New Business Models for the Digital Age: From After-Sales Services to Connected Strategies

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Abstract More and more firms use connected technologies to reshape fundamentally the way in which they interact with their customers. Rather than having few episodic interactions, companies are trying to create a continuous relationship with their customers that reduces friction and allows companies to anticipate the needs of their customers. In this chapter, we discuss new business models enabled by this development. We do so by reviewing some of the literature on after-sales services in general and some of Morris Cohen's pioneering research in particular. We then extend this prior work by articulating a framework of "Connected Strategy" in the form of a taxonomy of four connected customer experiences. Finally, we apply our Connected Strategy framework to the domain of healthcare delivery.

Keywords Connected strategy · Business model innovation · Healthcare delivery · Digital customer experience · Service design

1 Introduction

"Customers do not need a quarter inch drill. Instead, they need a quarter inch hole." This quote, often attributed to Marketing scholar Theodore Levitt (its origins are somewhat debated and might go back to the 1940s, see https://quoteinvestigator.com/2019/03/23/drill/), makes a simple yet powerful observation. Customers do not derive value by obtaining or owning a product (a drill), but rather from using the product to fulfill a need (creating a hole in the wall). The drill/hole example has a number of direct and indirect implications:

- Customer value or utility is not created at the time of purchasing a product, but at the time of using the product. For durable products (including a drill), this is very

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different from the time of sale and, thus, the value is created in the after-sales period.
- If customers derive their utility from the hole and not the drill, they might be better served by a hole drilling service provider (drill-me-a-hole.com) rather than a drill maker (Power Drills Ltd.).
- For the company that sees itself as the manufacturer of drills, the time period after the drill sale is more of an annoyance, during which its managers hope that the drill they sold is lasting and does not cause any warranty claims. Its favorite customers are those that stay away until they might need another drill. For the company that sells "hole drilling as a service," time of customer engagement and time of utility creation are much better aligned.
- Drill makers interact with their customers episodically, be that at the time when they sell the next product or when they deal with warranty issues. They are disconnected from their product when it matters the most, i.e., the point of use. This can leave them blind about how and how often the product is actually used. It is interesting to see that the most innovative drill manufacturers, including Bosch, DeWalt, and Stihl, all recently launched connected power drills that aim to overcome this blind spot.

For most of the business world, spare parts logistics and the after-sales markets rank fairly low on the totem pole of managerial importance. You have to do it in order to not upset your customers and hurt your reputation, but the focus is primarily on selling new products and services. This is true in the B2C sector—for example, in the maintenance of automotive vehicles—as much as it is true in B2B settings, including the servicing of production equipment.

One of the great accomplishments of Morris Cohen's research career has been the realization that there exist enormous opportunities for value creation in the after-sales market. Many companies, however, fail to take advantage of these opportunities. Often times, the reason for this failure is a lack of connectivity. For a company to succeed in the after-sales market, it needs high bandwidth connectivity with its customers, enabling good visibility into the product use and accurate information about the demand for spare parts. In short, Morris's research was essential in promoting a new approach to selling smart and connected products, something that, more recently, we have been referring to as a Connected Strategy (Siggelkow and Terwiesch 2019).

The purpose of this chapter is to:

- Talk about the emergence of new business models by reviewing some of the literature on after-sales services in general and some of Morris Cohen's pioneering research in particular.
- Articulate our Connected Strategy framework by first providing a taxonomy of four connected customer experiences and then explaining how firms can use business analytics to learn about their customer needs and spot future opportunities for innovation.
- Apply our Connected Strategy framework to the domain of healthcare delivery, an area where many services are delivered by providers that act like the

previously mentioned drill makers by focusing on the surgery, but ignoring the "after-sales" market when the patient has left the hospital (including problems like medication adherence and lifestyle management).

2 Winning in the After-Sales Market: Spare Parts Logistics and Performance-Based Contracts

The importance of managing after-sales services in general and spare parts inventory in particular has been discussed for a number of years. For example, Cohen et al. (2006) report that manufacturing firms make almost half of their profits from after-sales services, though these services account for only a quarter of the revenues. Moreover, the authors report that despite this financial contribution, most firms "perceive after-sales services to be a necessary evil and behave as though big business-to-business service contracts, small business-to-consumer warranties, and everything in between were–like taxes– a needless expense [Cohen et al. 2006]."

This poor management of after-sales services was first empirically documented by Morris Cohen and co-authors in a 1997 study, which showed that customer satisfaction in the after-sales market was dramatically below customer expectations in both B2C and B2B settings. Moreover, in either setting, be it customers waiting for their cars to be fixed or manufacturers waiting for a machine tool to be repaired, the costs of delays and poor quality in the after-sales market and the delivery of spare parts are much higher than during regular production. These parts typically need not only be available at the right time and location, but they also need to be handled by qualified service technicians.

Given the low demand rate, the high level of product variety, the geographic dispersion, and the increased time pressure, spare parts inventories need to be managed very differently from inventories for production parts (Cohen et al. 2006). Because of the distinctively different capabilities required in the spare parts supply chain, firms can and should design new business models which better align incentives with their customers. In most cases, this means shifting from selling them products to selling them services and integrated solutions.

The shift to services allows firms to move away from the traditional times and materials contracting. When manufacturers are compensated for the time and materials they provide ("fee for service," i.e., payments are based on the resources consumed), incentives are poorly aligned. The manufacturer gets compensated when things do not work ("pay me when it is broken"), which is not in the interest of the customer. Performance-based contracts (PBC) better align incentives by making payments contingent on uptime and availability (see Cohen 2006).

A great illustration of a transition from selling products to providing services and the associated PBC approach can be found in aircraft engine manufacturer Rolls Royce's launch of the "Power by the hour" program half a century ago, which was expanded in 2002 by its CorporateCare program. Rather than selling and

maintaining jet engines, flying time is sold to Rolls Royce customers as a service at a fixed hourly rate. This aligns the incentives of Rolls Royce with the objectives of its customers (the operator of the aircraft).

Once incentives are better aligned, the airlines operating the jet engine are also willing to share data about the usage of the product and its use environments at a very high level of granularity. This not only allowed Rolls Royce to be more responsive in predicting spare parts consumption and engaging in preventive maintenance, but also to provide other services to the airline. For example, Rolls Royce now offers additional services, including engine health monitoring, optimization of engine use, and the development of digital twins. In fact, the extensive jet engine usage data that the company collects across many airlines enable high margin services such as flight optimization and fuel saving (Smith 2013, Technology Analysis and Strategic Management).

The "big data" that comes along with Rolls Royce being connected to hundreds of airplanes 24/7 also has the potential to fundamentally change some of the challenges associated with the management of spare parts inventories and inventory management in general. Cohen (2015) outlines the unique opportunities of big data in inventory management and how the service business model opens up new data flows in the interactions between manufacturers and their customers. With new forms of connectivity emerging, the manufacturer is now "in the loop" when his or her products are utilized by the customer and thus learns about product use and the environmental conditions of use. This allows the manufacturer to revisit the decision architecture of managing spare parts inventory. Rather than following the old model of data collection, forecasting parts demand, and inventory decision-making (determining quantity and location for each part), big data and machine learning now allow for automatic decision-making linking the incoming use data directly with recommendations for spare parts inventory decisions.

3 Connected Customer Experiences

Big data, machine learning, and automated decision-making—how are these technological trends impacting supply chains in the twenty-first century? In the evolution of the architectures of modern supply chains, we observe two trends across many different industries. First, companies are trying to fundamentally reshape the way they interact with their customers. Rather than having few episodic interactions, companies are trying to create a continuous relationship with their customers that reduces friction and allows companies to anticipate the needs of their customers. This has long been true for B2B settings, where electronic data interchange (EDI) platforms are common in logistics and procurement, but also is increasingly becoming the case in B2C applications. Second, many companies innovate and disrupt industries by creating new connections among previously unconnected parties in their ecosystem. The first trend we call creating "connected customer

relationships," while the second is innovating on the "connection architecture" that exists in an industry.

To illustrate connected customer relationships in more detail, consider the realm of executive education, an industry that we, as business school professors, are very familiar with. As managers engage in their jobs, needs will periodically arise for skills that a manager does not possess. For instance, a production manager who is planning to suggest a capital investment may have the need (but not the knowledge) to compute an "internal rate of return." In an ideal world, the manager would like to press a "button" that would immediately deliver the precise knowledge that is needed. Companies that are able to deliver such a service have created what we call a "Respond-to-Desire" connected customer experience. In this case, customers (clients, patients) know exactly what they want. They want to listen to a particular song, for example, read a particular book, get a ride from their home to the airport, learn a particular framework, and they want their customer experience from placing the order to enjoying the product or service to be as easy and quick as possible.

A different situation might be a manager who just learned that she was promoted. In this case, the manager also needs new skills, but may not know all the relevant skills that would be useful to acquire. Companies that can help their customers to understand all the relevant options that are available to them and help them pick the best options for them have created a "Curated Offering" connected customer experience. This requires a much deeper information flow from the customer to the firm. With respond-to-desire the firm needed to know what the customer wanted (and possibly where the customer was located and how the customer wanted to pay). For a successful curated offering, a firm needs to know much more about the needs of the customer, because the customer does not know the best solution that is required.

A shortcoming of both respond-to-desire and curated offering connected customer experiences is that the customer only starts the process of looking for the development of new skills once he or she is aware of a specific need. Unfortunately, customers quite often become aware of their needs at times that are neither optimal for their own interests nor for the firms that help them fulfill those needs—if they become aware of them at all. Firms that are able to help their customers achieve goals that they have a hard time achieving themselves are creating a "Coach Behavior" connected customer experience. People want to take their medication, but they are forgetful; people want to lose some weight, but sticking to a diet is hard; people want to continue to learn and upgrade their skill set, but sticking to a curriculum is difficult. Organizations that can nudge and coach their clients by making them aware of their needs at more opportune times can create a tremendous amount of value for their customers. To pull this off, the information flow between customer and firm needs to be rich. The firm needs to deeply understand the needs of a customer, often before even the customer realizes that these needs have arisen, and then the firm needs to monitor whether the customer actually follows through with the actions that will address this need. To establish such an information flow clearly requires a tremendous amount of trust between the customer and the firm, a topic we will return to.

A fourth type of connected customer experience we term "Automatic Execution." In this case, a firm is continuously connected to a customer, detects possible needs before the customer is even aware of these needs, and then finds and executes solutions to these problems without the customer ever getting involved directly. If Tesla finds out about a possible edge case that its current automated driving software would not handle well, it can upgrade the software on all of their cars overnight via an over-the-air update without any owner ever becoming aware of the possible problem. Do learners wish they were Tesla cars, who could wake up and find that they had received knowledge and skills uploaded into their brains to help them address needs that they had not even realized would arise? Would that be magic? Or would that be creepy? Clearly both. This is an important aspect of connected customer experiences. Quite often, they operate on the fine line between magic and creepy. Different customers might have very different preferences on how much connectivity they desire and on how much they want to delegate decisions and have the environment act on them. As a result, there is no "one-size-fits-all" when it comes to connected customer experiences. Firms will have to create a whole suite of these experiences and learn over time which kinds of experiences a particular customer likes. Meanwhile, while customers may have some initial preferences, these preferences also will change over time as they have different kinds of connected customer experiences.

As the different vignettes illustrate, customer happiness is not only affected by the quality of the product or service they receive. Clearly, the quality of instruction is important, but it is not all that matters. How quickly a customer can get the instruction, how easily the most appropriate instruction can be found given the needs that have arisen, how easily the instruction can be accessed (e.g., does the learner need to travel, or is the instruction delivered in their homes), all affect the value a customer perceives. We find it helpful to think about the entire journey a customer embarks upon (see Fig. 1).

The point in time when a customer experiences the good or service a firm provides is actually fairly late in the customer journey. There are many pain points that customers might encounter before they actually enjoy the product, and each of these pain points is an opportunity for a firm to provide value to customers and to differentiate itself from its competitors.

The customer journey starts with some latent need. It is "latent" in the sense that it is always there, in the background, but not always in the mind of the customer. As an illustrative example, consider the case of executive education, an industry that as business school professors we are well familiar with. Here, the latent need is "to

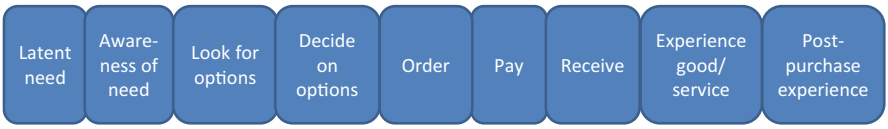

Fig. 1 Customer journey

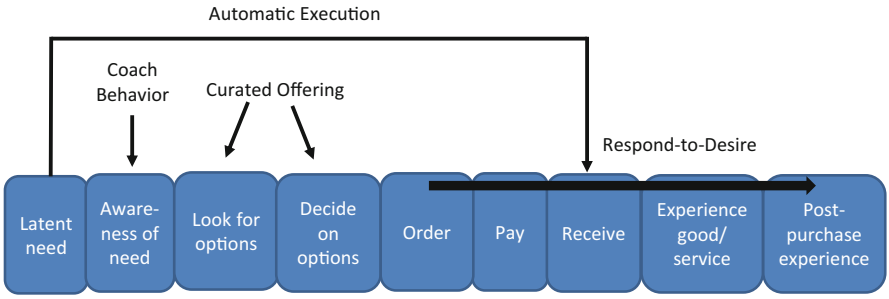

Fig. 2 Different connected customer experiences

have the right skills for whatever position I am in." Next comes the "awareness of a need." Customers are not always aware of their needs or only become aware of them at suboptimal times. Once a customer is aware of a particular need, the next steps in the customer journey are to discover all the possible options that could fulfill that need and then decide on the best solution. This can be an overwhelming step for many customers.

The World Wide Web is wonderful because customers can access the products and services of any company worldwide. But, at the same time, the World Wide Web also is horrible because now customers can access the products and services of any company worldwide. Providing customers with help at this step can remove a tremendous pain point in the customer journey. Once the customer has decided on the best solution, the steps of ordering and paying are next. In many industrial contexts, these steps can be amazingly complicated, requiring customers to create new accounts, set up bank connections, sign legal forms, wait for invoices, request invoices in different formats, and so on. Once the order has been placed and paid for, the question is: how does the customer receive the product? For instance, does the customer have to travel to the product, or does the product come to the customer? Finally, the customer can enjoy the product or service she bought. And then, as we noted above, the "post-purchase experience" begins, with its many possible value creation and appropriation opportunities.

We can now revisit the various connected customer experiences we described above and see how they act on different parts of the customer journey (see Fig. 2).

Respond-to-Desire experiences start at the "order" step of the customer journey. The customer has already worked herself through the first part of the customer journey; she knows precisely what she wants, and now she wants to press a "button" that makes the rest of the journey as smooth as possible. Curated Offering begins earlier in the customer journey. Curated Offering helps a customer understand the possible options, as well as the best option for a particular need. Coach Behavior operates even earlier: here, the firm helps customers become aware of their needs. And lastly, in an Automatic Execution experience, the firm realizes a need before the customer does and—if given permission—fulfills this need before the customer even notices it has arisen.

We find it helpful to think about three different parts of a connected customer experience. The first part is to "Recognize." The firm needs to recognize the need of a customer, or it must help the customer in recognizing a need. The second part is to translate the recognized need into a desired option that would fulfill this need and to send a "Request" for this option. In some cases, the request will be triggered by the customer; in other cases, the firm itself generates this request. Lastly, the firm needs to "Respond" to this request in a timely manner.

4 From Experiences to Relationships

Up to this point, we have been careful to talk about connected customer "experiences." We have not yet talked about the ultimate goal of creating a connected customer "relationship." To move from a series of experiences to a relationship, we need to add one more element: "Repeat." The repeat element closes the loop. By transforming a few episodic interactions that generate little information to a continuous relationship that constantly creates rich information, firms have the ability to gather more and more information which can enable it to become better and better over time in "recognizing," "requesting," and "responding" (see Fig. 3).

Indeed, it is only by "closing the loop" that we believe that firms will actually be able to create a sustainable competitive advantage using connected strategies. Many of the technologies that underlie connected strategies are available to all firms. As a result, many aspects of connected strategies will become table stakes, and imitation will be rampant. However, learning, which can accumulate over time, can create a formidable barrier to imitation. In Fig. 4, we illustrate two key learning feedback loops. If a firm, through deeper customer understanding, is able to create a better fit between the needs of the customer and the products or services it offers to the customer, then that particular customer is likely to come back to the firm. If—and this is an important "if"—the firm is able to use this next interaction to learn even more about the particular customer's current or future need, or is able to help the customer understand and express his/her needs more precisely, then the next

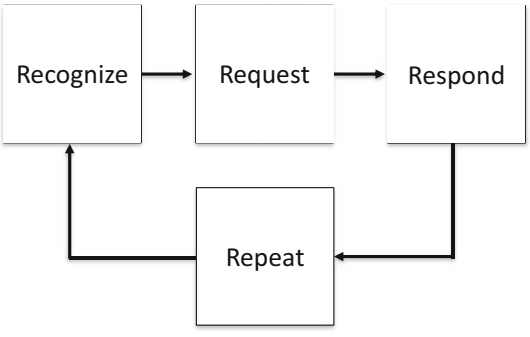

Fig. 3 The four "R"-framework of connected customer relationships

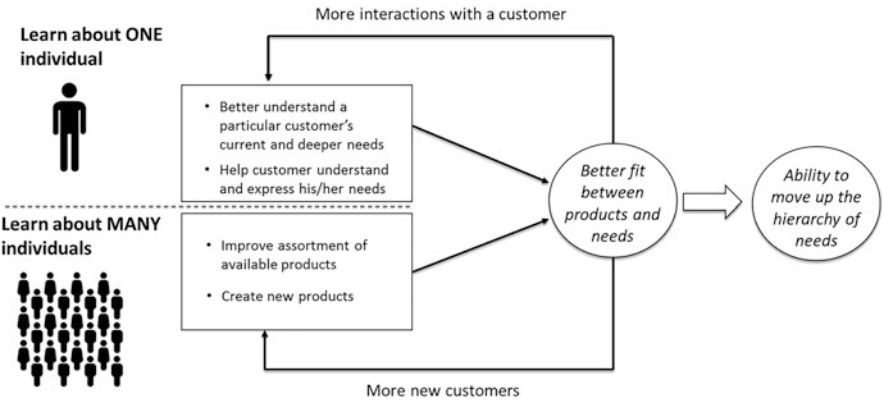

Fig. 4 Two positive feedback learning loops

time the firm interacts with the customer, there will be an even tighter fit between customer needs and the products offered. This positive learning loop (the top loop in Fig. 4) operates at the level of a particular individual. However, it often solves only half of the problem. Now a firm knows precisely what a particular customer wants. The challenge remains whether the firm has the required product available. Since firms usually can stock/provide only a finite number of different products, a second learning loop becomes important. Therefore, the firm also needs to learn about "customers like the focal customer," i.e., it has to engage in meta-learning at the level of the (sub-)population level. If a firm is able to generally provide a better fit between needs and products than its competitors, then it will also attract new customers (the bottom loop in Fig. 4). If the firm uses the information it gathers on all "similar customers" to the focal customer, it can over time improve the assortment of its products and even create new products that allow it to create a very tight fit between needs and available solutions, attracting yet more customers. Lastly, if a firm is able to delight customers repeatedly over time, and if the firm learns more deeply and broadly about the needs of a customer, a firm will be able to move up the hierarchy of needs of a customer. Rather than being simply a provider of the knowledge of how to compute an internal rate of return, a firm can become the "trusted partner in education" for a customer. At that point, a firm has truly created a connected customer *relationship*. Once a firm has been able to achieve this status, it is much harder to dislodge it from that position, and its competitive advantage has become much more sustainable.

5 Applications to Healthcare Delivery

The management of healthcare delivery is facing many of the challenges we discussed in conjunction with the after-sales market. First, consider the challenge

of dealing with repair requests in the field. Traditionally, healthcare systems did not pay a lot of attention to what happened to their patients while they were outside the walls of the hospital (Asch et al. 2012). During the episode of a hospital stay, clinicians would do anything they could to help the patient. After discharge, however, the patient was left mostly alone, disconnected from the healthcare system. This disconnect comes at substantial economic and medical expense, as even very sick patients spend the majority of their time outside the hospital. It is at this time when crucial decisions relating to lifestyle, medication adherence, and home care are made.

A second similarity between spare parts logistics and healthcare is the poor alignment of incentives. Traditionally, healthcare systems were compensated on a fee-for-service basis. When a patient was readmitted to the hospital, which resembles a warranty case in manufacturing, the hospital was able to bill for additional services. More recently, hospitals are creating value-based payment models for procedures such as hip replacements, which display a remarkable similarity to performance-based contracting in logistics.

Third, and finally, technology has the potential to create new business models, similar to what we have seen in the Rolls Royce example and the four vignette cases in our executive education example. As technology advances, a number of connected care devices have launched, including:

- Secure messaging and text- and email-based communication between patients and providers
- Video conferencing technology allowing for video-based consultations instead of office visits
- Connected pill bottles that monitor medication compliance
- Pills with embedded signal transmitters that connect to a mobile device indicating that they have been swallowed and digested
- Connected devices that track breathing problems and provide asthma medication
- Wearable trackers such as the ones made by Fitbit, Apple, or Whoop that monitor heart rate variability, breathing patterns, and sleep

With all of these new technologies, it is now possible to create patient journeys that go beyond the episodic care model of the twentieth century. But what might these new journeys look like? Below, we build on our Connected Strategy framework and the four connected user experiences described above to articulate four ways to serve patients using connected health technologies.

5.1 Respond-to-Desire Patient Experience

Consider the case of the respond-to-desire connected customer experience first. Most of us have experienced the need of reaching a clinician in a timely manner. More often than not, fast access to the care team has been difficult and associated with travel time, substantial waiting times, and other forms of inconvenience. Nor

surprisingly, the field of healthcare operations has put a great emphasis on studying patient wait times (e.g., Batt and Terwiesch 2015) and has shown that friction points such as poor access are associated with inferior health outcomes and lost revenue for the healthcare system. A number of prescriptive models have looked at optimal policies for patient scheduling (Zacharias and Pinedo 2013), panel sizing (Green et al. 2007), and the management of provider capacity (Green et al. 2013).

As much as creating easier access to healthcare is a noble objective worthy of academic investigation, it is associated with a potential downside. Most operations models treat patient demand as exogenous—following some stochastic arrival process capturing how patients fall sick and require care. But, is demand for care truly exogenous? When determining whether or not to seek healthcare, rational patients not only look at the potential benefits of care (hopefully, in the form of medical recovery), but they also look at the associated transaction costs in the form of waiting times, travel times, and medical expenses (e.g., co-pays).

If new technologies reduce some of these transaction costs, they have the potential to increase the overall patient demand. A driver of a car is unlikely to dramatically change her driving behavior knowing that vehicle repair is quickly and conveniently available. In contrast, a patient, who detects an abnormality in her skin, might not be sufficiently concerned about skin cancer to justify making a dermatologist appointment three months into the future, requiring a 30 min drive, and being associated with a $50 co-pay. If, however, that same patient were given the opportunity to take a photo of her skin and submit it directly to a dermatologist in an almost frictionless experience, she would decide to seek care.

This convenient customer experience has empirically been connected with two sets of problems. First, there is the effect of induced demand. Bavafa et al. (2018) show how demand for care in a healthcare system increased once patients were allowed to directly message their care teams through a secure patient portal. Though this increased demand also increased system revenue for patients insured in a fee-for-service agreement, it does consume more provider capacity. Since provider capacity is limited, congestion increases and some patients are crowded out. The authors show that this is especially hurting the opportunities for access for new (as opposed to existing) patients.

A second set of problems relate to the work hours of the providers. In traditional outpatient services, the clinical hours of healthcare providers were well structured and followed traditional business hours of operations (say from 8 am to 5 pm). However, when work for providers does not come in the form of patients but digital patient requests, taking care of patients becomes a 24 h operation with no respect for weekends, holidays, or vacations. Bavafa and Terwiesch (2019) show how the introduction of patient messaging technology has dramatically increased the number of hours a week providers spend on taking care of their patients. Again, incentives need to be put in place to compensate providers for their increased and less structured work schedule, especially given the current situation of provider burn-out.

5.2 Curated Offering

In most cases, patients do not want to see a specific doctor, but are interested in seeing a doctor that is right for them. If the patient is facing a new medical condition, she or he is especially unlikely to know which doctor is the right one to see. For example, the patient might want to see a dermatologist, but has no idea whether or not to see Dr Jones or Dr Zheng. Moreover, scheduling an appointment in the not too distant future at a time that fits the patient's busy schedule can be a major challenge.

The curated offering approach that has emerged in response to this problem is one of demand aggregation and guided navigation through the inventory of available appointments. What OpenTable is for restaurants, ZocDoc is for clinicians. As a two-sided market, it matches patients with providers. Beyond providing scheduling information, it also helps the patient community crowdsource physician reputation based on posted reviews. In the field of Dermatology, Smith and Lipoff (2016) have investigated patient reviews on ZocDoc and Yelp and how they impact demand for future care.

5.3 Coach Behavior

Most patients intend to live a healthy life, especially after encountering major health challenges such as a heart attack. However, myopia and inertia oftentimes get in the way of following through on these intentions. For example, it is a well-known fact in the healthcare community that medication adherence is poor, even for patients discharged from the hospital following major complications such as myocardial infarction.

In a large-scale, randomized control trial, Volpp et al. (2017) provided electronic pill bottles to newly discharged patients and engaged them through a battery of reminders and incentives. These ranged from simple automated text messages ("you have not taken your medication today") to incentives (lottery enrollments upon being compliant with medication regimen for a given duration) all the way to clinical interventions (a call from the nurse). In a follow-up study, Cohen et al. (2006) developed a machine learning method to allocate the capacity of the reminder resource to the patients that seem to benefit the most for them. The study showed that better health outcomes (fewer readmissions) can be achieved with the same level of clinical effort.

Such nudging, or as we refer to it, such behavior coaching, has been shown to be effective in a number of clinical domains, ranging from smoking cessation (Volpp et al. 2009) to weight loss (Volpp et al. 2008). As sensor technology becomes more and more sophisticated, it becomes easier to take an action without waiting for the patient to take the initiative. Though there clearly exist ethical concerns about monitoring the patient 24/7 (recall our earlier point of the tension between

magic and creepy), we propose that patient inertia and myopia can justify the use of connected healthcare technology and support the interest of the patients. For example, just as connected devices such as Fitbit or Apple Watch can remind a patient to get up from their chair and move, connected pill bottles can alert patients when it is time to take their medications. In fact, the drug Abilify is now combined with a connected delivery model in which each pill includes a small transmitter that connects with a patch the patient is wearing on the skin and that sends a signal once the pill reaches the gut.

5.4 Automatic Execution

As magical as coach behavior experiences might be, they still rely on the patient or the provider to eventually take an action. However, there might arise a situation in which the patient is simply not capable of taking an action. Consider the examples of implanted defibrillators as well as fall sensors. Patients that are at risk of sudden cardiac death due to ventricular fibrillation can benefit from the implantation of a cardioverter-defibrillator. This device is capable of automatically detecting abnormal heart rhythms. Upon detection of such an event, the device does not prompt the patient to seek the help of a cardiologist (that would be a coach behavior customer experience), but, instead starts pacing the heart by automatically initiating electric stimulation.

Similarly, patients that are at risk of experiencing a fall can benefit from wearing a fall sensor. The sensor, similar to sensors that activate an airbag in an automotive vehicle, detects a potential fall and automatically issues a 911 call without the patient being in the loop.

6 Conclusions and Opportunities for Future Research

In this chapter, we discussed a powerful trend that is reshaping many industries. More and more firms use connected technologies to reshape fundamentally the way in which they interact with their customers. Rather than having few episodic interactions, companies are trying to create a continuous relationship with their customers that reduces friction and allows companies to anticipate the needs of their customers.

The increase in connectivity also opens up many opportunities for future research in Operations Management:

- The continuous data exchange between firm and customer leaves an electronic fingerprint behind (sometimes referred to as digital exhaust, Terwiesch 2019), which can be econometrically analyzed to test hypotheses from theoretical

models of Operations Management (see Cohen et al. 2003 for an example of this in semiconductor equipment procurement).
- The massive data streams also allow for the deployment and advancement of machine learning methods, allowing for a better integration between forecasting inventory management decisions (Cohen 2015).
- The value that is created by the improved connectivity needs to be shared among the parties in the ecosystem, requiring the development of novel contracts and revenue models such as proposed by Kim et al. (2007a, b).

As predicted by Morris Cohen's research many years ago, the growing connectivity increases the importance of a deeper and higher bandwidth customer-firm relationship. In such a connected world, value is created continually, and the distinction between products and services loses its meaning. This paradigm shift in thinking about supply chain relationship opens up many opportunities for research, many of which will be the intellectual offspring of Morris's pioneering work.

References

Asch D, Muller R, Volpp K (2012) Automated hovering in health care — watching over the 5000 hours. N Engl J Med 367(1):1–3

Batt RJ, Terwiesch C (2015) Waiting patiently: an empirical study of queue abandonment in an emergency department. Manag Sci 61(1):39–59

Bavafa H, Terwiesch C (2019) Work after work: the impact of new service delivery models on work hours. J Oper Manag 65(7):636–658

Bavafa H, Hitt LM, Terwiesch C (2018) The impact of E-visits on visit frequencies and patient health: evidence from primary care. Manag Sci 64(12):5461–5480

Cohen MA (2015) Inventory management in the age of big data. Harv Bus Rev. Digital article

Cohen MA, Whang S (1997) Competing in product and service: a product life-cycle model. Manag Sci 43(4):535–545

Cohen MA, Ho TH, Ren ZJ, Terwiesch C (2003) Measuring imputed cost in the semiconductor equipment supply chain. Manag Sci 49(12):1653–1670

Cohen MA, Agrawal N, Agrawal V (2006) Winning in the aftermarket. Harv Bus Rev 84(5):129

Green LV, Savin S, Murray M (2007) Providing timely access to care: what is the right patient panel size? Jt Comm J Qual Patient Saf 33(4):211–218

Green LV, Savin S, Savva N (2013) "Nursevendor problem": personnel staffing in the presence of endogenous absenteeism. Manag Sci 59(10):2237–2256

Kim SH, Cohen MA, Netessine S (2007a) Performance contracting in after-sales service supply chains. Manag Sci 53(12):1843–1858

Kim SH, Cohen MA, Netessine S (2007b) Reliability or inventory? Contracting strategies for after-sales product support. In: Proceedings of 2007 International Conference on Manufacturing & Service

Siggelkow J, Terwiesch C (2019) Connected strategy: building continuous customer relationships for competitive advantage. Harvard Business Press, Boston

Smith D (2013) Power-by-the-hour: the role of technology in reshaping business strategy at Rolls-Royce. Technol Anal Strat Manag 25(8):987–1007

Smith R, Lipoff J (2016) Evaluation of dermatology practice online reviews: lessons from qualitative analysis. JAMA Dermatol 152(2):153–157

Terwiesch C (2019) OM Forum—empirical research in operations management: from field studies to analyzing digital exhaust. Manuf Serv Oper Manag 21(4):713–722

Volpp KG, John LK, Troxel AB, Norton L, Fassbender J, Loewenstein G (2008) Financial incentive–based approaches for weight loss: a randomized trial. JAMA 300(22):2631–2637

Volpp KG, Troxel AB, Pauly MV, Glick HA, Puig A, Asch D, Galvin R et al (2009) A randomized, controlled trial of financial incentives for smoking cessation. N Engl J Med 360(7):699–709

Volpp KG, Troxel AB, Mehta SJ, Norton L, Zhu J, Lim R, Wang W et al (2017) Effect of electronic reminders, financial incentives, and social support on outcomes after myocardial infarction: the HeartStrong Randomized Clinical Trial. JAMA Intern Med 177(8):1093–1101

Zacharias C, Pinedo M (2013) Appointment scheduling with no-shows and overbooking. Prod Oper Manag 23(5):788–801