commoditization, and anonymity of service and resource providers is going further. Photo storage is moving to the cloud. Stand-alone digital camera sales peaked in 2010 and have continued to decline.²⁶ Cameras are primarily on phones with videos beginning to overtake still photos and distribution performed largely through exchange sites and platforms.

So digitization has vertically de-integrated photography, with some stages converging across sectors while others are functionally decoupled. Image information is easily transferred in standardized file formats with no loss of quality. Processing, storage, transport, and consumption all use unspecialized equipment that is employed across a range of sectors. The software required for processing is of low cost or free. The result is a modular process which offers little technical or economic reason to tie different stages together and thus increases competition within those stages.

This kind of restructuring of sectors with vertical de-integration and horizontal or lateral dominance is occurring across all information intensive services.

But while vertical integration declines, companies providing technology and equipment operate horizontally across many sectors (as shown in the last two columns in Table 1). As a result, these firms, whether in telecommunications, server capacity, storage, or consumer devices, can become very large. The stages which provide some differentiation are at image acquisition (the camera) and in the software for processing content. But the cameras are cheap and usually bundled with other devices and, while image processing software is different from the editing software used for publishing or audio engineering, it is at historically low costs or even free. Neither stage can provide high profitability. This kind of restructuring of sectors with vertical de-integration and horizontal or lateral dominance is occurring across all information intensive services.

Entry, Differentiation, Platforms, and Bundling

In order for an established firm to remain profitable while new companies try to enter its sector, there must either be some barriers to entry, or the firm must find some way to differentiate itself. A combination of both is ideal so that differentiation does not devolve into tiny niches and fragmentation. Table 2 shows,

by stage, the typical pattern for entry barriers, differentiation, and the resulting process structures for information intensive sectors. Low entry barriers naturally encourage new entrants, spurring fierce competition. And because the new technologies are equally available to all players, there is little room for differentiation through expertise in technology, processing, or functionality. Web services and the virtualization of servers have made processing into a basic utility with flexible capacity which is available on demand at a competitive cost, and easily scaled to immediately match changing needs. Capital expenditures become operating expenses which are similar across firms. With extremely low transport and logistics costs, the result is low margins and intense price competition.

Still, there are a few stages which present opportunities for companies to differentiate themselves. At the information creation or capture stage, there is a window for extensive differentiation or for entry driven by novelty. But the ensuing variety can be so high – consider music or novels – that the result is fragmentation into small niches. These can have high unit margins but are rarely capable of expansion into large businesses at the creation stage alone.

Table 2: Entry Barriers, Entry, and Differentiation in Information Service Process Stages

Process Steps	Barriers to Entry	Differentiation	Consequences
Creation/Capture	Low	Very high	Fragmentation
Acquisition/Aggregation	Medium	Low	Low Margins
Content Processing	Low to Medium	Low	Low Margins
Storage	Low	Low to None	Commodity, Low Margins
Transport	Very High	Very Low	Commodity, Low Margins
Service Provision	Medium	High	Segments and Brands
Web Sites/Access	Low	High	Segments
Devices/OS	High	Reducing	Brands, Design

Transport (telecommunications) has very high barriers to entry. However, simply moving bits is an extreme commodity, so that competition is intense and margins are low even though there are just a few very large traditional telecom companies at the core of the system. Processing can be somewhat differentiated across industry sectors. However with the standardization of files and data, since the inputs and outputs are the same, it is hard for firms in the same sector to differentiate their service on the basis of processing methods even though internal algorithms might actually be different. Standardization also lowers entry barriers, inviting entry even by small companies.

The end consumption devices and operating systems (OS) also offer opportunities for differentiation. However, the OS layer has been rendered unprofitable by Google's introduction of Android. This was a way to disable competitors that might otherwise have controlled access to the customer. This has happened before when Microsoft bundled a web browser (Internet Explorer) with their OS, and effectively killed the pioneering Netscape browser. Companies have found some success in differentiating devices, but it appears that designs are now converging, despite legal efforts to protect them. So while Apple has heretofore been a design leader in mobile devices, it has begun to recognize rising competition from Asian firms, accompanied by the inevitable impending pressure on prices. In response, Apple appears to have begun a strategic shift from devices to services, a symptom of which is the recent departure of their key designer, Jonathan Ive.

Nonetheless, new firms are still able to establish themselves, grow to great size, create brands, and become very profitable. They have

often found this success at the service creation, response, and delivery stage, from which services are provided to customers on demand. For content based services, that stage is the delivery or streaming server. For financial services it is the server where transactions are executed in response to customer requests made through a web site. For a functional service like search it is a search engine, coupled with an ad server. All these examples are essentially about creating platforms. While functions differ across sectors, the basic processing hardware and software which underpin service platforms have converged. Within a given sector, companies must achieve superior functionality through better algorithms and interface design to create a better look and feel. This server stage is the locus for both functional differences across sectors and differentiation and segmentation within sectors, and occasionally for superior functionality or usability. Managing customer experience at this stage is thus of ever increasing importance in allowing companies to build their brand and differentiate themselves from competitors.

Bundling strategies play a complementary role to service delivery platforms. We have already mentioned how convergence facilitates the lateral or horizontal extension of resources and equipment for service providers. This same convergence of underlying technologies, along with some functional differentiation, lets companies adopt bundling strategies. Although information service sectors used to be quite distinct, it has become apparent that many firms which operate massive service platforms are now able to bundle other services along with their putative primary offering. These services may, at the outset, be tangential to their initial offering but, more and more, there seems to be no practical limit to the

extent and reach of bundling. Once again, lateral bundling strategies for growth, scale, and brand building replace vertical integration. Currently, Google and Amazon are perhaps the broadest service bundlers, while Apple appears to have just recognized the importance of broadening its service bundle and moving beyond its focus on devices. The overlaps between these service bundles are increasing, and firms that once seemed to be in completely different sectors now compete directly.

Mobility, Demand Shifts, and the Role of Consumers

In any service, traditional or industrialized, consumer experience remains important. In traditional services, the customer was usually physically present. But consumer experience is no less important for the success of digital and industrialized services, even though the customers may not be physically present. The nature of digital service interfaces ensures that the consumer is effectively a closely coupled part of the service system, with information and interactions flowing rapidly back and forth. It is therefore vital that companies routinely consider and analyze consumer experience at the consumption stage as well as the technologies and devices that affect that experience (see Tables 1 and 2 above).

Consumers know that there is no fundamental technical reason for delivery of services to fall short of excellence, since the tools, technologies and design ideas are equally available to all firms at reasonable cost.

Recent technological trends have rapidly moved people toward increased mobility as a growing proportion of the world's population enjoys easy access to online services. In response, the market for electronic devices has expanded rapidly from desktops and living rooms to individuals. This dispersion has increased device market size to the millions and billions. Consequently, the importance of the end customer has soared. The consumer base is likely to be micro-segmented, with ever more refined customization of service available down to the individual person. Combined with the compelling experience of interactive and networked communications, this individual tailoring has led consumers to spend substantially more, in both time and money, on devices and services. But there are still aspects of consumer demand and behavior that challenge both private and public organizations. Consumer expectations about service delivery are no longer limited to specific sectors. Instead consumers form opinions based on their best and worst experiences, regardless of service type. Consumers know that there is no fundamental technical reason for the delivery of services to fall short of excellence, since the tools, technologies, and design ideas are equally available to all firms at reasonable cost. Many companies in the service sectors are working to adapt to these converging consumer expectations, but the process is by no means complete and many organizations still operate in very traditional, even old-fashioned ways.

Management Implications and Service Strategies

In responding to these rapid changes, the most important thing for any company to do is to take an end-to-end, long-term view of their sector and their role within it. As the example of photography illustrates

(Table 1), many industries have already changed in radical ways. The pace at which technology drives change is so rapid that even technology leaders, with a sophisticated understanding of the field, have faced unforeseen problems and have missed opportunities, sometimes irretrievably. Others are in the midst of urgent repositioning, with varying degrees of success. While Sony is still a presence in consumer electronics, it has lost its leadership position to Apple and Samsung. Ironically, although the company's early success was rooted in transistor radios, it failed to recognize the technology enabled demand shift to mobile screens. Content based businesses like music and news have declined sharply with little prospect of recovery. Book publishing has had a brief recent respite, but the end game is clear. And the point of disruptive change is often far from a company's post position, so that it is easily overlooked until it's too late. Intel is still repositioning after being late to recognize the shift to mobile and low power devices in which it did not have a strong position, while the desktop market declined.

Another important defensive step is to systematically scan, with a certain degree of paranoia, for approaching threats from new technologies and new entrants.²⁷ A major threat in many sectors today is the appearance of very large, cash rich, brand rich, and tech savvy players, who are using lateral expansion across sectors as a primary growth strategy. The biggest of these are firms like Amazon, Google, Microsoft, and Apple which are constantly growing laterally. As their core businesses become saturated and commoditized, or as generational demands shift, companies like Facebook and the telecoms also appear to see horizontal expansion as a path to survival and growth.

However, many companies still have a long way to go in enacting basic industrialization strategies, both internally and externally with customer and supplier facing processes. Automation of functions is most often about the instantiation of traditional processes as software. Well defined transaction based processes are the easiest to automate, whether internal to firms or outward facing. Content management, including external content delivery, content acquisition, processing, and storage, is already largely automated. Well defined functional processes in both back rooms and front offices are increasingly amenable to automation, even in very complex knowledge-based decisions like medical diagnosis. The methodologies which fall under the umbrella terms of data analytics, business analytics, and artificial intelligence (AI), are enabling substantial new levels of automation in areas ranging from security management, to retail pricing, and the dynamic customization of processes.

The network of hardware and software technologies called the Internet of Things (IoT) also represents a major step forward in automation. The IoT is made up of a diverse collection of devices and technologies that combine sensors, radios, actuators, and increasingly complex control and decision-making software. Its applications range from simple identification with RFID tags²⁸ and sensors for data collection, to sense and respond systems and autonomous devices, including such extremely disruptive technologies as self-driving vehicles. While the internet and web created information chains extending from screen to screen, IoT tools and technologies create connections between objects, sensors, machines, computers, and people, to create complex networked systems encompassing all those diverse

entities. Smart transportation, energy, security, health care, and homes are early examples of applications which will soon become ubiquitous. Their operation will account for the largest data flows and transaction volumes in the internet of the future.

While services have traditionally been localized due to physical factors, information intensive services are highly portable and can be provided remotely. The globalization of many such services is already feasible and offers valuable opportunities for increasing market reach and cost advantages. Telecom companies globalized early, though many are now pulling back from certain markets due to the intense competition resulting from commoditization and too many entrants. Financial services, customer support (call centers), and content delivery are already dispersed globally. US financial service companies are beginning to create global back rooms, but, except for cases like Citibank and American Express, do not yet have an extensive worldwide presence. Retail banks from many other countries appear to be more globalized than their US counterparts, though some have had to retreat due to intense competition in commoditized online banking channels.

Although industrialization and convergence have caused the vertical de-integration and modularization of many sectors, there are certain cases in which judicious and limited reintegration has been valuable. Many companies now look to forward integration and direct-to-customer channels for visibility, accessibility, and brand recognition. In some cases, supporting service back-rooms and consumer devices can complement one another. Apple's first portable consumer device, the iPod, owed some of its success to the iTunes library, even though the latter was

not a big source of revenues or profits. Apple is now moving to increase its role as a content supplier and as a service channel. These areas are complementary to its strength in devices and consumer experience. Although Google and Amazon have not been successful in producing revenues with their forward integration into consumer devices, this is a result of an on-ramp strategy which ensures that their customers always have an easy pathway to their services, while weakening their competition by offering alternative routes to the same end. When Google acquired Fitbit, its goal may have been more about access to the associated data than about profit from delivering content or other functionality. Conversely, content distributors like Amazon and Netflix are finding that it is not enough just to have huge libraries of content, since their competitors inevitably catch up, causing price competition to increase. Their natural response is to look in the other direction and integrate backward into content acquisition, project funding, and eventually production.

One emerging strategy that is further driving the trend toward services is so-called servitization or everything as a service (XaaS). The term servitization was originally used to describe the bundling of pre- and post-sales services with products. Adding financial services to help consumers purchase a car or selling maintenance contracts and repair services, added profitable service lines to products with limited or shrinking margins. When bundled with products which face increasing global competition, services can partly localize a product and help to lock in the customer. The current trend toward a sharing economy takes this concept to an extreme, encouraging consumers to rent products as a service rather than buying and

owning them. While the concept is not new, it is spreading into many new areas. Web and cloud services are turning computing, storage and communications into a utility. In the B2C world, so-called "micro-mobility," consisting of sharing vehicles from scooters to cars, is a highly visible current form. The rental model even extends to personal items such as apparel, accessories, toys and household goods. These micro-rental platforms are feasible in part because of the reduction in transaction costs and because automated online markets offer effective search-and-match functions, small transactions, and micro-payments. They also rely heavily on interactive communications and online reviews, allowing customers to enforce vendor reliability, improving trustworthiness and quality.

Implications for Public Policy

The combination of service industrialization and its resultant economic trends have a range of consequences for social welfare, many of which call for action by policy makers. Decisions to industrialize naturally lead to a growth in productivity, but the results of that growth are mixed. On one hand, increased productivity results in an increase in average wealth. However, it can also increase income inequality as wage shares for some occupations rise, while those for others level out or decline.²⁹ Wage differentials were historically correlated with education levels. However, a closer look reveals that certain white-collar occupations are now waning in job share as well as wage share.³⁰ At the same time, high wage white collar jobs which require specialized professional or technical education are increasing in share. So higher levels of professional education will still tend to have high rates of return but much college education may not.

Unfortunately, education choices are often made early, and once made are not easy to change later in life. What's more, the fields which tend to show higher returns often cost more and have higher requirements for admittance, including entry exams and past grades. A result is mismatches between education and job requirements leading to unemployment in one field accompanied by unfilled jobs in another.

A major consequence of service industrialization is its impact on jobs.

For a given sector, higher relative productivity growth can initially create economic growth in GNP and job shares. Eventually, however, that trend reverses and the sector begins to decline.³¹ Manufacturing has followed this path in many developed economies and, like agriculture, will probably do so in every economy. Within services, we are seeing a growth of information intensive services and a leveling of physical services. But that trend is likely to reverse just as it did for manufacturing. A major consequence of service industrialization is its impact on jobs. While services will still be the largest source of jobs, some large service sectors are likely to shrink in job share. Information intensive firms clearly tend to have very large revenues per employee and to create comparatively few jobs. In other sectors, technology and industrialization disrupt job

locations and availability. Already, the San Francisco Bay and Seattle areas are booming because of the presence of technology providers, while manufacturing locations like Detroit, Cleveland and Buffalo have been in decline. Industrialization is now causing declines for basic, white collar, information intensive service jobs which are mostly located in large metro areas.

Summary

The US, along with most other economies, is in the middle of a dramatic economic shift brought on by technology-driven service industrialization. This rapid change has major effects on all levels, from individual jobs and firms to industry sectors and the national and global economy. The consequences of this process are mixed. On one hand the average wealth will increase, and consumers will benefit in terms of cost, convenience, and new consumption opportunities. On the other, gains in productivity will lead to job losses, while shifts in employment patterns and the substitution of capital for labor will increase inequality of income and wealth. The most notable recent shift for jobs, only visible in the aggregate over the last decade, is a substantial decline in white collar jobs for both front office and back room occupations.³² There have already been significant disruptions for industry sectors related to content distribution. More disruptions are yet to come for several other sectors that still seem to be grossly unprepared.

A small change in a seemingly distant stage can be extremely disruptive quite quickly.

Managers must learn to continually assess new technological advances and to constantly scan their industry sectors from end to end, though still with an eye to the underlying needs of customers. A small change in a seemingly distant stage can be extremely disruptive quite quickly, like the trend toward consumer mobility and its effects on chip demand and consumer electronics. Finally, for any type of service today, incursion by new entrants, bringing new service designs and industrialized processes that render traditional formats obsolete, is a constant and major danger. One of the largest of these changes, with global implications, will be the impending advent of autonomous intelligent devices, including drones and self-driving cars, and of the new services these devices will require. ■



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