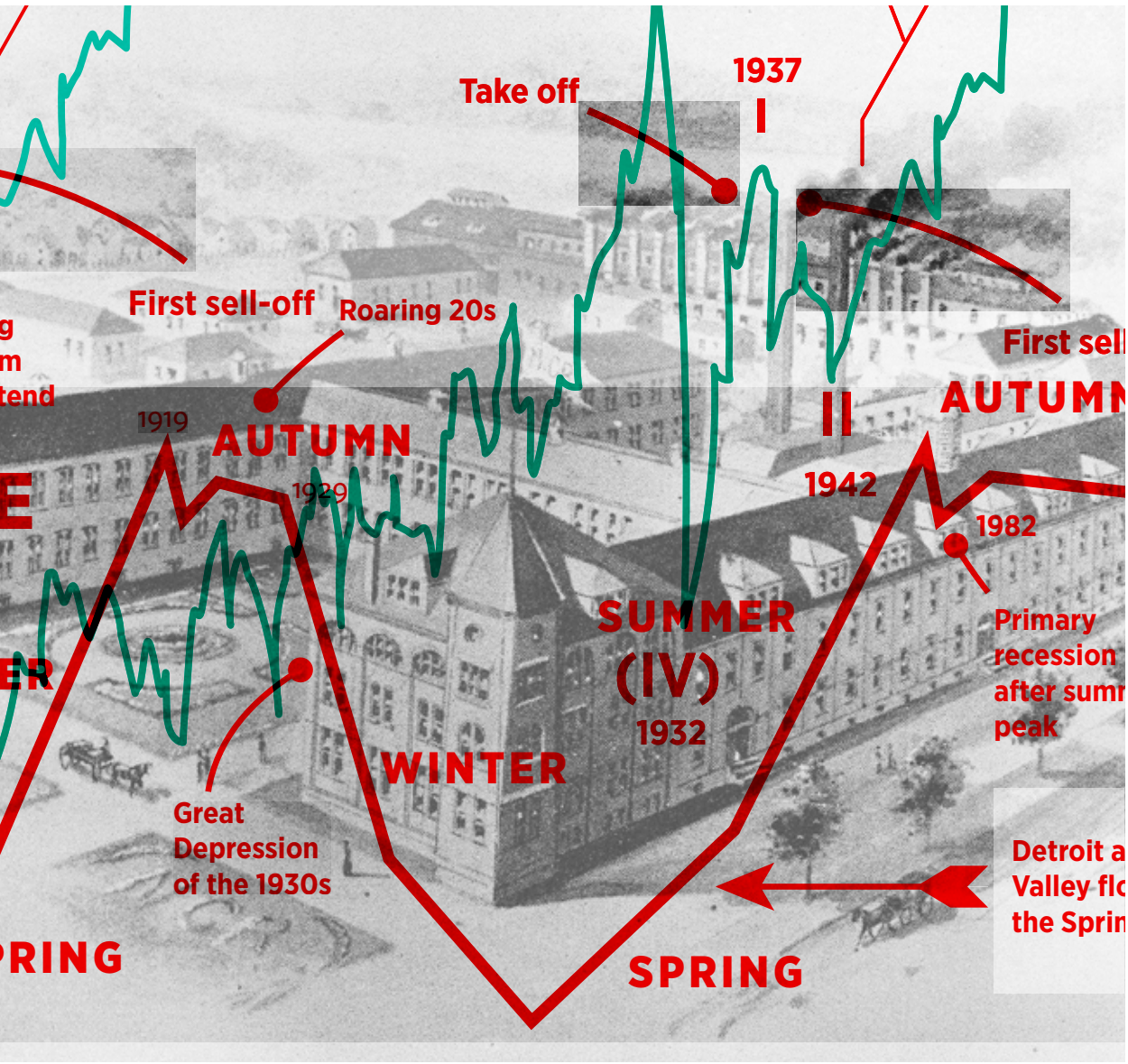
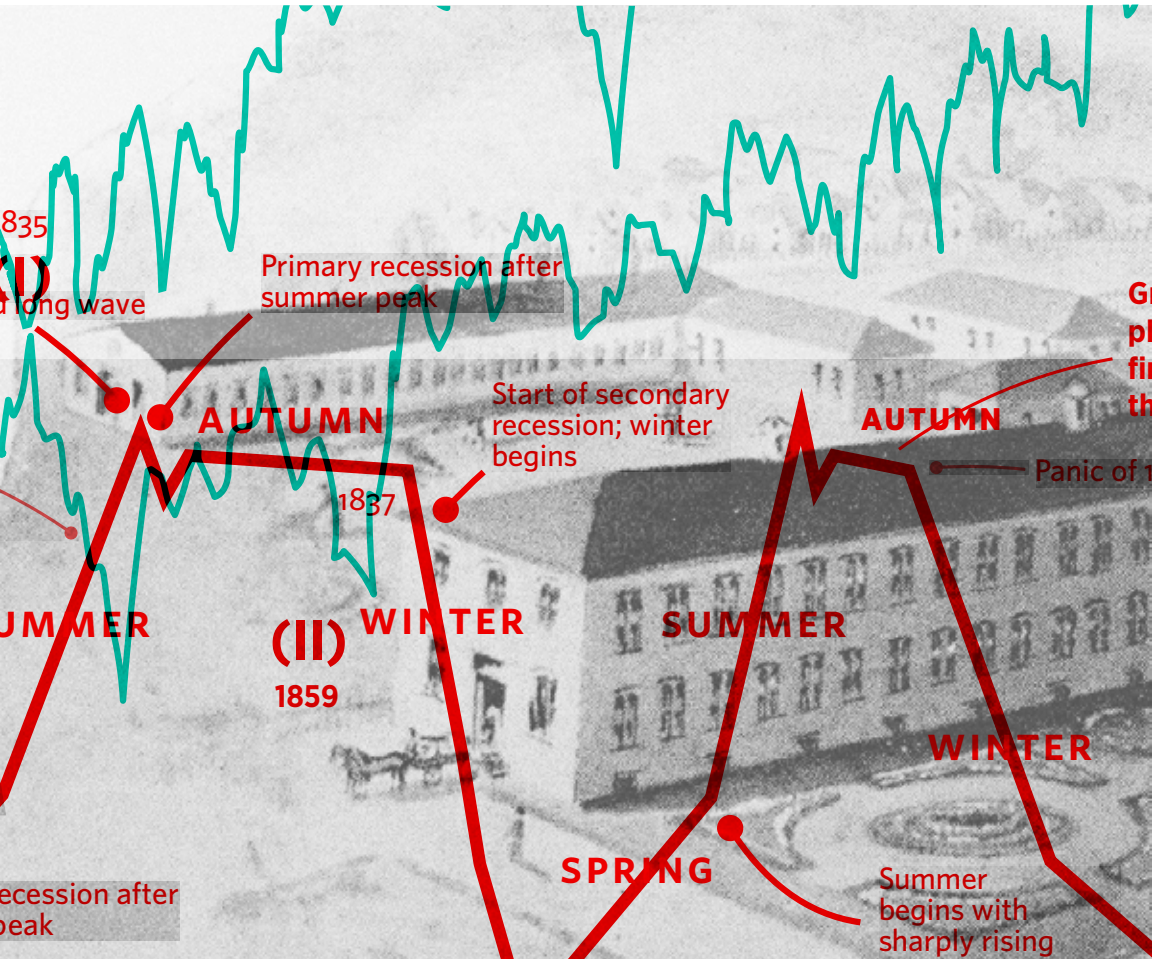


FORESIGHT PLAYBACK

MAPPING THE FUTURE OF INDUSTRIAL REGIONS BY LEARNING FROM HISTORICAL CYCLES OF INNOVATION

NEAL HALVERSON


835
(I)
long wave
Primary recession after
summer peak
AUTUMN
Start of secondary
recession; winter
begins
1837
UMMER
(II)
1859
WINTER
SUMMER
AUTUMN
Panic of
WINTER
SPRING
Summer
begins with
sharply rising
ecession after
peak

FORESIGHT PLAYBACK

MAPPING THE FUTURE OF INDUSTRIAL REGIONS BY LEARNING FROM HISTORICAL CYCLES OF INNOVATION

NEAL HALVERSON

Submitted to OCAD University in partial fulfillment of the requirements for the degree of Master of Design in Strategic Foresight and Innovation

Toronto, Ontario, Canada
April, 2019

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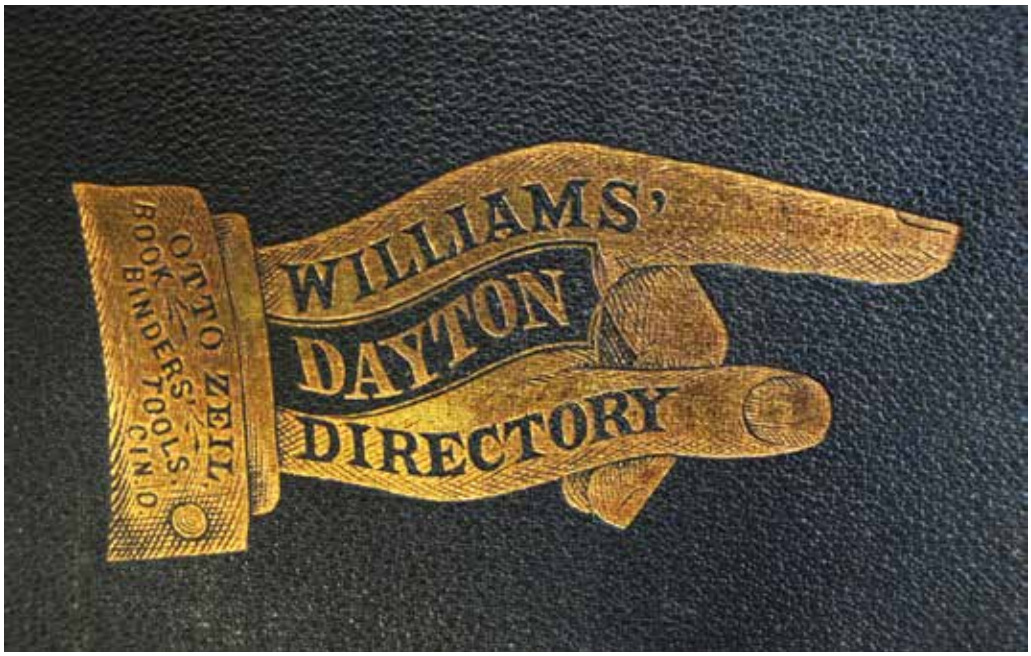
ABSTRACT

This paper explores how mapping historical cycles of innovation and finance can inform the future of innovation for industrial clusters. This method is discussed in combination with strategic frameworks for increased cluster survival — such as the GEMS model for cluster adaptation — and the Three Horizons foresight methodology that can complement the historical cycles method. Three stages of cluster development are described and charted for five regional clusters , detailing factors contributing to their rise and fall which can help firms and clusters understand their place along a life cycle. Beneficial agglomeration externalities are also detailed for the case studies. Kondratieff, Schumpeter, Elliot waves and the Fourth Turning generational cycles are brought together to show how cycles of innovation and decline can be mapped over long periods, adding to the insights that other foresight methodologies can bring to cluster planning.



Dayton City Directory
and city seal, 1858
Dayton Metro Library

The emergence of an industrial cluster: Dayton City Directory, 1858
Dayton Metro Library

LEWIS B. GUNCKEL. HIRAM STRONG.

GUNCKEL & STRONG,

ATTORNEYS AT LAW,

Office in CONOVER'S BUILDING, south-east corner Main and Third streets, and just opposite the Phillips' House.

D. BOONE,

MANUFACTURER OF

WELL AND CISTERN PUMPS,

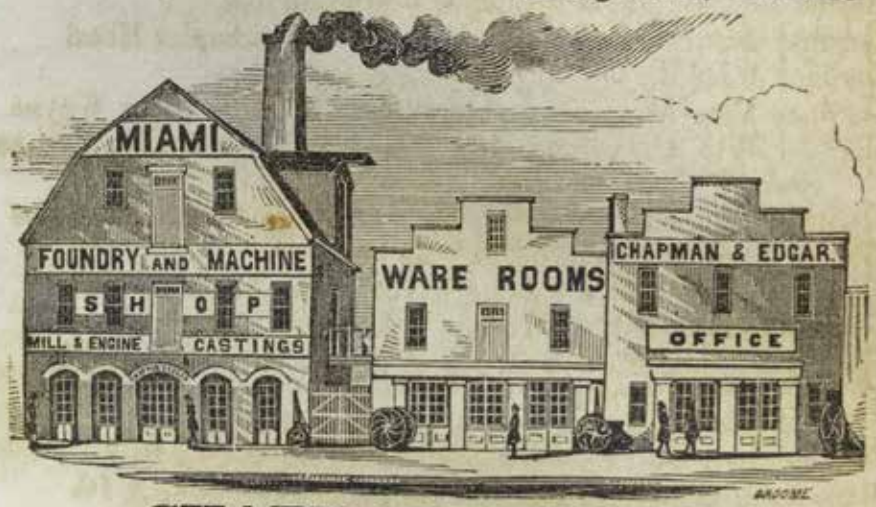
EAST FIRST STREET, OPPOSITE SWAYNIE HOUSE,

DAYTON, OHIO.

MIAMI FOUNDRY AND MACHINE SHOP,

First-st., opposite the Swaynie House,

Dayton, Ohio.



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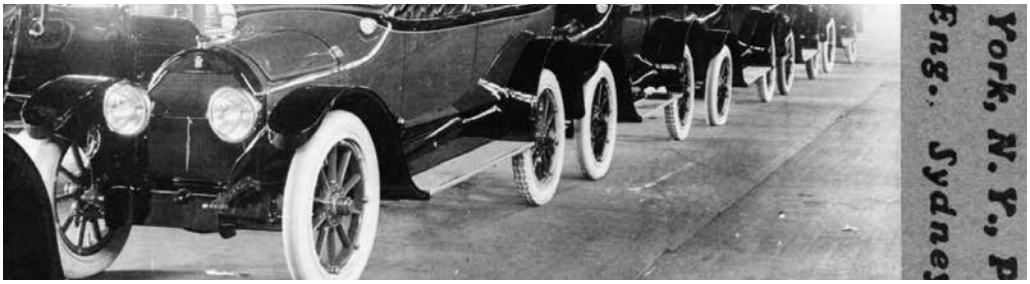
INTRODUCTION

In this paper, I will attempt to show how history can be used to prepare for a better future when combined with theory and emerging foresight practices. I have always been interested in American business history, and was introduced to the historical development of key processes in the growth and development of the modern corporation during the nineteenth and twentieth centuries while in university. Personalities associated with the rise and fall of famous firms, the decisions they made in the context of their time, and surrounding historical and social movements are compelling to me. Of particular interest is the history of the automobile, which I felt could be a starting point for a major research project if I expanded the area of study to organizational management, systems thinking and social influences around a few key firms. In order for the project to include a significant foresight and innovation component, however, I resolved to expand the study to include multiple regions where innovation took hold and then experienced decline — and then reflect on lessons learned that can ensure success for the clusters of today and of the future.

My research question developed into: how can we inform the future of regional innovation ecosystems by learning from historical case studies and historically-informed innovation systems alongside firm and inter-firm dynamics, which can bring a more substantive approach to foresight methods and guide strategies and governance for future innovation ecosystems and their component firms? With this question, we can also ask why prominent innovation regions can lose their ability to sustain themselves in a new technology regime. Is it because of unchanging competencies, fixed routines that benefited an earlier era, the permanent drying-up of financing sources following an economic downturn, or ineffective management, or all of the above? Can factors identified in the rise and demise of a city like Dayton and its capacity for far-reaching invention, or a similar progression for Detroit's manufacturing dominance help envision the future of innovation centers beyond Silicon Valley's digital computing importance? Can loss of a regional hegemony be prevented? By going back into history, foresight techniques can be strengthened through insights based on factors that benefited or hurt an industrial cluster.

Cadillacs emerging from the factory, Detroit, ca. 1917
Author's collection



SURFING THE WAVES AND WALKING THE STREETS: THE METHODS

To generate insight into how firms and regions might plan for the future, I undertook a primary and secondary study of present and former regions of innovation, combined with the study of historical wave theory and other foresight methods. Historical examples of clusters relating to their emergence as centers of innovation and reasons for decline are explored in long-term case studies of three American industrial regions. I chose American clusters for discussion because of the dramatics of their rise, the fascinating figures identified with their histories, and because narratives of American firms and clusters are plentiful in cluster and business literature*. My narrative of the three regions — Dayton, Ohio, Detroit, Michigan and Hartford, Connecticut — focuses on their stature as technological regimes with centers of expertise that were unique in the nation before being disrupted. It is my belief that shared factors of their emergence and decline can point to lessons for present and future industrial clusters. In order to get a sense of what I understood to be a proud history and contrasting present situation up close, I conducted field research in Dayton. I interviewed local historians, an institutional manager, and a director of a small business hub to get a sense of what went wrong, and if there is a new future being built. I engaged in ethnographic research, photographing decline in the city center.

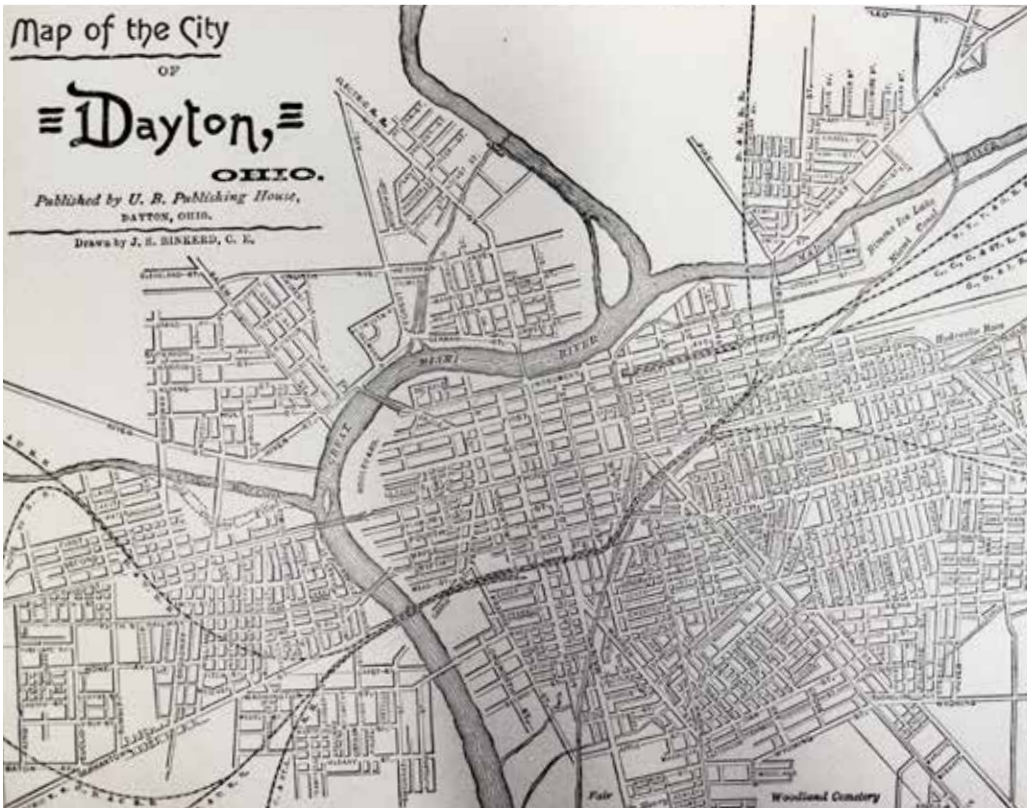
* The Italian garment industry is one other cluster model that is frequently cited as a successful

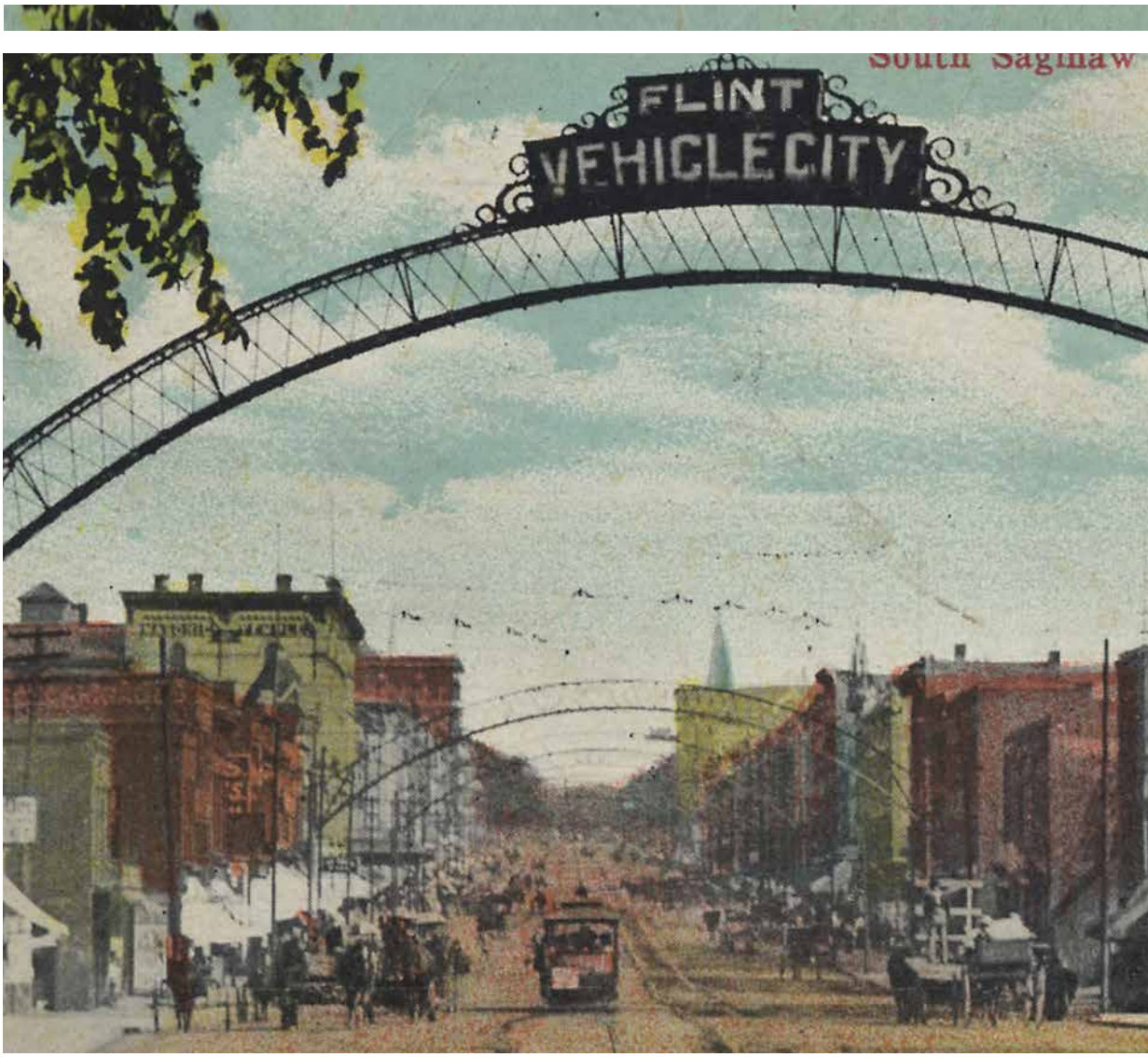
Secondary case study research includes Detroit, with its similar narrative of rise and decline, and a comparably minor study of a single firm in Hartford. Modern clusters are represented by Silicon Valley — currently positioned in a late stage of the information age, heading into a fourth industrial revolution — and New York City, which is emerging with other candidate cities as a favoured tech cluster. As with historical clusters that I have positioned as useful for foresight study, Silicon Valley is subject to internal and external systems that can ensure its dominance or imperil survival. I will point out positive growth strategies that a few choice emerging clusters exhibit, but will also feature an effort underway in downtown Dayton to reverse the region's long decline with strategies for commercial success. Historical lessons derived from factors related to the emergence and decline of regions can be combined with knowledge of strategies for cluster growth currently in use, and then strengthened with foresight methods to construct a better course of action for regions. Another device that can be used to mirror the past in the present (while also having a foresight function) are reputable historical waves of economics and innovation, which are included in the project to function as a companion to the cluster narratives. They demonstrate that the emergence, success and failure of innovation and its capitalization can be traced along cycles through history, and suggest that the future can be planned for by following an expected trajectory of economic events that spur or interrupt innovation's advance.

Along with history, theory and strategic thinking needs to be a part of a discussion that aims to advance the success of industrial clusters. For a background of how clusters exist as complex systems that have their own structure that influences their behaviour, I have included a few key takeaways of cluster theory. Along with a description of clusters as complex systems, I will identify the benefits and vulnerabilities of clustering, the stages of cluster emergence, maturity and decline, and will discuss how a cluster's architecture may help or hurt its ability to adapt to changing circumstances. Three strategic models that are designed to influence the adaptability of clusters are reviewed, along with a discussion of why people in some industries make their home in certain regions instead of others — movements of people and talent that have a great influence on the future of a region's wellbeing.

How government policy can help or hinder nationwide economic growth is also discussed, and likewise holds lessons for the present and the future. The most straightforward tool for stimulating useful foresight proposed in this paper is a framework designed for bringing people of past, future and in-the-now mindsets together to work out strategies for growth. It is hoped that armed with different varieties of knowledge — of the past, theories of what makes up the current system and signals of what is emerging in the present — a purposeful foresight tool can direct firms and clusters towards a positive future. The signals pertaining to developments and risks for regions comprise a section which also includes uncertainties which clusters should plan for, and a look into possible future scenarios that give a glimpse into a world of innovation and work which can go in different directions.

The city of Dayton in its emergence as a thriving industrial cluster, 1898
Dayton Metro Library





Flint, Michigan, 1910
Wayne State University Digital Archives

CLUSTER THEORIES

We start by considering clusters as complex systems, and then define the benefits of the coming-together of agents in geographic proximity. The stages of a life cycle of clusters are considered, and how the architecture of clusters can help or hinder their adaptability.

DELIVERING THEORY TO A TANGLED LANDSCAPE

A COMPLEXITY PERSPECTIVE FOR CLUSTERS

It is important to establish the nature of clusters at a system level, to inform lessons learned when looking at historical examples or in attempting to make changes for the future. If we want to ensure effectiveness when making changes to the different cluster agents (firms, educational institutions, suppliers, etc.) or their interactions with each other as needed to ensure adaptiveness, we need to have some understanding of their complex interactions that may help or conflict with our change efforts. Clusters, as described by Kirsten Press in *A Lifecycle for Clusters?* are complex systems that have emergent properties that are derived from the activities of agents and the interdependencies between them. Agents are configured in their own individual forms, having evolved to their state depending on the industry and territory. It can be said that clusters, therefore, have the first three requirements of systems: agents, interdependence and distinctness.

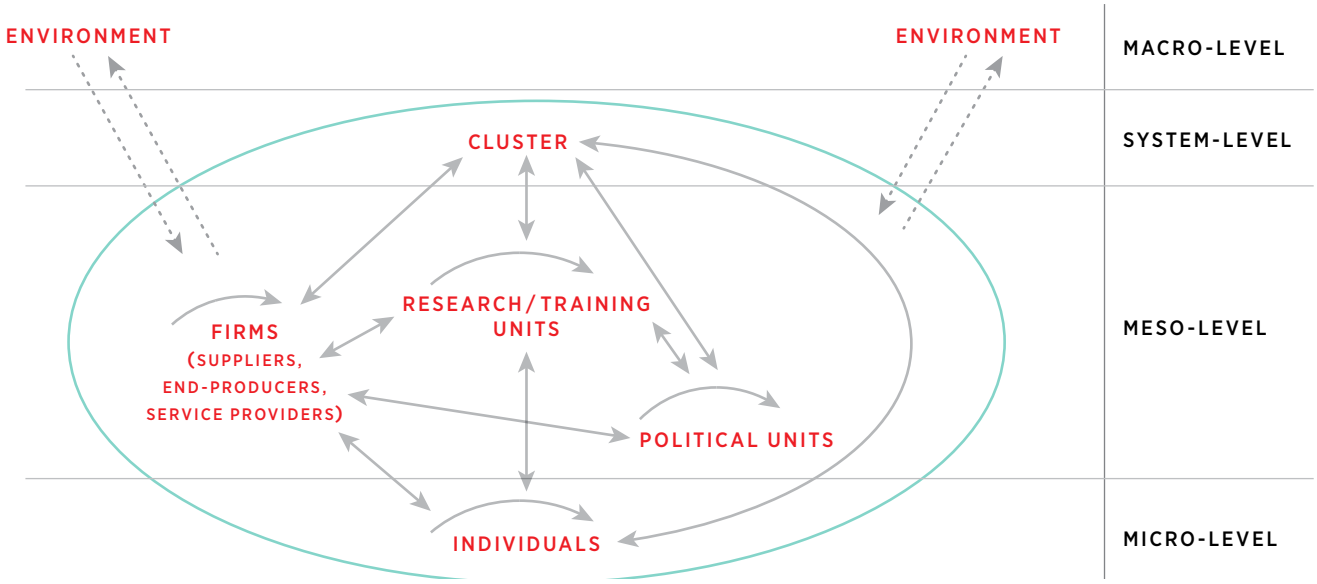
These agents that are able to use their proximity to each other to benefit from trust-based relationships, whether with partnering firms, government institutions, local buyers, local universities and others who can mutually benefit from co-location. Because of this partnering, innovations are thought to be able to spread faster, with products that can achieve greater specialized value while having the capacity to be upgraded at a quicker pace (Press, 2006). In the U.S., examples of clusters are found in the high concentrations of mutual-fund companies that can be found in Boston, aerospace and defence builders in Seattle, the familiar automotive firms in Detroit, motion picture studios in southern California, amusement parks in central Florida, and so on (Dzialo, 2018, McCraw, 2000). In order for these firms survive in a complex system, there needs to be a certain degree of agency at the system level, with interacting components of non-linear relationships that are open to environmental influences. At the higher level, the architecture of the cluster will have significant impact on the behaviour of elements at the component level, extending to all the components within the cluster. The cluster cannot adapt on its own, but can steer individual activity from a systems perspective (Press, 2006). It will be seen that automotive firms in Detroit, for example, had individual strategies for combating the initial influx of foreign competition, but also attempted to act in unity as a cluster. These were agent and cluster decisions that ultimately proved to be of insufficient foresight.

Since adaptation cannot be understood by studying the individual firms of a cluster alone, clusters meet the second definition of complex adaptive systems (“the overall behavior of the system of elements is not predicted by the behavior of the individual elements”). Clusters do not have the central decision-making authority that would suggest a simpler pro-

cess characterized by integrated organizations. Interdependent agents might be adapting to external changes, while at the same time relying on fellow agent's activities and trying to conform to behavioral restraints of the cluster's understanding of acceptable business practice. In Detroit's example, car makers responded to foreign competition by trying new model strategies at the firm level, but adopted a don't-rock-the-boat behaviour at the larger cluster level). Adaptation can take time, and the efficient system can be endangered if the surrounding environment is unstable, as is almost always the case (Press, 2006). The complexity of the adaptiveness of agents is one of the more inaccessible features of studying clusters, but a disciplined study of complex systems in the form of inter-firm dynamics would be a benefit for those who aspire to lead industrial regions. Texts such as *Thinking in Systems: A Primer* by Donella H. Meadows (2008) or *Systems Thinking: Managing Chaos and Complexity* by Jamshid Gharajedaghi (2011) could provide a valuable grounding in trying to figure out sensible systems that address this complexity.

Fig. 1 shows Press' conception of the nature of ideal clusters, with agents, interdependence and co-ordination behaving within territorial boundaries. All of these agents contribute to agglomeration externalities. The arrows represent the competing and complementary exchange of activities by different cluster agents (Press, 2006).

FIG. 1 THE NATURE OF IDEAL-TYPICAL CLUSTERS (Press, 2006)



WHY STAY TOGETHER?
THE BENEFITS OF CLUSTERING

Though clusters are indeed complex in their difficulty to successfully regulate at the firm or system level, sharing a spatial proximity has a history of benefits. These benefits are seen in the first stage of the emergence of clusters, and are also be seen in the initial upward thrust of historical waves of innovation. The founding text that extensively analyzed and proposed a theory of why clusters emerge was Alfred Marshall's *Principle of Economics* (1890, revised in 1920), which discusses benefits of co-location, the spillover of information, scale, specialization and attraction of demand. This work builds on economic theories going back to Adam Smith, who recognized the importance of division of labour and specialization. Marshall, however, investigated the wealth of regions and industries rather than nations, and proposed that firms cluster spatially in distinct areas because of three benefits that are self-reinforcing:

First, **labour clusters where firms cluster**; firms and labour can match each other's special characteristics, making both more productive, possibly reducing unemployment (pooling resources). Second, clustered firms benefit from other firms in **technological learning**, which builds up the productivity of all firms, allowing clusters to be more productive (information flow/spillover). Third, suppliers that enter a cluster allow for **lower transactions costs and specialization**, benefiting both suppliers and firms (integration of specialized inputs) (Klepper, 2011, Agrawal, J., et al., 2012). This mutual knowledge and trust saves money for everyone involved, with skill transfer and benefit of qualifications that promote innovations and innovation diffusion (Agrawal, J., et al., 2012).

CLUSTERING OF A COMMUNITY

The least centralized system is the traditional competitive system. When relationships eventually form among firms, costs such as searching decline (e.g. just-in-time delivery of parts embodied by Toyota in the 1980s). Three dimensions of embeddedness that can be reinforced in clusters are territorial, social and network. Strong ties among workers, including managers, can increase the amount of information available to firms and readiness of people to share what they know. From there, relationships gain a dimension of friendship, which counterbalances the competitiveness among firms. Chance meetings may promote discussion of common problems and new initiatives (Jacobson, et al., 2008). A local culture of informal institutions might govern local business practices, enabling and facilitating inter-firm exchanges within the cluster (Press, 2006). An important example of informal institutions and chance meetings can be seen throughout the history of Dayton, as will be shown in the discussion of the rise of Delco and the strong ties held by those connected with or influenced by the National Cash Register Company (see also the GEMS model).

KNOWLEDGE IN THE AIR

Labour mobility found in industrial clusters can enhance knowledge in a district; workers change jobs, become foremen, and set up business themselves (spin-offs). Some of these businesses will fail, but talented people who have gone out on their own can then be reabsorbed as employees in other firms. In Silicon Valley, for instance, entrepreneurship is rewarded, and failure is not stigmatized (though there is the potential weakness of today's unbounded confidence in the aimless "cool idea" criticized in today's Silicon Valley). Knowledge generation occurs because of the effective mechanisms for its diffusion, and the ability to transform that knowledge for new contexts* (Jacobson, et al., 2008). When learning in these communities of practice transcends firm boundaries, a kind of character can be imparted to the cluster. As Marshall wrote of 19th century Britain, "to use a mode of speaking which workmen themselves use, the skill required for their work 'is in the air, and children breathe it as they grow up'". This too would have been felt in Dayton's 19th century intense atmosphere for invention, or in the companies that were putting America on the move in Detroit. Along with information diffusion, the creation of new sets of knowledge through shared preoccupations can result in a stronger "gene pool" within the sector. Solutions originally regarded as competing may turn out to be complementary and well-suited to different niches in the district (Jacobson, et al., 2008).

* Uncertainty about whether spatial proximity is truly needed in the dispersal of knowledge-intensive work appears in the literature, and most activities are frequently outsourced locally in today's digital world. But it will be seen that important instances of convergence -- of money, skill, social benefits and opportunity still seem to demand a contingency for like minds to meet together for complex transactions.

In Silicon Valley, for example, there is a recognition of a '20 minute rule' of how long venture capitalists are willing to travel to hear a high-risk tech pitch. Some commuters, on the other hand, are willing to endure ever-longer commutes to be able to work in an important cluster (Florida, 2008). The Three Horizons method for devising a practical future (discussed later) is an example of the possibilities for convergence of imagination that would be difficult remotely.

MODULARITY AND SPECIALIZATION

With new information gained from the frequent meetings of participants, improvements in processes can be integrated by leading firms in the cluster that collect information along several segments of the supply chain. In these processes, high levels of differentiation and specialization allow firms to focus on aspects of the supply chain in which they are especially competent (Press, 2006). From an industrial perspective, when common practices in a cluster lead to high degrees of consistency of products and processes, formal and informal modularity can be achieved to the cluster's benefit (Jacobson, et al., 2008). This occurred as far back as the early 1920s in Detroit, when a dominant auto design emerged, leading to a significant increase in the modularity of cars, which allowed for a thriving after-market of parts (Argyres, Bigelow, 2010). A more generalized vision shared by participants of a cluster's business and how firms are expected to go about it can also take place (which would eventually work to Detroit's disadvantage, and perhaps in time, Silicon Valley's as well). Good working knowledge of how products relate to existing configurations or components can help firms and their suppliers innovate to achieve success in the marketplace (Jacobson, et al., 2008). Richard Florida, an economic geographer, cites Jane Jacobs in stating that innovation is drawn from a diverse pool of resources, in cities where "so many people are close together, and among them contain so many different tastes, skills, needs, supplies and bees in their bonnets" (Florida, 2008). The coming-together of agents in a cluster, therefore, brings about a shared community of knowledge and habits that sustains success for a certain period of time.

SPINNING-OFF SUCCESS

In the literature, Steven Klepper discusses the spinning-off of firms that are an important activity of clusters that through history, have created much innovation and contribution to the economy. Leading firms in clusters are predominantly spin-offs of other leading firms originating in the cluster (Klepper, 2011). Important spin-offs in history will be detailed in the narratives of Dayton, Detroit and Silicon Valley. Learning the heredity of familiar companies that are the result of an enterprising individual, chafing under a successful but constraining firm, can be surprising. Some of the characteristics of spin-offs are:

- Clusters begin with a successful diversifier, often former employees who have learned much from a successful firm, and go out on their own to start an organization that in some way mirrors the incumbent firm.

- Clusters experience a high rate of spin-offs; the percentage of entrants that are spin-offs is greater in clusters than elsewhere.

- Clusters are home to the most fertile spawners of spin-offs.

- Spin-offs in clusters are more competent on average than spin-offs elsewhere and other kinds of new firms denoted as startups, based on the superior knowledge and practices learned from the successful founding firm.

The National Cash Register Company (NCR), based in Dayton, Ohio, influenced talent that went on to form Delco and the Dayton Computing Scale Company, which would later become IBM. In Detroit, this heredity of organizational reproduction can be seen in the founding of automobile firms, started by former 'pupils' from successful firms that set the pace. The Olds Motor Works, for example, trained several men that would make their name in the auto industry: Olds subcontractors helped build both Ford (1903) and Cadillac (1902); and a former Oldsmobile executive started Maxwell, which eventually was folded in with another firm to become Chrysler (1925). The better performance of firms equates to more valuable lessons for enterprising employees, resulting in spin-offs located near the incumbent businesses' location (Klepper, 2011).

THE VERTICAL IMPULSE

Historically, vertical integration was the most common structure of firms, as small markets do not permit specialization. Dynamic transaction costs in the early stages of an industry may force organizations to produce their own inputs and exhibit centralized processes. Complex, new-to-the world products are built by firms that have their own central product architectures, often earning a price premium based on the uniqueness of product design (Argyres, Bigelow, 2010). As will be seen, The Pope Manufacturing Company in Hartford spent years perfecting the painstaking process of building some of the world's most sophisticated and exclusive bicycles before inviting (and then acquiring) suppliers to speed up growth. These external suppliers may only appear after a product has estab-

lished itself, followed by a more horizontal business landscape of cooperating firms and suppliers.

The reverse can also happen: an industry may develop quickly into an industrial cluster but transform into a vertically integrated firm when innovation raises dynamic transaction costs. Examples of this are the early Detroit automobile industry* or with watch manufacturers in Switzerland in the late 20th century (Jacobson, et al., 2008). In the case of Ford, however, the result of extreme centralization of production and control tended to suffocate success (Liu, et al., 2015), as it did with NCR. For modern-day tech industries, the architecture of their complex products tends to become more modular as they develop, while mechanisms for innovation knowledge in open systems vary in degrees of centralization. Ultimately, it is helpful to know to what degree a structure should be vertically or horizontally integrated for optimal success; the consideration is mentioned here only as part of a background on clusters to influence further firm and cluster-level discussion.

* Ford had been in business for ten years before it stopped buying components from the Dodge Brothers and geared up for its famous vertically-integrated Rouge River plant

4 o'clock shift at the Ford Motor Company assembly plant in Detroit, Michigan, ca. 1915
Wikipedia

STAGES OF A CLUSTER

As innovation and its investment can be plotted along historical innovation time lines, Kirsten Press has identified stages particular to clusters. Analyzing these stages of development can be useful in the emergence or maturity of a cluster to prepare for a possible decline in a later stage. A cluster's emergence follows the discovery of something in a region that makes it a suitable location for the industry. Pioneering startup activity that exhibits success will attracts firms to the emerging cluster, accelerating its advance (Press, 2006, McCraw, 2000). An increasing division of labour follows: mergers, acquisitions and exits of firms, and the arrival of resources from outside the area. Eventually, a buoyant cluster will find what Press calls its 'carrying capacity' — its maximum size before becoming unsustainable. Press analyzes the relative success of clusters based on changes in firm and employee numbers, describing how the cluster's carrying capacity results from varying external conditions that shift from positive to negative (between a positive and negative change event) (Press, 2006).

FIRST STAGE

Firms may enter an emerging cluster to take advantage of geographic benefits such as the availability of raw materials or access to transportation networks that are present. There may also be a promise of agglomeration (benefits of locating in a cluster) shared by a number of firms, reinforcing the movement of products further along innovation life cycles (Jacobson, et al., 2008).The firms that enter into an emerging cluster learn by proximity, facilitated in part from shared sources of technical knowledge, such as research institutions or other firms (Press, 2006). Stanford Industrial Park in Silicon Valley was a major center of development at the beginning of the region's tech cluster, and the possibilities of knowledge sharing would have been considerable. At this stage, there are benefits from the low transaction costs enjoyed by emerging clusters, plus the security of being able to manage one's size in order to avoid over-capacities, made possible by division of labour through coordination among participating firms. This coordination results in the development of a dominant product design that is favoured by users (Argyres, Bigelow, 2010).

Because of these benefits, energetic clusters will have out-competed isolated firms. Over time, the need for frequent knowledge transfer and inter-firm coordination declines as a result of the stabilized nature of production and design. It should be noted, however, that this sequence of events in the cycle may reflect the more traditional story: not all industries move toward standardization, vertical integration, mass-production and cost competition. Transaction cost savings, tacit knowledge, division of labour may also not be important at the beginning of a cluster (Press, 2006). An accelerated flow of innovations occurs, stemming from suppliers, or from the soundness of the relationship between

assemblers and their suppliers. Suppliers in the early stages of a life cycle can offer new variations on their components, which benefit assemblers by adopting improvements that consumers approve of (Jacobson, et al., 2008).

SECOND STAGE

The second stage of cluster development sees a consolidation of firms and growth of the cluster. A result of this growth is the increased competition of suppliers seeking to input into the system, a growth of infrastructure and a higher cost of increasingly scarce local products. Major consolidation occurred at multiple times in the Detroit auto industry, with a major shake up occurring in the mid-1950s, when Ford launched an aggressive campaign to be number one in the industry, pricing the remaining important independent car makers out of most markets, leaving only Ford, General Motors and Chrysler with a market share of over 90 percent (Klier, 2009). What Press describes as "negative agglomeration externalities" can take hold in the second stage, limiting the growth of the cluster, or even triggering its demise in changing economic conditions. The strength of a firm's response to change events are influenced by the responses by other firms (expressed in the Press cluster model as 'fitness') (Press, 2006). As the industry matures, technology becomes standardized and production more integrated, which reduces the initial benefits of co-learning and discovery of important efficiencies made possible by proximity. The sustained strength of agglomeration economies that made for positive agglomeration will shift in time as more firms enter the cluster, decreasing as the threshold of the cluster size is reached. Competition for scarce location-intrinsic resources will eventually make the cluster less viable.

THIRD STAGE

The level of standardization increases in the third stage, with the cost of a firm's product now seen as more important than its innovation or performance. The decreased benefits of operating in a cluster and negative externalities become overwhelming, and a convulsive dispersal of activity may occur following an external event, such as the arrival of a lower-cost non-local entrant to the industry, or the emergence of an entirely new industry. Completely original ideas and products often come from discoveries that happen outside the existing cluster, and new industries tend to take shape in new locations that are relatively low-cost compared to the original cluster. With the new locations established by the upstarts, their new technologies, often incompatible with the technologies established by the incumbent cluster, will in time become dominant (Press, 2006). New entrants will often have a smaller stake in the established technology known to the incumbents, and will therefore have less to lose from the cannibalization of the current technology (Rosenbloom, 2000). It will be shown, for example, that Silicon Valley was better positioned geographically compared to Detroit in accessing the right suppliers of electronics for electric vehicles (though it can be argued that the Tesla example might not yet come close to true disruption). Other sources of exhaustion could be internal or regulatory inflexibilities, changes in quality or demand, changes in production, and changes in transportation options (Press, 2006).

Altogether, there are many factors of emergence, maturity and decline that can be traced along the three stages of a cluster, and can serve as useful signposts for taking action in anticipation of the next stage in avoiding or mitigating disruption. The benefits of observing the workings of these stages with the resolution to act can be made more powerful when analyzing longer-term waves of innovation and historical case studies that demonstrate these waves. While understanding the various benefits and dangers that can occur in a cluster's life cycle is helpful, an expanding toolbox for cluster adaptiveness requires a more detailed knowledge of cluster architecture, its dynamics and points to leverage adaptability for successful outcomes.

A DEPENDANT ARCHITECTURE

It has been suggested above that the apparent benefits of cluster success can take a turn for the worse, to the point of ensuring the cluster's decline in unstable circumstances. For firms, this is a difficult paradox. It certainly supports the characterization of clusters as a complex systems — hard to conceive of in their myriad detail, and ultimately hard to manage effectively. In spite of this, Kirsten Press imagines a possibility for clusters to have agency in adapting to change events. Press proposes an N/K simulation model (originally developed to study the evolution of genomes where N counts as the number of components in the system and K measures the degree of interaction between components) to explain when and why a cluster's architecture assists or hampers adaptability to external threats. The simulation model can link the performance of agent adjustment to the influence of different cluster architectures — looking into when and how agglomeration externalities impact the fitness of firms and the cluster if economic conditions vary. Weak externalities, for example, make adaptation easier, but result in weaker cluster success (Press, 2006).

Press' simulation model investigates the pros and cons of architectures based on a hub-and-spoke arrangement versus flexible specialization to cope with the challenge of globalization, and then compares the different adaptability of districts. The N/K approach Press chooses "enables a comparative analysis of the adaptive performance of differently configured complex systems", highlighting superior architectures that can adapt to external changes. In spite of the benefits of flexibility, Press has implied that cluster development has an element of betting to it*, and describes cluster adaptation and survival as path-dependant as a result of their structural properties (the architectural features that evolved throughout the cluster's history which portend it's future). Cluster architectures with established intermediate degrees of division of labour and a more collective arrangement of governance fosters adaptability and possible future survival.

A cluster's successful adaptation to change is dependant on how well its agents can either self-organize or increase activity in other sectors to make up for failures in the original cluster. There also needs to be effective decentralized problem solving and communi-

*An interesting insight gained from a *Sloan Business Review* article is that while (surprisingly) innovative output might actually decline for clustered firms, knowledge spillover that does happens tends to be of a marketing nature, and can use this knowledge to find markets and customers for the right products (Yu, 2002).

cation by local actors at the cluster level in order to recognize a change event and make effective adjustments. Survival seems to depend on an architecture of cluster-level factors to allow the contribution of positive actor-driven adaptation to change events. In this architecture, both formal and informal institutions would rise to facilitate the effective participation of cluster agents towards desirable actions. In Press' description, "individual activities 'drive', while cluster level properties 'steer' adaptation to external events" (Press, 2006).

THE NEGATIVE EFFECTS OF EMBEDDEDNESS

Players in the industrial cluster need to be able to adjust to externalities to survive, and good external channels of communication need to be cultivated. As seen the third stage of the cluster life cycle, however, a source of exhaustion could come from within. Firms can develop institutional behaviour patterns throughout their evolution to cope with environmental risk and uncertainty — patterns that can be hard to unlearn in the face of a change event. Strong agglomeration externalities can lead to great success but hamper adaptability to change. The close relationships in industrial clusters could eventually reduce access to knowledge developed outside of the district or from unfamiliar sources (e.g. success myopia). Both too much and too little proximity can hinder learning and innovation. To function properly, proximity requires just the right amount of distance between agents or organizations. Proximity and embeddedness can evolve over time, from not enough to just enough to too much, suggesting a link between the issues of embeddedness and life cycle considerations. For instance, decentralized industrial districts may be at a disadvantage in generating innovations that require the development of new components as well as new ways of integrating components (Jacobson, et al., 2008).

Fig. 2 CONTINUITY AND CHANGE IN CLUSTER DEVELOPMENT (Press, 2006)

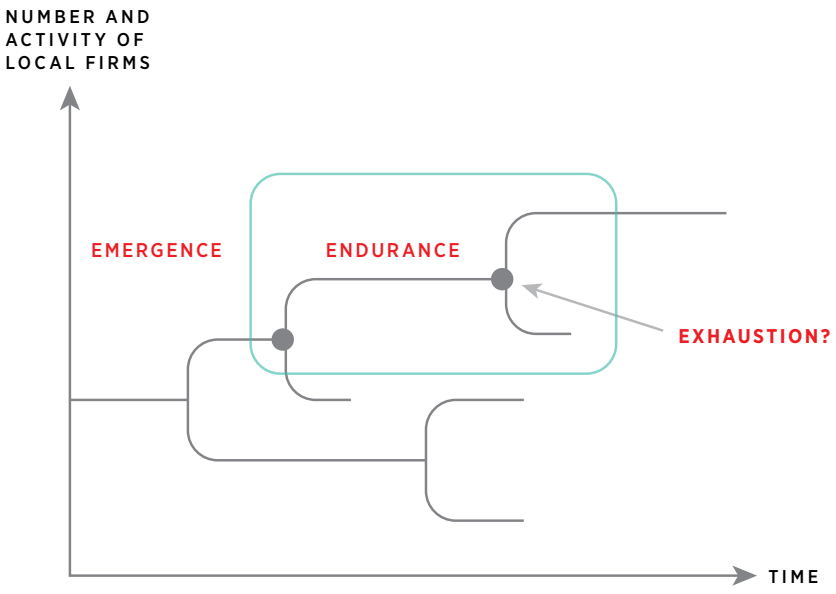


Fig. 2 visualizes the investigation of factors that shapes the development of the cluster through continuity and change: the drivers of emergence, endurance and exhaustion.

LEADERS AND INTEGRATORS

First-mover firms are crucial to the formation of clusters, sustaining development and maintenance of the cluster. In today's clusters, firms that are in a position to lead should understand that much of the success of the cluster depends on their approach. These flagship firms can pull a network together, and facilitate learning and adaptation throughout a change event. To do this, they must possess a wide range of knowledge or capabilities. They also need to be powerful enough to force other firms to follow their lead. Lead firms might be in a position to help smaller firms when, for example, there is difficulty in jumping from one technology to another in an attempt to adapt. Lead firms can integrate with strong external connections to smooth this process of change (Jacobson, et al., 2008). A leading firm, for example, might assist in alliancing several independent district firms to form closely-linked business groups. Resource constraints faced by small firms can then be overcome though the shared adaptation of several independent agents in coordination with each other. Adaptation by arbitrage is a form of integrating for adaptation, where consolidation or elimination of actors can be benefit the cluster, such as when old industries can act as incubators or as a source of resources for newly-emerging sectors that hold promise (Press, 2006).

An example of a lead firm from the case studies is The National Cash Register Company, which reigned supreme in Dayton in the early 1900s. Its example of doing businesses would have been considered a model to surrounding firms (exemplified by the firm's willingness to open up its factory to public view). In the 1920s, General Motors lead their industry with the very latest in business and production organization methods. More recently in Silicon Valley, a leadership or integrating role has been undertaken by denizens in the form of venture capitalists or lawyers who have a strong grasp of the tech landscape in the region, and can strategize connections among small high-specialized firms (Jacobson, et al., 2008). Of course, quality of leadership matters. Will a lead firm or integrator act with the longer-term sustainability of the greater cluster in mind, or will it treat other firms and suppliers as perishable commodities or leverage points for fleeting profit?

VALUE OFFERED

Whether a lead firm or just a supplier, all firms in a cluster need to offer value for successful commercialization of their outputs. Firms dropping off the Fortune 500 "are likely to have experienced value deficiencies, and failed to remediate these deficiencies by redesigning and/or creating new work processes to provide offerings that the marketplace valued," according to a paper in *Journal of Enterprise Transformation* (Liu, et al., 2015) As will be seen in the case study of the Wright Brothers Institute, enterprise transformation is driven by observing or anticipating value deficiencies (the Institute would recognize

that their technology lacked a receptive audience). In the paper *When Transformation Fails,* the authors identified processes that contributed to the failure of automobile companies; they judged that success emerges from processes driven by accurate forecasting of market requirements, and by the adoption and execution of development processes that resulted in the right car at the right time. These decisions were driven less by ego and single-minded financial dictates, and benefited from a champion or keeper of the vision who was able to surmount various corporate hurdles (Liu,), 2015).

WATCHING OVER THE GOLDEN EGG

Overseeing all these contingencies and moving parts (though not always in a position to have direct control) are cities and towns throughout the world who are striving to attain the economic benefits that come with counting themselves as being part of a regional hub of innovation. This attention to regional development has brought a new focus to the study of the geographical distribution of wealth and of the 'clustering force'. Cities and regions that exhibit the most vital cluster activity have become nothing less than the engines of economic growth, and a select few will continue to expand their dominance (Florida, 2008). In surviving the advance of globalization, many nations are now seeing the nurturing of industrial clusters to be of chief importance in sustaining economic competitiveness.

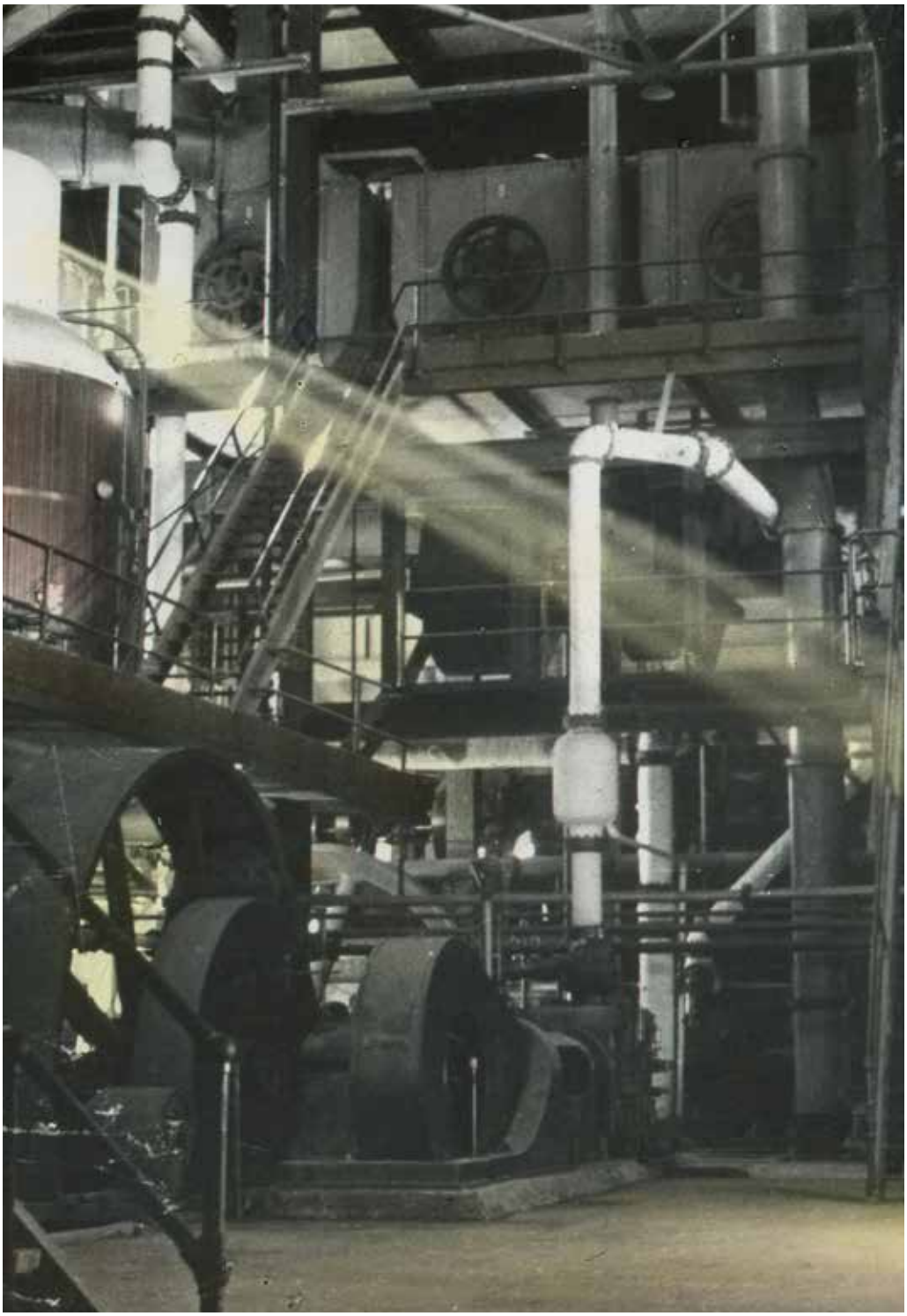
But these clusters often fail, and the resulting deep pockets of wealth and poverty are a distressing feature of the 21st century, leading to social and political upheaval. Economic inequality is the cause of debilitating effects on the economic health of an increasingly sizable percentage of the U.S., with some regions and cities reaping huge rewards in capital and status, while others are forgotten and embittered — even enraged, and ready to tear down what they perceive as an elite, fixed game (Florida, 2008). This pronounced inequality can be argued to rival the inequality of Roaring '20s, and can be found in all dimensions of American life: income, wealth, education and health, to mention just a few (Stone, et al., 2016). To walk the streets of a city in its decline can be a haunting empirical exercise for a student of industrial clusters, with factories, warehouses, office buildings and hotels spoiled and abandoned in what should be the vibrant city center. In Dayton, the heavy burden of so much empty and decaying square footage downtown seems impossible to overcome with the few tenants that could, in theory, pay cheap rent, restore and revive.

Pockets on once-successful decline can be seen throughout history where a region decided to devote itself to a single type of industry or way of doing things. In the 19th century, the British cotton textile industry grew up around Manchester and prospered for several decades. In the 20th century it lost its lead to overseas competitors who were quicker to modernize, and saw eventual collapse (McCraw, 2000). Alfred Marshall, original theorist of industrial clusters, recognized the risk:

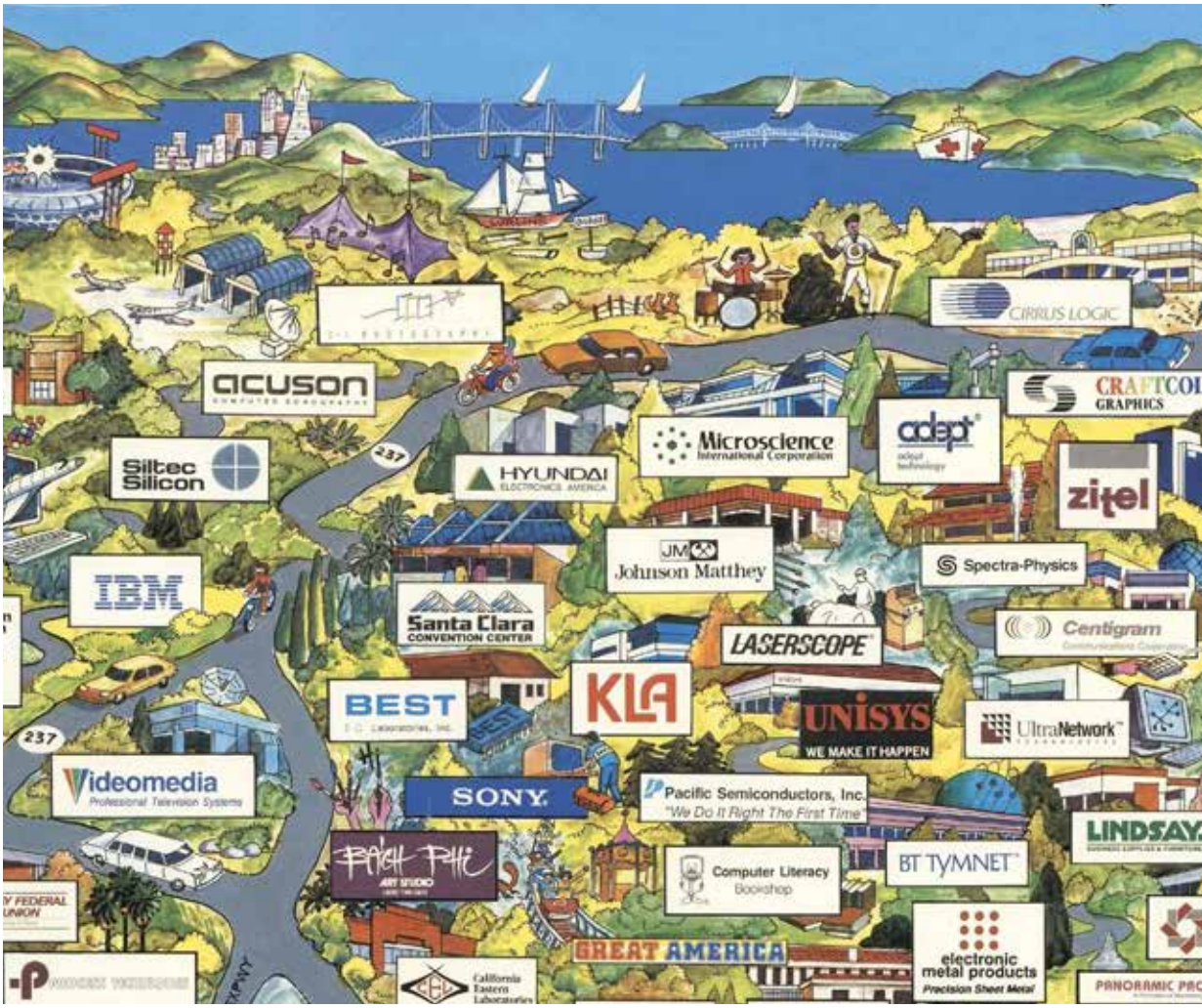
An industrial district which is dependent chiefly on one industry is liable to 'extreme depression', in case of a falling-off in the demand for its produce, or of a failure in the supply of the raw material which it uses (Alfred Marshall, 1890).

On the historical waves of innovation and investment, certain industrial districts, seemingly, will never see an upward ascent.

View of an empty factory, unknown location
Wayne State University Digital Archives



Silicon Valley, 1991
Reddit



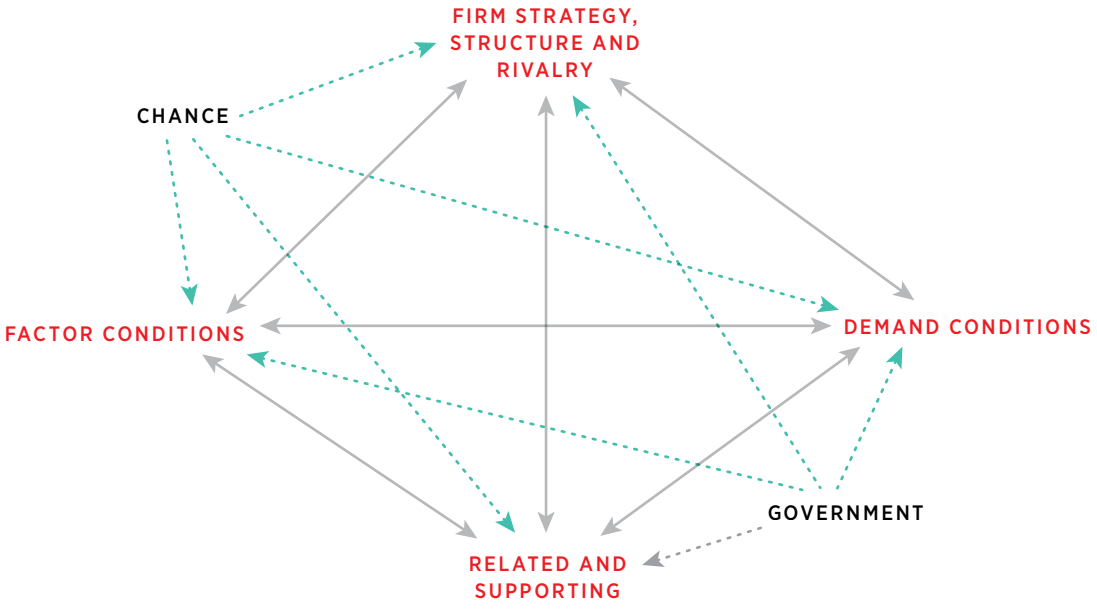
MODELS AND FRAMEWORKS

Two frameworks that can effectively contend with the complexity of maintaining industrial clusters will be suggested. Historical waves of technology, innovation, finance and generations will then be introduced to show that cycles of the future can be prepared for by observing those of the past. Finally, a convivial foresight tool to effectively plan for the future will be discussed.

ENHANCING FORTUNE:
THE PORTER DIAMOND

Kirsten Press' N/K model was introduced as a frame of reference for understanding the variables of cluster architecture that can work for or against each other for adaptiveness. Another model that can be used for achieving cluster success can be uncovered in Michael Porter's *The Competitive Advantage of Nations* (1990). His model took the form of a diamond, and identified four key factors that enhance regional productivity and competitive advantage: factory conditions, local demand, inter-firm rivalry, and related and supporting industries. Like Press, Porter used Alfred Marshall's founding theories of agglomeration externalities to explain the development of the cluster — the greater the number of local firms, the better the development of industry-specific production factors. Shared learning and collaboration plays an important part in Porter's diamond, with competition pushing each agent towards greater performance in the cluster (Agrawal, J., et al., 2012).

Fig. 3 THE PORTER DIAMOND AND ITS CONSTITUENT ELEMENTS (Press, 2006)



Attracted by Porter's book, other researchers have identified new factors that contribute to cluster success, such as the nature of face-to-face interaction and the influence of the creative class (Florida, 2002).*

* Richard Florida has cited Porter explaining in the years since he created his Diamond model that location matters as much as ever in the success of regions: "The more things are mobile, the more decisive location becomes" (Florida, 2008).

FURTHER POLISHING:
THE GEMS MODEL

Recognizing that the Porter Diamond may be considered incomplete because of the valuable insights brought forward since the model was published, Shyam Kamath, Jagdish Agrawal and Kris Chase introduced the Global Economic Management System (GEMS) model of cluster formation and sustainability. This model is described as bringing significance to ignored factors in making location decisions and cluster formation. The GEMS name signifies that it represents a broad and comprehensive coverage of the issues: "Economic outcomes hardly ever have a single cause, especially in the case of such complex processes as those of long-term economic development or regional development. A good explanation should thus try to account for the major factors that affect such developmental success" (Agrawal, J., et al., 2012).

The GEMS model takes into account new understandings of the role of business and socio-political climate, facilitative government policy, path dependence, a culture of innovation and entrepreneurship, and agglomeration economies. Public policies and corporate strategies that account for these key factors may prove relatively more fruitful for establishing regional advancement. A brief summary of the new elements that transform the Porterian model into a GEMS model: (Agrawal, J., et al., 2012)

Anchor effect: Large firms that were the first to innovate in a particular cluster are often crucial to the formation of clusters. They sustain the development and maintenance of an ecosystem of firms that are suppliers to and/or have dealings with such anchor firms (Agrawal, J., et al., 2012).

Business climate: Favourable aspect of a business climate such as the enforcement of private property rights under common-law systems; quality of business regulation; low top marginal tax rates; the absence of corruption; the climate for risk taking; and business innovation all have a positive impact on economic development. These were features of the business climate of Silicon Valley, for example. Also emphasized under this variable are the role of a "results-oriented meritocracy, an open business environment, and collaboration between business, government, and non-profit organizations" (Agrawal, J., et al., 2012).

Industry networks: As firms in proximity to each other are important to the health of the industrial cluster, vertical, horizontal, and unrelated industry networks are also important to competitive success. Inter-firm linkages explore the role of cross-border networks, indicated by high levels of inter- and intra-firm linkages; presence of cross-border industry networks; presence of industry associations; collaboration between firms and research associations; and the sharing of labor and other resources between firms (Agrawal, J., et al., 2012).

Public Policy: The role of government and public policy is described in terms of the presence of open trade and investment policies; the presence of favorable tax laws and tax incentives; the presence of financial incentives; the presence of facilitative incorporation and bankruptcy laws; the presence of R&D policies and incentives; the absence of foreign exchange and capital restrictions; the existence of laws for the protection of private and intellectual property; the existence of fiscal, trade, and investment incentives; and the educational background of public policy makers (Agrawal, J., et al., 2012).

Concentration of firms: The positive benefits of being near other firms in a region/cluster; spillovers of knowledge between firms; and the presence of a large number of firms/suppliers in a region (Agrawal, J., et al., 2012).

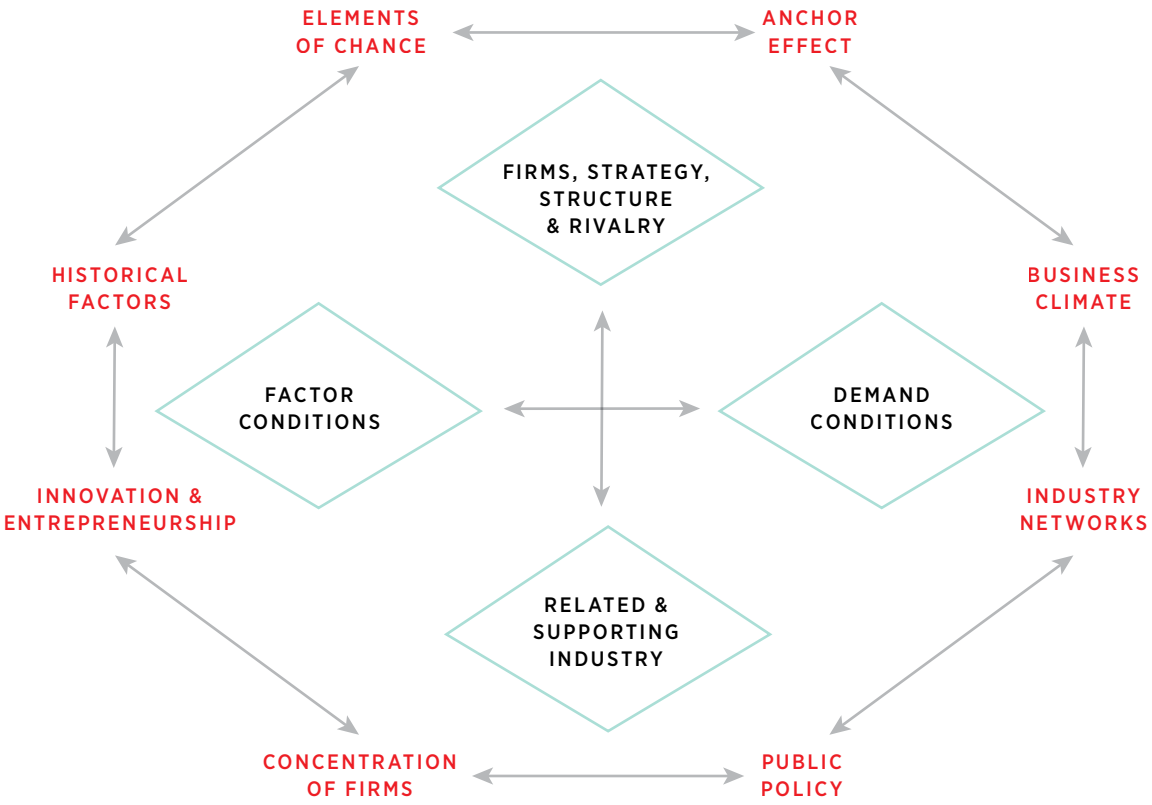
Innovation and entrepreneurship: Locational decisions, wages, and employment growth are known to be measurable effects of innovation and new economic knowledge. In addition, there is a link between innovation and entrepreneurial discovery or activity as fundamental causes of national economic and firm growth. The presence of local entrepreneur-started firms; the local availability of technologists and managers; the presence and number of local incubators; and the extent of patent and intellectual property activity in the region are used to define the role of the "presence of local innovation and entrepreneurship" variable for cluster success (Agrawal, J., et al., 2012).*

* Many cities in India and China are now producing patents at a rate comparable with U.S. cities comparable in size (Florida, 2008)

Historical factors: Related to path dependence, history impacts cluster formation and success through the completely "natural" locational advantage of a region, the serendipitous presence of key firms in the region, the fortuitous circumstances of early lock-in, and other similar "naturally" given circumstances. Operational indicators of this "presence of historical factors" variable are the historical presence of key firms in the region and the past history of links between the incoming firm and firms located in the cluster (Agrawal, J., et al., 2012).

Elements of chance: Particularly relevant to high-technology clusters, chance is often important to cluster formation and the development stage. Under this variable lives sub-elements such as the reputation of the cluster as a leading location; its geographical location; the origins of the founders in the region; and the element of pure chance (Agrawal, J., et al., 2012). Dayton, for example, saw the coincidental arrival of key personalities from other parts of the state, each feeling the inherited problems of their world should not have to be unchallenged (Bernstein, 1996); Likewise, Detroit's dominance in cars began largely with the elusive factor of a gathering together of business-like and eccentric newcomers.

Fig. 4 THE GEMS MODEL (Agrawal, J, et al., 2012)



Having the necessary thoroughness and variety to match the complexity that cluster systems exhibit, the GEMS model probably comes close to an ideal model for managing the inter-firm dynamics of clusters. Add to this the mileposts that the stages of industrial clusters forecast, and there is already a good mix of cluster time line and cluster system management that can bring a more solid approach to strategic thinking for innovation ecosystems. We will now look at the more expansive historical innovation timelines that will provide clusters with a deeper perspective of innovation and financing cycles which can be used alongside cluster theory, life cycle stages and structural models for greater decision making and foresight.

The Packard plant, Detroit, Michigan, 1911
Wayne State University Digital Archives

HISTORY MEETS FORESIGHT: KONDRATIEFF, SCHUMPETER, ELLIOT & THE FOURTH TURNING

Analyzing past and current cyclic economic and innovation patterns can be a compelling exercise in the service of advancing regional innovation ecosystems because they give a stronger vantage point to prepare and intervene. Real potentials can be anticipated where foresight methods that look only towards the future will entirely miss the severity of potentials like severe economic downturns. Cyclical economies have been observed since ancient times, with alternations between growth and crisis. Over a century ago, only the crises of business and their causes were considered in the study of business cycles. Only after years of accumulation of information did the study of periods of economic expansion take shape. The business cycle follows the economic activity of society, and impacts the economic policies of nations and the business plans of companies. The study of economic cycles following the Industrial Revolution recognized the need for broad and deep monitoring of rapidly industrializing economies in order to identify cyclical changes in the development of production (Alexandrov, 2018).

Cycles in business can be observed in the repetition of the development of processes resulting in the change of key indicators and economic dynamics. Some of these indicators are population growth, efficiency of production, the rise of new markets and new sources of raw materials, structural transformations in the economy, and others. From there, statistical information is gathered, and a quantitative and qualitative analysis of the changes are selected for analysis. A business cycle can take the form of long waves, economic growth cycles and short-term business cycles, with each economic cycle consisting of smaller business cycles. A downward trend in the economy could result from a series of smaller or decreasing gross domestic growth rates over a period. The desire of economies is to mitigate economic shocks or to build on any positive economic policy outcomes that are expected in a coming wave (Alexandrov, 2018).

LONG CYCLES OF INNOVATION

Gross Domestic Product has been unsuccessful as a forecasting tool, as it requires insight into how productivity can be expected to change in the years ahead, among many other things. In history, economists like Adam Smith to Karl Marx have struggled to understand growth; 20th century thinkers theorized that the output of an economy depends on its inputs — capital and labour. It is traditionally thought that the increase of both will increase output (*The Economist*, 2014). But growth has been experienced despite the slower increase in workforce in North America. The combination of technological progress plus other forms of new knowledge in the form of innovation

is given as the new element to the equation. Innovation, it seems, may account for more than half of all growth — more than the application of capital or labour. The relationship between innovation and the life cycles of an industrial cluster can be complex (which, as Marshall McLuhan shows in his Laws of Media, is better understood by zooming out to the extent that the previous cycle, the current cycle, and the next cycle are part of an evolutionary chain which can be taken as repeating patterns). It is in this stepping back that knowledge of the past and foresight can come together to produce insights for cluster adaptability.

KONDRATIEFF

The Kondratieff wave is the principle long wave model that I have used in this study, as its structure and theory fits best with the industries I have chosen. Long multi-generation cycles with the growth and exhaustion of credit across 200 years can be closely aligned with the fortunes of Dayton, Detroit and Silicon Valley (the latter for which it offers up an unfolding view of the future). In the theory of long waves, Kondratieff, who studied industrial capitalism and was the first person to recognize the existence of long waves, identified fluctuations in economic activity lasting from 40 to 60 years which result from indicators like technological advances, population dynamics, various social revolutions, credit cycles, and the renewal of capital goods. Each cycle has an upswing lasting about 25 years, charged by the development of new technology and capital investment, followed by a downswing of about the same length, usually ending in a depression (often containing a number of recessions). In the up phase, capital flows into productive industries, and is then trapped in the finance system in a downturn (Mason, 2015). Though not traditionally accepted by the majority of economists, long wave theory is gaining popularity, and is used for studying the economy in the past and for analyzing stock markets. For Kondratieff, long waves are caused by crises brought on by an outdated economic structure contrary to modern technologies and the new, more efficient organization of production (Alexandrov, 2018).

In each wave, the up phase begins with a frenetic decade of expansion (a 'K Spring'), accompanied by wars and revolutions, in which new technologies that were invented in the previous downturn are suddenly standardized and rolled out. Next, a slowdown begins, caused by the reduction of capital investment, the rise of savings and the hoarding of capital by banks and industry; it is made worse by the destructive impact of wars and the growth of non-productive military expenditure. However, this slowdown is still part of the up phase (K Summer); short and shallow recessions follow, while growth periods are frequent and strong (K Autumn). The downturn begins with commodity prices and interest rates on capital falling. In this stage, there is more capital accumulated than can be invested in productive industries, and will therefore be stored inside the finance sector. Recessions then get worse and become more frequent, with an inability to make the

necessary changes in the structure of the economy. Wages and prices collapse, and a slow and painful depression sets in (K Winter) (Mason, 2015).

It is only after the inconsistencies between the economic structure and the new technologies have been overcome that there is a revival and the conditions for new, sweeping development are improved. In this slow upswing, major political and policy events and the improvement of the conditions for the development of the economy play a part. In *Fostering Inclusive Innovation for Sustainable Development,* Raphael Kaplinsky calls for "the recognition that current trajectories of economic growth and development are experiencing a period of structural crisis" (Kaplinsky, 2018). We are somewhere in the middle of the second half of a deep Winter in the Kondratieff cycle, which started in the beginning of 2000. This wave unfortunately suggests a recession trudging towards a depression that is foreseen by some to end by 2020.

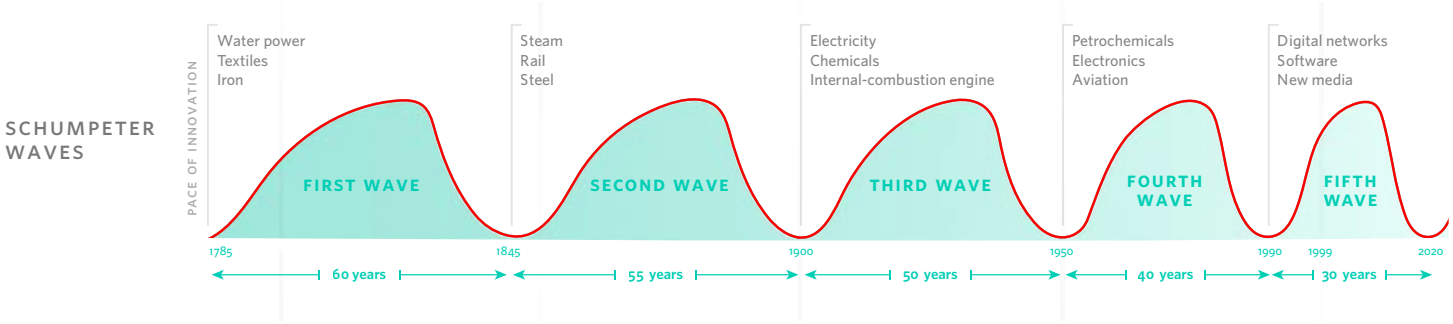
In a 2017 *European Journal of Sustainable Development* paper, the authors state that hyper globalization created a chaos that calls for the return to sustainability which involves a certain degree of re-localization as a precondition for returning back the power to the people for creative use of its own resource base. Transition is a process that will not take place easily without good and bad (nationalism, fascism) consequences. The radical change of the development paradigm pursued by the U.S. is a process that comes as a consequence from the depletion of the positive effects of the fifth technological Kondratieff wave and entering into a structural debt crisis (Jovanova, Nikolovska, 2017). In *Postcapitalism: A Guide to Our Future,* Paul Mason believes that the present crisis is a disruption to the Kondratieff cycle, and the signal of something bigger than the end of a 40–60-year cycle. This should be expected, as Kondratieff suggested that successive long waves are by no means a simple repetition of the preceding cycle. The start of the next long cycle will see a few trigger events, including the roll-out of new technologies, the rise of new business models, new countries dragged into the global market and rise in the quantity and availability of money. These triggers can be seen as evidence of the threat of breakdown that leads to adaptation and survival (Mason, 2015).

SCHUMPETER

Another originator of long-wave thinking, Schumpeter believed that a normal, healthy economy needed not equilibrium, but constant disruptions of technological innovation. Schumpeter took the things that Kondratieff pointed out in the long-wave theory and studied them in even more depth. In *Business Cycles* (1939), Schumpeter argued that capitalism is shaped by interlocking wave-cycles, ranging from a short three- to five-year cycle produced by the build-up of stocks inside businesses, through to the 40–60 year waves Kondratieff had observed. He argued that "Innovation is the outstanding fact in the economic history of capitalist society and…is largely responsible for most of what we would at first sight attribute to other factors." Schumpeter recognized Kondratieff waves as functioning in turn as innovation cycles. The Schumpeter cycle was very attractive to economists, business leaders and policy makers, as the entrepreneur and the inno-

vator drive each new cycle, with periods of breakdown resulting from the exhaustion of innovation — precipitating the 'creative destruction' of old and inefficient models (Mason, 2015). Jane Jacobs has also contributed to the view that innovation drives economic development (as opposed to only Marshallian specialization) (Florida, 2008). Schumpeter's waves start in the late 18th century with pre-industrial revolution innovations such as steam, textiles and iron, followed by increasingly short waves of 19th century rail and steel, electricity, chemicals and the internal combustion engine of the 20th century, and so on. Each upward swing on the wave stimulated investment and expanded the economy. These long waves of economic expansion eventually dissipated and flatlined as the new technologies became common and investors saw less return with the fewer opportunities. Following this, a wave of new innovations begin a new cycle. Schumpeter would later warn that the bureaucratic way research labs were organized by many businesses would stifle invention (Florida, 2008).

Fig. 6 SCHUMPETER WAVES (THE ECONOMIST)



LIVING IN THE FIFTH, FORECASTING THE SIXTH

According to Schumpeter's innovation cycles, we are now in the fifth wave, or industrial revolution, based on semiconductors, fiber optics optics, genetics and software — a cycle that has brought great wealth, exemplified in Silicon Valley, and is approaching maturity. Stephen Aguilar-Milan observes that Silicon Valley "reflects American views on the freedom of speech and individual liberty. Had the epicenter of the fifth wave been elsewhere, say France, then we would have today a very different Internet to the one we currently see." He sees public policy around the world attempting to steer the sixth wave into their jurisdiction: "The authority that contains the epicenter will be able to dominate the business environment for two to three generations" (Aguilar-Millan, 2012). The history of this fifth wave and the waves preceding it suggest that Schumpeter's long economic waves are shortening, from 50–60 years to around 30–40 years. This fifth industrial revolution that started in America in the late 1980s may last no more than 25–30 years. If we are already more than a decade into this new industrial cycle, it may now be almost too late for the slow actors to catch up. The rapid-upswing part of the cycle — in which investors reap big margins, kill off weaker rivals and establish themselves as main players — may have only another couple of years left before the downswing. Latecomers can expect only smaller investment opportunities before the cycle comes to an end (*Economist*, 2014).

The coming sixth wave is predicted to be driven by upcoming huge advancements in the application of big data, artificial intelligence, virtual reality, augmented reality, internet of things, and blockchain technology. Unequal gains will probably be seen across companies — and by extension regions — with the major tech companies dominating all industries via the application of new technologies. Risks of this wave are high unemployment, high debt and the leverage of U.S. and European economies. It also brings political risks associated with a clash of superpowers attempting to scale the increasingly elite and concentrated centers of innovation possessed by mega-regions — which Richard Florida calls a "noxious brew" (Li, 2018, Florida, 2008). Artificial intelligence in particular is a major factor pushing towards the emergence of the sixth wave, and is seen as a central element in developing superhuman productivity and expanding the horizon of the human cognitive and practical abilities (Bahji, S., 2018).

A present-day follower of Schumpeter, Carlota Perez, has used the tech-driven theory of the sixth wave to urge policymakers to give state support to info-tech, biotech and green energy — promising of a new 'golden age' to follow sometime in the 2020s. This can be seen as a neo-Schumpeterian envisioning of a green economy and its transitioning to clean energy (Knuth, 2018). In understanding the present phase, she departs from Kondratieff and Schumpeter with a 'techno-economic paradigm' which features a 'new common sense, guiding the diffusion of each revolution' (as opposed to the usual cluster of innovations at the start of the wave cycle). It is the replacement of one set of technologies and business practices with another, possibly guided by the state, which could regularize the situation to make way for growth. Perez puts little emphasis on the struggle between classes or the distribution of wealth — rather on technology and government (Mason, 2015). The sixth wave theory can be bolstered with the emerging discussion — crucial for industrial clusters — of the "Fourth Industrial Revolution", which forecasts an extended period of structural disruption and radical societal change driven by the development and diffusion of a number of digital innovations, including robotics, Artificial Intelligence, nano technology and biotechnology.

Schumpeter cycles can pair well with those of Kondratieff, in that the latter's cycles can be broken up into relatively neat seasonal patterns (Spring, Summer, Autumn, Winter) that are closely aligned to historical developments in industries, while Schumpeter waves indicate the shortening pace of innovation that points to the need for ever-efficient and nimble management of firm and cluster adaptation. Both wave theories represent science and technical revolutions in each phase, suggesting what kind of future we should be prepared for. Like all K-Springs that turn into Summers, the next wave of innovation on the horizon will revolutionize costs — perhaps a revolution in energy — will overturn commercial patterns and eliminate old business models, though the full effect of this revolution will probably not be felt until its diffusionary stage, when a sort of adaptation by arbitrage will allow an old energy source to facilitate the new. The history of Kondratieff waves allows us to reasonably assure ourselves that in this new wave, there will be a great movement of private investment, new innovation bubbles, graft, failures and fraud as accompanied earlier revolutions in railways, the auto sector and information technology

in their day. Will the next wave brought about by its generation of authors feature more responsible speculative risk — as opposed to credit expansion — "undertaken by those who can afford it and who will perform the indispensable task of shaking out the good innovations and corporations from the bad"? (Budden, Kopala, 2015). The predictions of the coming sixth cycle gives plenty to think about.

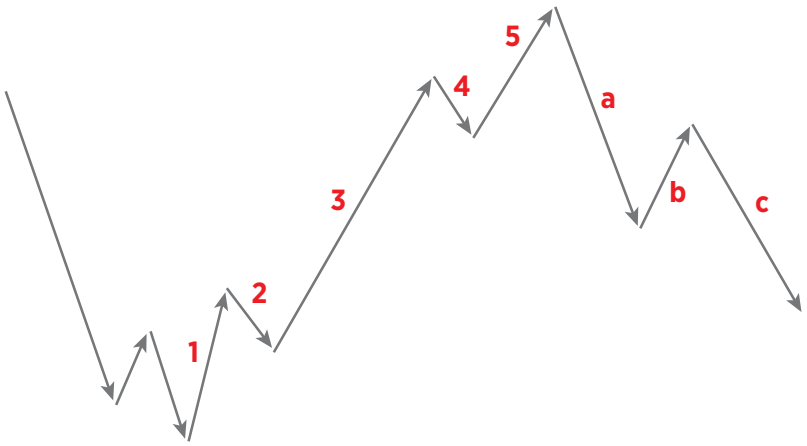
ELLIOT WAVES AND FORECASTING

Elliott wave theory is somewhat secondary to the Kondratieff and Schumpeter waves in importance in this paper, but is still relevant to many traders and institutional investors, having been applied to the currency market and analysis of the stock market since the 1930s. For the topic of innovation clusters, Elliot waves are interesting for their inclusion of social psychology and finance. Elliott waves theory focuses on studying a time series in market prices, and assumes that historic patterns are able to predict future patterns (D'Angelo, Grimaldi, 2017). Elliot broke ground with this theory by pointing to the then-new theory of mass psychology, and how it affected the behaviour of market participants — to such a degree that order could be distilled from the seeming chaos of the stock market. Elliot's theory is somewhat based on the Dow theory in that stock prices move in waves. Because of the "fractal" nature of markets (fractals are mathematical structures found in nature), however, Elliot was able to break down and analyze them in much greater detail. Elliot Waves gained popularity in the 1970s when A.J. Frost and Robert R. Prechter published their classic book, *Elliot Wave Principle: The Key to Stock Market Profits*. They predicted the bull market of the '70s and the crash of '87.

The basics can be distilled down to five points:

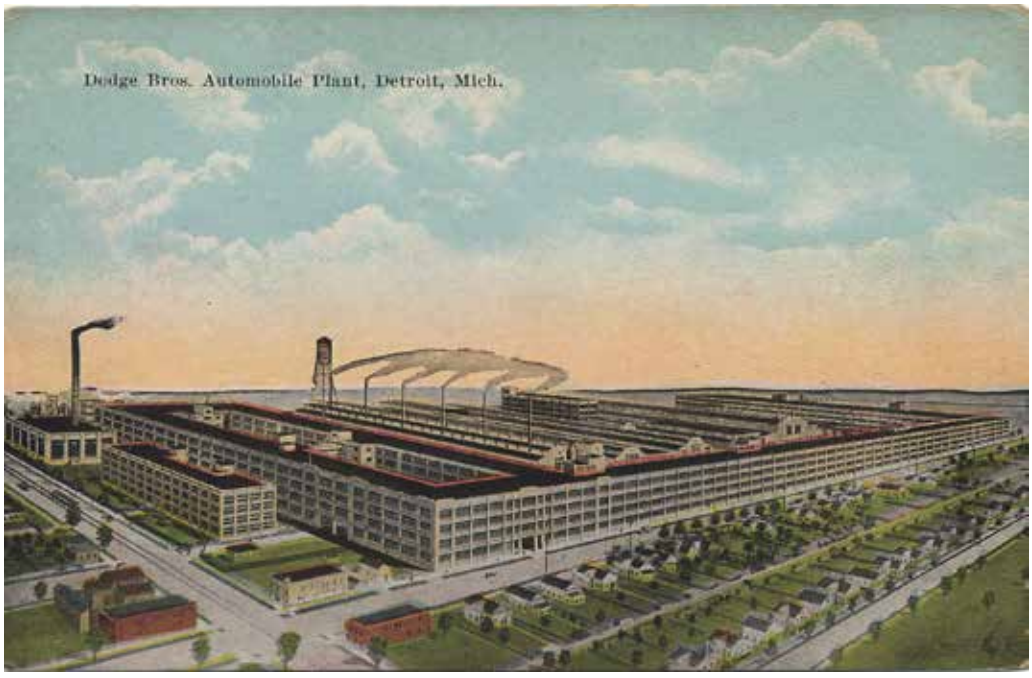
1. Every action has a reaction.
2. Five waves move in the direction of a trend; then three "corrective" waves, moving in an opposite direction, follow the preceding five waves.
3. Five main-trend waves followed by three corrective waves is called a "5–3 move", and completes a cycle.
4. The 5–3 move the becomes two subdivisions of the next, higher 5–3 wave.
5. The 5–3 pattern remains constant, even as the time span of each wave varies

Fig. 7 ELLIOT WAVES (D'Angelo, Grimaldi, 2017)



- **1** represents an initial rally, signifying a shift in trend direction (the "one" leg of the Elliot Wave pattern). It is rarely obvious when it's just getting going, typically accompanied by news that is negative.
- A retracement follows (the **2** leg). Its low can never extend below the start of 1.
- The market then shoots up like a rocket (the **3** leg).
- **4** is another retracement (a good place to buy), followed by **5**, which is the final bullish breakout, apexing at the highest point of the cycle. Buyers in wave 1 (the Bulls) will have exited the market by this time.
- **1–5** are **impulse/motive** waves following a **main trend** (up trend in this case).
- An **a**, **b**, **c** moves down, and are corrective waves. Wave a corrections are harder to spot than in the dominant trend (it is here that many analysts ignore the Elliot Wave theory, thinking that happy days are there forever). In wave **b**, prices reverse higher, but volume is lower than the previous wave. With wave **c**, it becomes obvious you're in a bearish trend.
- Together, the **5** moves in the **impulse/motive** and the **3** moves in the **corrective** make up the 5–3 pattern/move, representing the completion of a **cycle**.

This is the general format of how Elliot waves function. It represents the action taken of all market participants in the market being traded. Psychology is represented in three actions: investors see a major downturn, get in, market rises, and then a pull-back. At the time of Elliot, this was only considered in the context of the stock market, but as years have gone by, it is now thought that it works for all markets. It may be that the Elliot wave could be an attractive device for technology firms in a cluster to understand and prepare for the activity surrounding the uptake, financing and decline in investor popularity for a new technology.



The Dodge Brothers plant, Detroit, Michigan, 1922
Wayne State University Digital Archives

THE FOURTH TURNING

A final cyclical model that can be used in seeing the future through the past is The Strauss-Howe generational theory, or Fourth Turning theory. Described somewhat fancifully as "An American Prophecy" by the authors, this theory features a repeating generation cycle that can be observed in American history, where historical events can be traced alongside recurring generational personas, or Archetypes. These archetypes drive the creation of a new era (called a turning) that witnesses a new social, political, and economic climate. These successive eras (turnings) tend to last around 20–22 years. At a higher level is a cycle that is the length of a long human life, usually spanning 80–90 years. The Fourth Turning states that after every life cycle, a crisis takes form, followed by a recovery, where institutions and community values are strong. Eventually, the generational archetypes who follow attack and weaken institutions in the name of autonomy and individualism, creating turmoil in the political environment that presages another societal crisis. This coupling of demography, sociology and generational insights has the strong possibility of being correct to a degree, and one can always take actions to prepare for the America they prophesize (Schumann, 2005).

In the Fourth Turning, generations are identified by focusing on cohort groups that share three criteria. First, a generation will share an 'age location' in history, by encountering key historical events and social trends while living through the same phase of life. A generation living through events of a particular phase are shaped in lasting ways, and will come to share certain common beliefs and behaviors, and will self-identify as being of a membership in that generation, e.g. growing up in the Great Depression; being a mistrustful teenager during Vietnam; being an adult hopeful for the future in the 1990s. Many potential threats could result in a crisis, such as a terrorist attack, a financial collapse, a major war, a crisis of nuclear proliferation, an environmental crisis, an energy shortage, or new civil wars. Though the generational cycle cannot explain or take account of the role or timing of these individual threats, the Fourth Turning can explain how society is likely to respond to these events in different eras. It is the response, not the initial event, which defines an era according to the theory. According to Strauss and Howe, the crisis period lasts for approximately 20 years. It also predicts that Millennials could be the next 'greatest generation' (Wikipedia, 2018). Ultimately, The Fourth Turning can serve as one more layer of complexity in anticipating future patterns of the world through the medium of observing recurring patterns of the past.

Table 1: A selection of Fourth Turning archetypes, with a focus on behaviour in the workplace

Source: https://compendium.ocl-pa.org/wp-content/uploads/2015/06/4th_turning.pdf

	GI 1901–1924	SILENT 1925–1942	BOOMER 1943–1960	GEN-X 1961–1981	MILLENNIAL 1981–2000
					
	THE HERO	**THE ARTIST**	**THE PROPHET**	**THE NOMAD**	**THE HERO**
Famous people	John F. Kennedy Katherine Hepburn	Martin Luther King Jr. Bob Dylan	Bill Clinton Bill Gates/Steve Jobs	Jess Bezos Larry Page Stewart/Colbert	Mark Zuckerberg Jennifer Lawrence
Came of age	Great Depression World War II	American High	Consciousness Revolution	Culture Wars	Millenial Crisis?
How raised	Protected	Suffocated	Indulged	Abandoned	Protected
Endowments	Community, affluence, technology	Pluralism, expertise, due process	Vision, values, religion	Liberty, survival, honour	Community, affluence, technology
Key events	• Emergence of the car, movies • Sinking of the Titanic • Trust busting • World War I • League of Nations • Prohibition • The Jazz Age • Great (African American) Migration • Women's suffrage	• Great Depression • Midwest dust bowl • New Deal • Pearl Harbor • FDR dies • VE, VJ Days • Korean conflict • McCarthy hearings	• Jonestown • Civil Rights Act • Birth control pills • JFK, MLK, Jr, RFK • Peace Corps • Woodstock • Moonwalk • Viet Nam	• Corporate layoffs • AIDS • Reagan • Challenger explosion • Berlin Wall • Desert Storm • Gas shortage	• OKC bombing • Columbine • Y2K • September 11, 2001 • War in Afghanistan, Iraq • Clinton Impeachment
General characteristics and values	• Selfless • Rational • Grew up learning to respect authority • Possibly overbold • Mechanistic	• Dedicated • Respectful of authority • Duty before pleasure • Patience is a virtue • Honor and integrity • Reluctant to challenge system • Resistant to change	• Live to work • Optimistic • Big influence on policy and products • Willing to go into debt • Team and process oriented • Convenience and personal gratification	• Work to live • Want clear expectations • Want new skills, and will stay for them • Want sense of real contribution • Want frequent feedback	• Conditioned to live in the moment • Used to tech immediacy • Grew up learning to respect authority • Give respect only when they get it • Astoundingly diverse
Decision making style	Collaborative	Hierarchical	Participative	Independent/ Directive	Collaborative
Communication style	Constant	Formal, face to face	Informal, often indirect	Immediate, casual, direct	Constant, multimedia
Can be seen as	Restless	Stodgy	Long winded	Blunt	Restless
Institutions	Should be judged on their own merit	Deserve loyalty	Can be changed	Are suspect	Should be judged on their own merit
Basic question	When?	How?	Why?	What?	When?

THE PRESENT AND FORESIGHT: THREE HORIZONS

In studying the historical innovation cycles and factors of automotive, business machine and electronics clusters, simplistic reactions to the complexity of external events, social pressures and internal business decisions and innovations can be seen. The complexity of change events require more than typical boardroom quibbling. When businesses elect to introduce the long view of historical analysis and foresight into their thinking and planning, the Three Horizons framework can serve as a useful companion to tracing their cluster's historical trends along the major economic and innovation waves (Kondratieff and Schumpeter) with a historically well-informed eye attuned to the future.

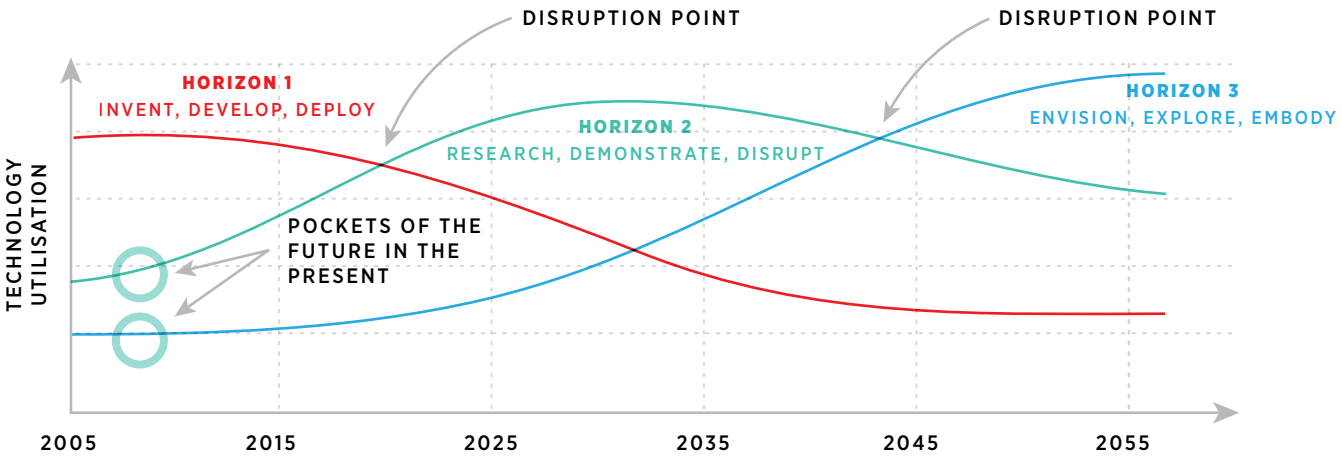
COALESCING FOR CHANGE

The complex challenges of an industrial cluster require the coming-together of people — with outlooks ranging from the fantastically futuristic to the soberly practical — to work together to solve for the future world. And they must do this in spite of a formidable lack of knowledge of exactly what the future will hold for the cluster. Three Horizons can help a group of minds ostensibly divided by pie-in-the-sky forward-thinking and stolidly conservative impulses to constructive agreement and future-forward action. The Three Horizons framework works by neutrally capturing the dynamics of change in a simple representation of patterns that point to a far-away future that can be grasped by all. It helps guide the way for needed adaptability, and armors itself for the disruptions that can set a cluster up for decline. To the insights brought forward by wave theories of innovation and investment, Three Horizons brings practical, workable solutions to complex issues. It offers a way forward to an initially incomprehensible future that would ordinarily doom its subjects to ride a pre-determined wave. Like historical waves of investing (particularly Elliot waves) Three Horizons demonstrates the slow process of change, which is embedded in fractal-life processes that extend far outside initial boundaries. What was once the dimly-imagined boundary of the future eventually becomes the present — collapsing old, seemingly stable patterns (Sharpe, 2013).

The horizons can be understood as three 'voices': the conservative managerial voice of the first horizon, concerned with everyday responsibilities ('keeping the lights on'); the entrepreneurial voice of the second horizon eager to move forward with new projects; and the aspirational participant of the third horizon that reaches for the imagined future of how things can be. If the Three Horizons was practiced by a group of companies that make up Silicon Valley, one might imagine the actors representing investing or owner functions presiding over years of growth in the Valley, but seeing trouble ahead; the entrepreneurial personality sensing the necessity for new thinking and wanting meaningful projects to be

proud of; and the impatient visionary who wants to 'put a dent in the universe' through radical reinvention. It is through these intersecting viewpoints where the framework could envision a shared future, with each group participating in effective activities for change (Sharpe, 2013). The below figure shows Three Horizons as employed by Hodgson and Sharpe. This is the basis of Three Horizons thinking used in a Hodgson/Curry paper that features future scenarios (hypothetical models of the future) for UK transportation:

Fig. 8 THREE HORIZONS IN ANTICIPATING TECHNOLOGY DEVELOPMENTS
(Hodgson, Sharpe, 2013)



The systems thinking inherent in Three Horizons allows for helpful patterns to develop, as opposed to individual events, unexamined trends and other limited forms of analysis of the variety practiced in corporate boardrooms. The experience, Sharpe point out, is like a three-dimensional view of seeing the present and the future (Sharpe, 2013). Being able to look decades both into the past and the future will show an emergence of patterns/cycles that suggest future actions (and therefore being future consciousness).

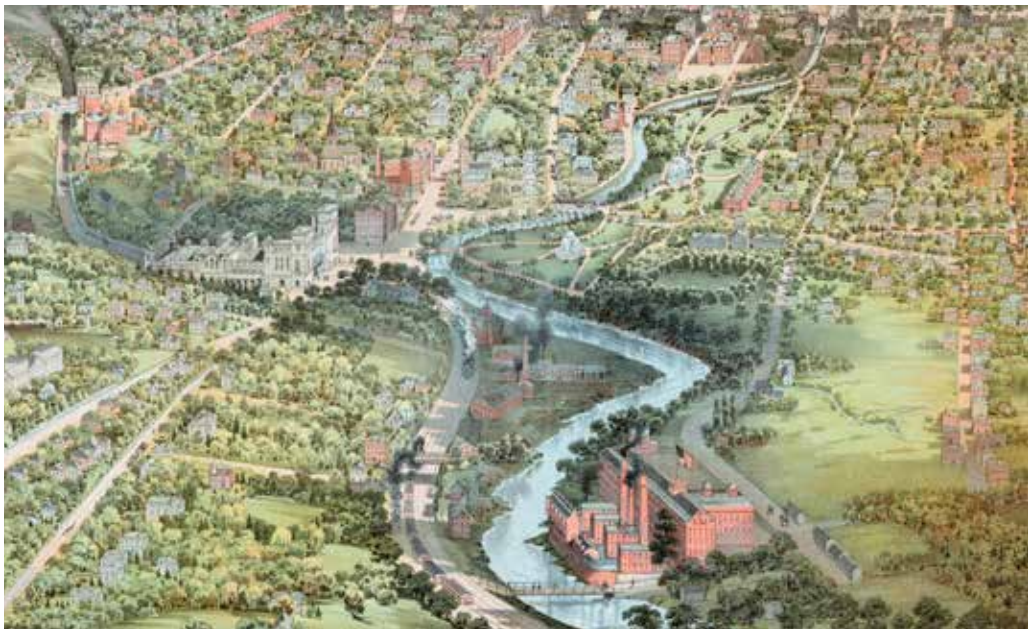
FACILITATING A THREE HORIZONS WORKSHOP

The workshop should begin with a topic around which the three types of personalities discussed above can come together. A Silicon Valley example may take the form of: "how would the current processes of innovation and capitalization in the Bay area affect the development and long-term success of electric cars if Silicon Valley becomes the leading automotive industrial sector in the world over the next 30 years?" The facilitator should have participants capture the basic processes that currently maintain the innovation and capitalization cycle. The far-away third horizon envisioned by enthusiastically future-oriented participants can then be captured. With the first and third horizons now in front of the group, the facilitator can now invite the group to question of the adaptability of the first horizon for a potential future.

The second horizon space is where the activity of bridging the two opposite horizons occurs, with the facilitator challenging participants to lean as far to the third horizon as possible to ensure long-term advantages of the innovations generated. Look for places where new processes may be starting to grow as assets for the second and third horizons. In a Three Horizons workshop, resistance is expected and should be considered a positive attribute that allows for good ideas to be tried, tested and adapted to work with established systems. An example of adaptability is how Apple worked with the established system of how people bought music downloads when developing Apple Music (Sharpe, 2013).

A full Three Horizons experience designed to produce actionable second horizon points for change should be a full-day workshop, and could extend longer. An early milestone of success in a Three Horizons workshop is reducing confusion between the personalities that make up the different horizons, and the potential realisation that all the participants aspire to some shared qualities in the third horizon. The different participants will also be able to see which horizon dominates their thinking and how it relates to the thinking of their colleagues (Sharpe, 2013).

Three Horizons may be fruitful in key projects relating to the survival of a cluster, whether it's a cluster of central importance with vast influence, like Silicon Valley, or for a single organization's presence in a small town, where the leaders of the organization's local branch can help the town or district plan its future. Combined with historical waves theory and strategies for cluster management, they will be contributing to true systems thinking, taking in all the complexities of people, partnerships, products and competition. Partnering Three Horizons with systems thinking increases the chance of significantly adding to the longevity of success in the cluster, along with the ability to better cope with external influences compared to past efforts that have lead to the incremental activities (Sharpe, 2013).



Right: Bird's eye view of Hartford, Connecticut , created in 1864 by Jacob Weidenmann
Knowol

Left: The Stoddard-Dayton Manufacturing Company, 1909
Dayton Metro Library

National Cash Register Company in the early 1900s
Shorpy.com

The Ford Motor Company, Detroit, Michigan, c. 1912
Wayne State University Digital Archives

THE CASE STUDIES

Three case studies of American clusters and the firms that represented them will demonstrate factors in their emergence, maturity and decline — while reflecting on their performance during historical cycles and the stages of cluster development. Also discussed are patterns in regional employment and wealth disparity.

THE STORY OF REGIONS

While recalling that general stages of the cluster life cycle were described in the section devoted to cluster theory, significant attention will now be paid to the life cycle of key clusters and firms, with developments in their history marked along the Kondratieff wave. The first cluster would be disrupted by digitalization and poor strategic planning; the second by foreign competitors and other externalities; the third by national competitors and price. All three clusters suffered from internal and external activity that hindered growth. The cycle of the auto industry in particular follows the cycle of the K-Waves (which now shows signals that follow the credit dynamics of the K winter). While NCR's signal events may not fit the Kondratieff credit cycle (they experiencing growth during global decline in the '30s, and then decline during the growth period of the '90s), this had largely to do with culture and an unwillingness to embrace a sufficiently forward-thinking future centered around digital technology.

But these industries could have taken their choice of any of the models or theories described in this paper, and perhaps have used them to strengthen their tenacity to adapt to changing conditions, whether from competition, the economy or internal rigidities. The intent of these case studies is to describe with adequate contextual detail the opportunities these firms enjoyed, the challenges they faced, and the directions they took in the face of change. Their narratives contain insights related to their agglomeration externalities, their activities up and down a cluster architecture, regional leadership and internal culture, strong customer value achieved or found lacking — all the while intersecting with the larger world and history.

THE MACHINE AGE: THE RISE AND DECLINE OF THREE GIANTS

DAYTON, OHIO: NCR AND DELCO

Along with Detroit's story of rise and fall, Dayton should be studied as an industrial cluster replete with lessons for firms and industries in their struggle for adaptation in the face of change. In the late 19th and early 20th century, Dayton benefited from hundreds of entrepreneurs with a drive for marketing inventions that built large companies, many publicly traded (Staley, 2008). That geographic benefits are not necessarily a prerequisite to the emergence of a cluster is somewhat true for Dayton, where climate had no apparent advantage, and minerals, fine building stone, and stretches of tall forests are absent. Absent as well was any major university or capitol which would benefit a growing cluster. It's transportation waterways have been both a feature and cause for disaster; Historian Mark Bernstein writes that "from the first, the city was an exercise in intention against circumstance", and its waterways "as likely to drown as to enrich it". Dayton would experience a number of small floods before the big one in 1913, which early Dayton citizens prophetical-

ly foretold and later generations would never forget (Bernstein, 1996). The city had to compensate for these shortcomings with a dynamic business environment to meet the challenges of the age.

Dayton's first stage in cluster development began by making practical things with the knowledge and mid-nineteenth resources at hand before the pool of local craftsmen and capital were able to build on each other's knowledge. By sharing knowledge as they moved forward, they began to have "a freeing sense that a mind can make and shape a thing imagined and set it to perform a task." Starting off as a city of trading, Dayton became, like the New England area of an earlier time, a place of small-scale manufacturing, eventually known as "the city of a thousand factories." Its place as a center of internationally-recognized invention would come later (Bernstein, 1996). The Dayton of that era has been described as a proto-Silicon Valley — of mechanical engineering know-how with the capital to support a whole class of inventors and thinkers. By 1900, Dayton held more patents per capita than any other U.S. city. Bernstein notes that "by then, imagination was the city's leading industry and its most significant export" (Bernstein, 1996).

Dayton also nurtured spin-off companies characteristic of successful clusters — spin-offs that would take their place on the Fortune 500, including NCR, Mead Paper Company, business machine companies Standard Register and Reynolds and Reynolds, and Dayco and Phillips Industries. As the U.S. economy took off after World War II, Dayton was home to the largest number of General Motors employees outside of Michigan.* Its entrepreneurial climate nurtured inventions of all kinds, and like the Silicon Valley of the past few decades, innovation attracted more innovation. In one of the more famous examples of what can be described as the kind of embeddedness that benefits clusters, the Wright brothers, Charles Kettering and enterprising colleague Edward A. Deeds were known to socialize together and trade ideas at the Engineers Club in downtown Dayton (Jacobson, et al., 2008). Kettering became known early in his career for his ingenious rearrangement of existing components to perform a new task. He believed that instead of merely putting out the day-to-day fires of the mechanical world around him, the proper aim of industrial research was to "build a corporation's mastery of its technical field and, hence, its options for the future" (Bernstein, 1998). Kettering's first of 23 major advances for NCR was the electric cash register, which made the ornate and increasingly complex and heavy cash registers easier to ring up.

*Cities in Ohio such as Cleveland were early innovators and in automobiles and home to several firm headquarters, but Ohio banks had a conservative attitude towards the business compared to Detroit, and the Ohio auto industry would find itself more secluded as time went by, with suppliers remaining dominant in the city.

Main Street,
Dayton, Ohio, 1904
Shorpy.com

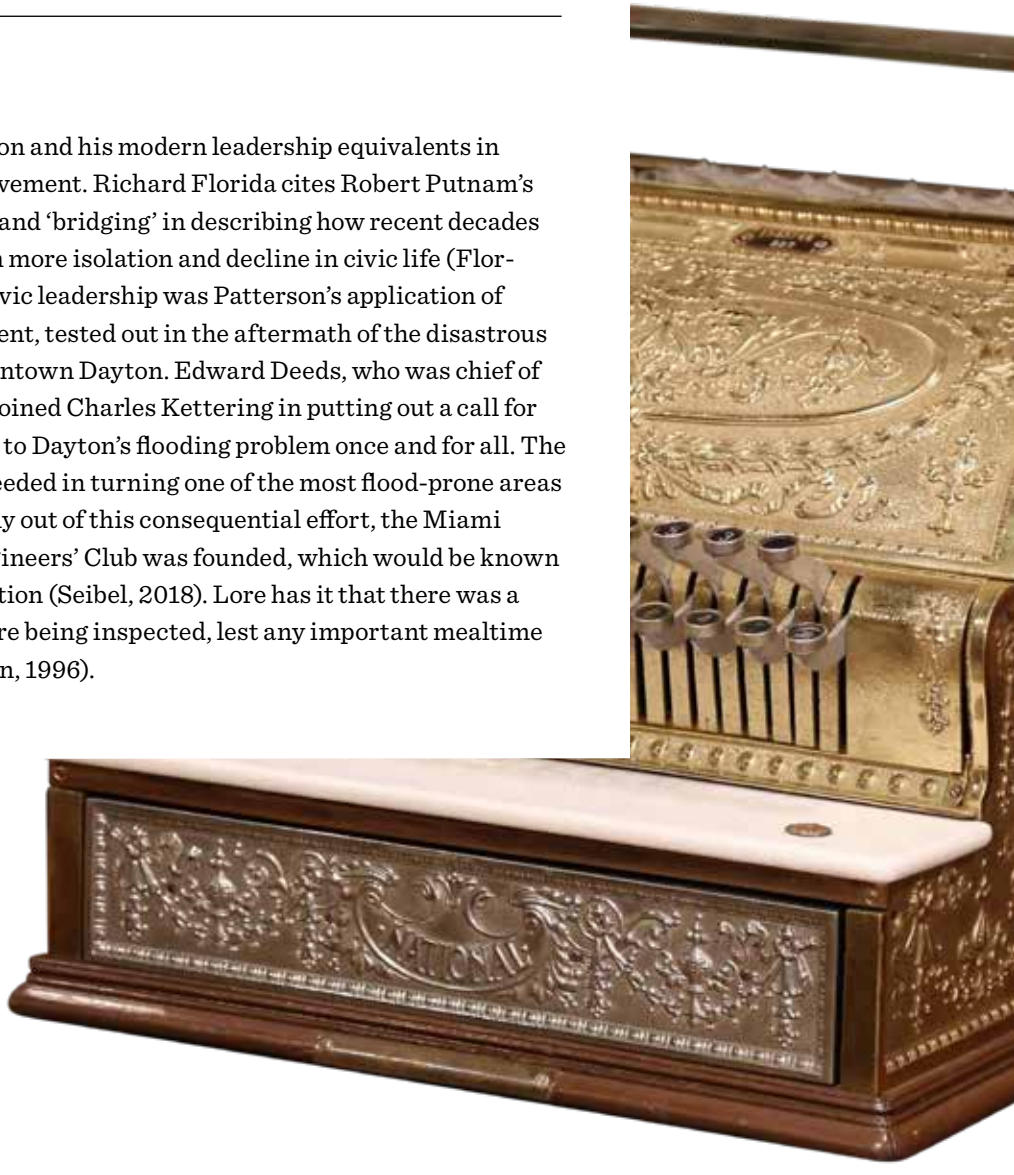
DELCO

In one of the famous spin-offs of history, Kettering then brought his technical mastery to the operation of automobiles. Having devised a small motor for cash registers to perform the work that was assumed to require a much larger motor, he applied the same thinking to the starting of a car engine. Upon demonstration of his self-starter, Kettering's invention won over Henry Leland of the Cadillac Motor Co., and Kettering and Deeds were asked to provide an electrical system for the entire 1912 Cadillac line then in development. It was found, however, that subcontracting the production of an unprecedented number of batteries to supply their invention was impossible. The solution was to start Delco (Dayton Engineering Laboratories Co.) to manufacture self-starters for shipment to Detroit. The new company would soon come to employ thousands of workers. The offshoot of this rapidly-expanding business was Delco-Light Company, built to manufacture mobile electric power systems. As these products became successful, Delco built a large plant in Dayton dedicated to the production of small consumer appliances, including vacuum cleaners, toasters, waffle irons and mixers. The nationwide success of these goods further invigorated the Dayton economy. Delco became an important manufacturing center that supplied General Motors, with divisions such as Delco Moraine, Delco Products, Inland Manufacturing, Frigidaire, Moraine Assembly and Aeroproducts (Carillon Historical Park, 2018).

Charles F. Kettering with a Buick automobile, Dayton, Ohio, 1913
Ohio History Connection Selections

NATIONAL CASH REGISTER COMPANY

Successful spin-offs originate from successful forebearers. For Kettering, the mother firm was NCR. John H. Patterson founded the National Cash Register Company in Dayton in 1888; by 1911, NCR enjoyed a market share of 95 percent of the world's cash registers. This extraordinary market dominance was achieved by harnessing the scale advantages of selling and manufacturing the type of business machines that were at the time transforming retail practices, while going to unheard-of lengths in protecting itself from competition (Rosenbloom, 2000). Patterson introduced a host of innovations across the entire range of business activities: manufacturing, marketing, corporate leadership (the annual sales convention), organizational behaviour and sales (the trained salesman, quotas and sales territory) that forever changed the business landscape (Friedman, 1998; Bernstein 1996). Patterson did all of this largely by following his own inclinations, turning a distinct ignorance of business practices into a fearless curiosity that would have jolted the astute sensibilities of most business thinkers of the day (Bernstein, 1996). His intense overall interest in building efficient organizations was coupled with an equally intense vigour for civic engagement, and its importance should not be glossed over by today's businesses that wish to be leaders in their cluster (Friedman, 1998).



Nickel, bronze and marble National Cash Register, ca. 1915
Chairish.com

Patterson and civic responsibility

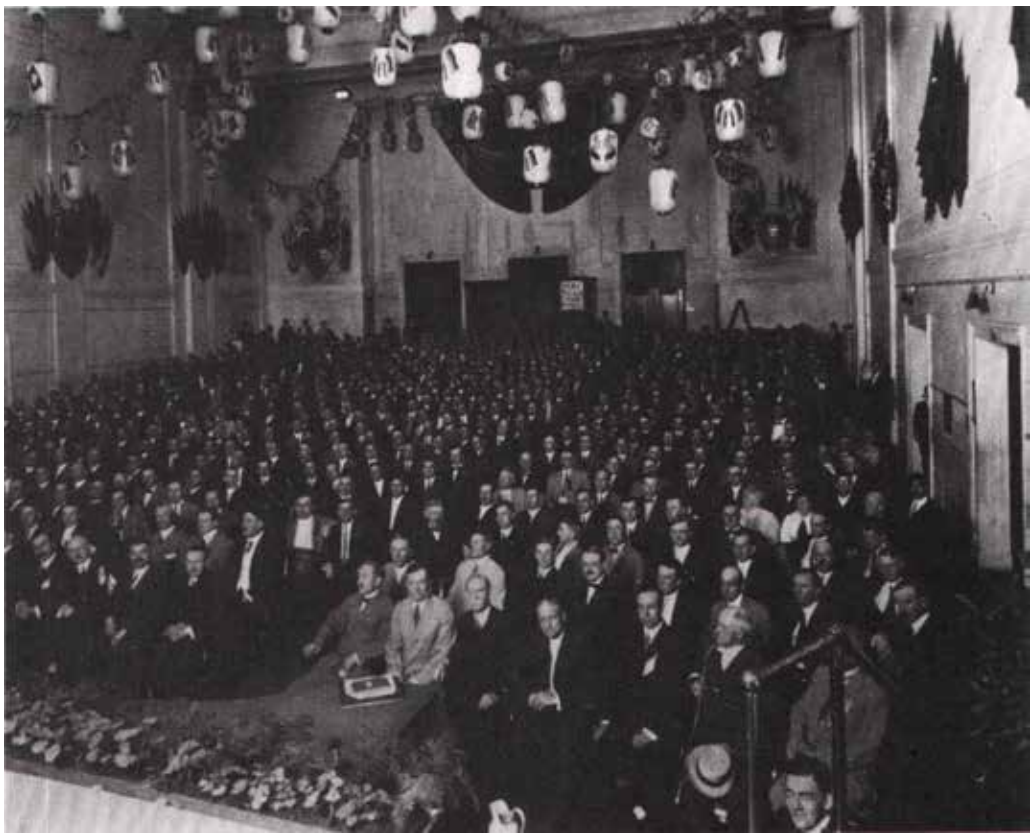
A noticeable difference between Patterson and his modern leadership equivalents in Silicon Valley was an intense civic involvement. Richard Florida cites Robert Putnam's ideas about the importance of 'bonding' and 'bridging' in describing how recent decades have exhibited a less caring society, with more isolation and decline in civic life (Florida, 2008). A dramatic example of this civic leadership was Patterson's application of scientific management to local government, tested out in the aftermath of the disastrous 1913 flood which destroyed much of downtown Dayton. Edward Deeds, who was chief of development and construction at NCR, joined Charles Kettering in putting out a call for the nation's best minds to find a solution to Dayton's flooding problem once and for all. The great minds answered the call and succeeded in turning one of the most flood-prone areas on the planet into one of the least. Largely out of this consequential effort, the Miami Valley Conservancy and the Dayton Engineers' Club was founded, which would be known for years after as a birthplace for innovation (Seibel, 2018). Lore has it that there was a rule against laundering tablecloths before being inspected, lest any important mealtime scribblings be lost in the wash (Bernstein, 1996).

Patterson believed that better working conditions in the factory returned more in productivity and higher quality than the prevailing thought of a mass of workers that could be shunted in to replace workers who could just as easily be discarded. He created a kind of welfare program that focused on engendering self-respect, a broad self-interest in the world beyond work, and stimulated ambition. This is in stark contrast to the situation the average American factory worker found themselves in at the time, who had "a smoldering apathy toward work." Before Henry Ford, Patterson was the prototype of the charismatic leader wishing to create a model working environment, encouraging a sense of mission among sales agents and a spirit of industrial initiative. A person's job was a way of life (Bernstein, 1996). It should be noted that Dayton's counterpart in this paper — Detroit, personified by Henry Ford — would demonstrate his interest in the improvement of lives of his employees only until the 1920s, when workers saw a ceaseless and ever-quickening assembly line extinguish self-motivation, while workplace bullying at all levels of the business would tarnish Ford's image of benevolent and forward-thinking leadership. There seems to be a lesson here for the Fifth Wave's warehouse workers, who number in the hundreds of thousands for Amazon alone: corporate leaders need to be working a lot harder to create 21st century model working environments, or they will be at the helm of a huge population of disaffected, apathetic workers who will not be in a position to show their full potential, ultimately at the firm's expense.

From the heartening results achieved with factory workers, Patterson then turned his attention to the wider world, starting with the factory environs. He set out to improve the neighborhood, redirected the wayward energies of local children into planting gardens, and cajoled neighbors to beautify their own property with prizes for good results. At the end of the 19th century, NCR was operating dozens of classes, clubs and brigades for thousands of workers. Patterson regarded himself as Dayton's leading citizen, and couldn't stand when the city's government would not heed his advice for city reforms. He denounced the city's leadership and their lack of civic mindedness and tolerance for corruption. He threatened that he would take NCR and its 3,800 jobs with him east, and then invited citizens to inspect his sprawling, model factory up close, to show them what they were about to say goodbye to (Bernstein, 1996). A 21st century equivalent of a business leader's passion for the city's health would probably involve cooperating with the city's governance to mitigate the growing pollution seen on the outskirts of centers of innovation, as can be witnessed in Silicon Valley. Socially, the difference between Amazon's lack of care for its workers and NCR's numerous programs to get its people involved in life could not be farther apart.

Lock and drill department, National Cash Register Company, ca. 1902
Shorpy.com

In the end, Patterson didn't make good on his promise to leave Dayton. In the 1913 flood, he helped his city through the calamity with such organizational skill and perseverance that astounded observers. After his death in 1922, the business was taken over by Edward Deeds, who operated NCR in a more moderate, pragmatic manner. By 1930, an estimated one-sixth of all U.S. corporate executives had either been an executive at NCR or had attended Patterson's management training programs. Among NCR's alumni were IBM's visionary CEO Thomas Watson as well as the presidents of Packard Motor Car Company, Toledo Scale, Delco and dozens of other corporations (Friedman, 1998, Staley, 2008). There were clearly good things happening at NCR, from countless mechanical innovations, a revolution in selling and marketing, social programs and assistance for workers and the wider community, spawning of spin-offs and training for future leaders. While the Detroit case study will be analyzed in conjunction with historical waves of innovation and investment, NCR's narrative contains insights for success in the numerous factors detailed that made it a center for innovation and, it seems, real pride and happiness.



NCR sales convention, about 1910. Thomas Watson, future leader of IBM is seated second from the aisle, first row, at the right hand of Patterson.
Bit by Bit

Left: John H. Patterson;
Right: Edward A. Deeds
MCD Water; Dayton Area Chamber of Commerce

Roots of decline

NCR's history is long and eventful enough that substantial stories can be told for both its success and its decline. Just as numerous factors can be citing its first four decades for things which leaders should do, the second half century of the firm details factors that should be lessons for avoidance. NCR's slow and uneven transitioning to electronics began in 1938, when the company sensed electronics would one day become important to the development of their products and the industry. For a time, NCR was a pioneer in computational research (much in the way RCA was a pioneer in the technology of colour television) (McCraw, 2000). NCR pioneered, among other digital technology, an electronic calculator in 1942. After the war, there was much pent-up demand for NCR's more traditional mechanical products, and management failed to seize the opportunity to define the strategic direction for the digital computer (in the same way RCA failed to lay the groundwork for continuing capitalization on the technology of colour television, and suffered at the hands of Japanese competition beginning in the 1970s) (McCraw, 2000). At this time, the business machine industry was highly concentrated among a small number of firms in the postwar years; IBM, NCR, Remington Rand, and Burroughs held the market for years in this highly-stable industry structure (Rosenbloom, 2000).

NCR continued into the 1950s and '60s with a culture, leadership and operating methods that had not changed since the 1930s. Among their competitors, NCR was ultimately the last to move into the electronic era in a competitive way (in contrast to Hewlett-Packard's nimble moves into an important string of digital technologies). NCR used a cautious strategy in slowly introducing electronics to their products, whereby sales would inform research and development of what type of products the public wanted. Cautious too was the acquiring of electronics expertise: with the purchase of outside knowledge and insights of the Computer Research Corporation, NCR limited the opportunities for innovation by taking the view of electronics as less than intrinsic to the future of the industry. In the early 1950s, some electronic components were incrementally attached to accounting machines, but blocked the digital group's activities in building a general-use computer. The idea that electronics could lead a transformation in the development of business machines was little noted by NCR executives in their leisurely approach to product development throughout the era (Rosenbloom, 2000).

If little organizational capital was allocated to an electronic future, a tremendous amount of capital was instead built into a vastly complex manufacturing enterprise devoted to the highly integrated production of machine parts, employing thousands of workers. In the early 1960s, 2000 research and development staff worked in Dayton, but their efforts were constrained to working in the mechanical-centered traditions of NCR. At the time, it was recognized that only two percent of total revenue came from electronic devices, which seemed to justify pouring money into the established, current technology (Rosenbloom, 2000). Clusters, according to Porter, are extremely vulnerable to what he calls "internal rigidities," that is, group thinking that depletes competition and a collective lack of imagination that can slow innovation and limit breakthrough advances in products (Dzialo, 2018). By the mid-1960s, NCR's manufacturing might turned into a handicap, with increasing costs and inflexibility; its core competencies, notes Rosenbloom, became

its core rigidities. As Ford in the 1920s almost obsessively committed to vertical integration, NCR's problem can also be seen as a vertical integration taken to the extreme, with its attendant consequences.

1962 NCR 390 computer advertisement; NCR Auditorium *Pinterest*

Brush with destruction

NCR's management style was formalistic and procedural, with no rotation among teams. At the firm's core, a group of executives who understood in NCR "a togetherness of the executive family referred to as chumminess, referred to as the Dayton mentality. Employees not working at that location were referred to as outsiders." This seemed to be common among large industrial organizations of the time; RCA's labs had likewise become a sort of "country club" for pet projects without any apparent commercial goal (coupled with an intense mutual dislike between researchers in New Jersey and manufacturing in Indianapolis) (McCraw, 2000). For NCR, technology's relationship with the market was becoming tenuous. During the decade, big department stores began to experiment with digital point-of-sale technology. Some of NCR's customers began to ask for the firm to offer this technology, but NCR struggled to make sense of the opportunity, citing mixed market signals. By the end of the '60s, NCR's internal resources were strained, margins were squeezed and costs rose. The company barely broke even in 1971, and dropped to third place in the point-of-sale market that they had just recently confronted. NCR would soon determine that as a part of their new longer-term strategy in the electronic era, it would have to make wrenching changes that would include letting Dayton's operations dwindle away — and build up elsewhere (Rosenbloom, 2000).

The decision was made to stop being a high-precision mechanical parts fabricator and instead become a high-quality assembler of purchased components as one of the main changes in becoming an electronics company — a transition that by 1978 was complete. Rosenbloom states that management's longstanding commitment to meet the needs of customers allowed NCR to have the courage to make important and difficult changes to survive. NCR survived the coming of the electronic age because new leadership recognized the need for its latent dynamic capabilities to be harnessed in breaking from the limitations of manufacturing which were quickly sinking the company. Just as architectural changes are needed at the cluster level, NCR as a firm had to adapt to competency-destroying innovations from outside and profoundly change how they did business. It can be argued that the rest of Dayton, at the higher level, did not join NCR in this move, which perhaps made the city less likely to produce enough talent with the necessary digital skills to allow other firms to thrive in the information age. The dynamic capabilities for learning that NCR was able to nurture — before it was too late — allowed the firm to achieve new forms of competitive advantage, if only for one more generation (Rosenbloom, 2000).

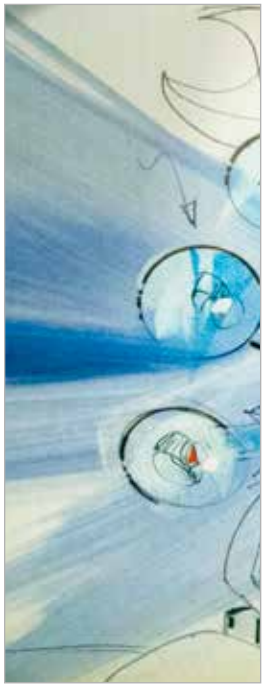
NCR foresight in 1984: a foresight time capsule

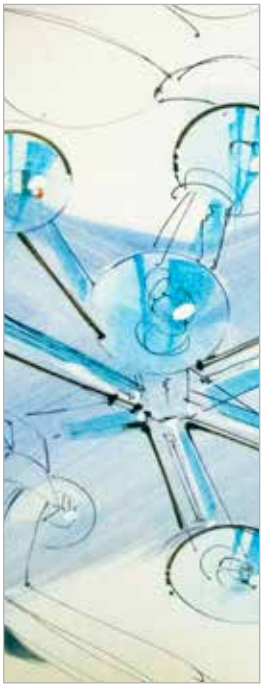
In 1984, NCR published a set of books celebrating its centenary, with the third volume focused on the world in the electronic age. The book is filled with foresight, including a look at various future scenarios. By that year, electronic funds were beginning to change people's experience of banking, and the writers recognized a future that would include banking at home and electronic payments. NCR contemplates if the information age will see an increase in the ability of human beings to apply information in the sense of wisdom. It also questioned if our ability to understand situations, set goals, consider consequences or make decisions will be enhanced or handicapped by the vast amount of information at our disposal.

The text also asks how artificial intelligence will analyze data (they already understood AI will one day produce the electron equivalent of human assistants), and if it will only take a handful of people to run a production facility by 1987 with computer-aided manufacturing "with factories humming along on autopilot". Robots were described as "stumblers that move with difficulty, not grace" compared to humans, but were already taking on sophisticated sensing abilities. Prescient was a passage about technology's effect on people and society:

The prospect of workers losing jobs to robots; forced early retirement to ensure employment for younger people in a post-industrial age; dwindling career choices; automation economies that make man-machine interactions for banking, shopping and other transactions the only affordable choice.

"The dynamic office of the 1990s"
NCR, 1984





The book asks if newly-automated businesses will be able to keep the economy moving strongly enough to create new replacement jobs and keep unemployment in check, and what retraining rights should employees have. It speculates that if high technology keeps its promise, wealth should increase, and called for a massive retraining of employees for the computer age — and to involve workers in planning the changeover and restructured work flow.

A look at a few of NCR's future scenarios (now 30 years in the past) illustrates the accuracy of some of NCR's predictions:

The Global Business World is an Information Society
In this scenario there is a rapid and extensive exploitation of new information technologies in production. The emphasis is on management in both the public and private sectors. Management is a combination of various forms of information ranging from data and communication to judgment and wisdom.

How the Learning Society is an Information Society
The Learning Society presumes broad acceptance and use of the emerging computer and telecommunications technologies. It is characterized by a continuing quest for access to knowledge.

How the Third World's World is an Information Society
A principal feature of this scenario is likely to be disorder in the internal control of new technology. One of the key features that may make it possible for many Third World nations to advance is their ability to obtain knowledge and technology from worldwide sources. Technology transfer is likely to be constrained by exporting nations. Knowledge and technology are clearly recognized as power and the key to productivity and competitive advantage.

World of Regional-National Alliances (over 20 to 40 years)
Culture is fragmented into relatively distinct regions with strong national or religious sentiment

The Leisure Society (over 30 to 60 years)
Focused on production and consumption with emphasis on leisure and health industries

The Learning Society (over 30 to 60 years)
Principal mechanism of cooperation is the exchange of knowledge (including technology, products, services, art etc.)

The Third World's World (over 10 to 60 years)
Developed world's role and function fades in the face of newly industrialized country growth and less developed country independent growth (NCR, 1984)

DAYTON AFTER NCR

After saving itself at the beginning of the electronic age, NCR was little-recognized for industry-defining innovation again. In 1991, AT&T bought the company for $7.5 billion, but sold it off to its shareholders five years later after losing $3 billion. The realization had set in that once a firm loses their edge in technology, it is very difficult to appear back on anyone's radar (Klebnikov, 2001). NCR's world headquarters closed in 2009 and moved to the Atlanta area. From the 1980s on, Dayton's dependence on traditional manufacturing emphasizing machining and assembly line work put the region at a competitive disadvantage as growing international trade and dramatically reduced transportation costs allowed for the global dispersion of factory work. It is part of a larger and slow-moving decline of old industrial districts, with cities like Pittsburgh, St. Louis and Cleveland seeing their innovation and economic peaks erode, with other regions throughout the world stepping up.

In the background, manufacturing jobs in the U.S. accounted for 49 percent of all employment in 1950; in 2005 it was 24 percent (Florida, 2008). As late as 1990, five General Motors plants in the Dayton region alone employed more than 20,000 people regionally (Staley, 2008). Now, most GM activity has disappeared (though there are still nearly 20,000 people who work in automotive manufacturing if suppliers of global companies are included). After weathering the recessions of the 1980s and 2000s, Dayton's population was down to just over 140,000 in 2017, having peaked at more than 260,000 in 1960. Meanwhile, the suburbs have grown, and now less than 20 percent of the metropolitan

area's population lives in the city of Dayton (Staley, 2008). This case study of Dayton's history as an innovation center provides numerous factors for growth and its sustainability, for a firm and the region. It also hold an equally powerful lesson detailing the decline that can set in when external threats are met with corporate rigidities, and in my opinion, the lack of foresight work to prepare for an initially unrecognizable future.

Images of Dayton decline, downtown and residential


OUR
CORE
VALUES

HARTFORD, CONNECTICUT: THE SWIFT RISE AND FALL OF THE POPE MANUFACTURING COMPANY

The literature shows that companies most often last no more than 50 years. This smaller study of the Pope Manufacturing Company has been chosen for its more compact life span, with a meteoric rise and crashing fall that occurred within one generation; it is a good candidate for positioning on the Kondratieff cycles of innovation. Pope started in the 1870s, when a K-Autumn, when mechanical innovations financed through the K Summer were still being financed through built-up credit in the market. The bicycle as developed through this era brought a demand for widespread, flexible personal transport, and was responsible for first putting urban dwellers in motion. The bicycle industry in New England was an early example of a successful industrial cluster — in this case home to Pope, America's greatest bicycle manufacturer. Pope produced technically sophisticated bicycles, becoming the largest mass producer of bicycles in the 1880s and '90s. Pope was one of many industrial companies in New England, which was home to 20 percent of America's manufacturing workers, in spite of accounting for just eight percent of the nation's population (Rosenbloom, 1998).

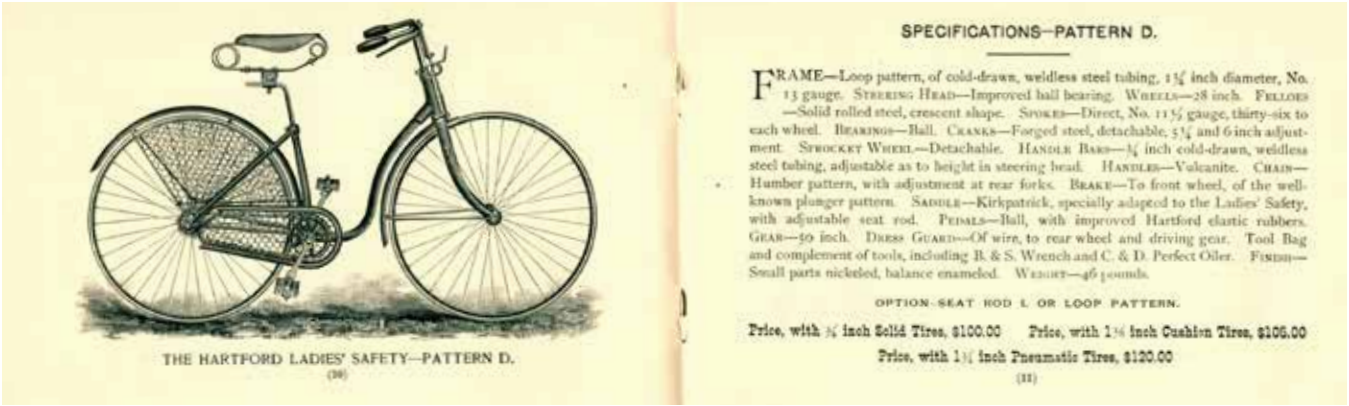
As described by Glen Norcliffe in Critical Geographies of Cycling, Pope specialized in high-quality factory methods that influenced future practices of testing, quality control and mass production in the automobile industry — characteristic of a lead firm in a cluster, according to cluster theory. Following the introduction of the instantly-popular safety bicycle at the beginning of the 1890s, the previous pattern of Pope's small batch manufacture became untenable, and vertical production became necessary as the industry recognized the new format as the standard pattern (Epperson, 2000). These developments occurred in a K-Winter, which lasted from the 1870s to the mid-1890s, a period of little capital for new innovations and low prices. What innovations were being developed at this time would come into fruition in the next K-Spring cycle which would last about a dozen years into the future.

Following the trend of industrial clusters that form specialized departments or firms that are geographically aggregated, Pope made use of clustering supplier firms in a flexible arrangement of sub-contracting. Following this was an ambitious acquisition of firms to make vast quantities of light steel tubing that became part of Pope's large vertically-integrated industrial complex. The main bicycle factories in Hartford were enlarged several times, followed by the horizontal integration of two separate assembly lines in adjacent factories to produce a lower-priced marque, served by the same group of suppliers. This expansion occurred in the depths of the K-Winter, propped up by the 1880s and '90s bicycle craze, which attracted hundreds of manufacturers to the boom. Pope clearly wanted to be the best and succeed ahead of the competition. Equipment that made the now-standardized bicycle parts possible for many firms inevitably made competing designs and older bicycles obsolete as the cluster entered the third stage of the cluster life cycle (Norcliffe, 2015). The new standardization of components and suppliers allowed smaller and less capital-intensive outside bicycle makers to compete with the large, vertically-integrated makers on price and volume, and Pope was overtaken by the new competition. When Pope later tried to enter the automobile industry with new products, the challenge

of pursuing cars as a entirely new clean-slate innovation proved insurmountable, and the great Pope organization disappeared (Epperson, 2000). This exit from the industry occurred just as the innovations that emerged in the 1880s-90s would fuel the spectacular rise of the automobile in the K-Spring in the first decade of the 20th century.

The eventual decline of the New England manufacturing cluster can be attributed to the eclipsing of the region's elite high-precision manufacturing of smaller items in favour of western manufacturers, who mass-manufactured with large-scale stamping and pressing methods, as used in the carriage and farm implements trade. This is consistent with the life cycle of clusters as detailed in the theory, where the original cluster and its patterns are overtaken by different innovations and lower price points from other regions. New England's decline is also due in part to the massive new factory buildings that were first developed on Detroit's outskirts that could handle an unprecedented mass of material in their vertically-integrated processes, unlike the old New England "mill" factory design (Hyde, 1996). Science and history writer John Heitmann cites the shift of fortune from New England and the Midwest to Detroit in *The Magnificent Ambersons*, where the "widespread diffusion of automobiles, landed elites, complacent and spoiled, who were living in prosperous mid-sized towns, lost their economic power at the expense of the new auto-centered manufacturer class, comprised of inventors, entrepreneurs and engineers" (Heitmann, 2009).

Hartford Bicycle Company, 1891
Northwestern University's Transportation Library


THE HARTFORD LADIES' SAFETY—PATTERN D.

SPECIFICATIONS—PATTERN D.

FRAME—Loop pattern, of cold-drawn, weldless steel tubing, 1¾ inch diameter, No. 13 gauge. STEERING HEAD—Improved ball bearing. WHEELS—28 inch. FELLIES—Solid rolled steel, crescent shape. SPOKES—Direct, No. 11½ gauge, thirty-six to each wheel. BEARINGS—Ball. CRANKS—Forged steel, detachable, 5¼ and 6 inch adjustment. SPROCKET WHEEL—Detachable. HANDLE BARS—¾ inch cold-drawn, weldless steel tubing, adjustable as to height in steering head. HANDLES—Vulcanite. CHAIN—Humber pattern, with adjustment at rear forks. BRAKE—To front wheel, of the well-known plunger pattern. SADDLE—Kirkpatrick, specially adapted to the Ladies' Safety, with adjustable seat rod. PEDALS—Ball, with improved Hartford elastic rubbers. GEAR—50 inch. DRESS GUARD—Of wire, to rear wheel and driving gear. Tool Bag and complement of tools, including B. & S. Wrench and C. & D. Perfect Oiler. FINISH—Small parts nickeled, balance enameled. WEIGHT—46 pounds.

OPTION-SEAT ROD L OR LOOP PATTERN.

Price, with ¾ inch Solid Tires, $100.00 Price, with 1¾ inch Cushion Tires, $106.00
Price, with 1¾ inch Pneumatic Tires, $120.00

(11)

DETROIT'S RISE AND DECLINE: WAVES OF THE AUTO INDUSTRY

THE EARLY DETROIT CLUSTER

Detroit's automakers are the second historical case study that can be plotted against Kodratieff waves — in this case, two waves, from the mid-1890s to 1950 and from 1950 to the 2020s. On these waves, there are many signposts for the financing of innovation, its profits extended with the help of credit, and then the drying-up of credit while new innovations are being developed but not exploited. In the literature, there are other waves that have been applied to the history of the Detroit car makers' decline which will also be analyzed for its lessons. Though the internal combustion automobile was invented in Germany in 1885, it was in America where engineers and mechanics tinkered and experimented with the technology in order to make it into a marketable product through reasonable means of production (Dzialo, 2018).

As in all Great Lakes clusters, Detroit was well-positioned to accept shipments of building materials in bulk. Hardwood from Michigan had been providing support to the carriage industry for generations, and many carriage makers were able to make the transition to automobiles (a possible example of adaptation by arbitrage, where older firms are used to support new industries). The declining fortunes of the traditional mining and utility companies influenced local money to get in on the automobile business, but it was mostly the coincidental meeting of future notable auto personalities that converged in Detroit that made it the capital of automobile innovation and marketing (Dzialo, 2018). Some of the features of this early cluster stage can be found in the GEMS model, where innovation and entrepreneurship, historical factors and elements of chance played a factor.

The Detroit automobile cluster really began when the Olds Motor Works moved from Lansing, Michigan to Detroit in 1899, becoming the first automobile manufacturer in that city. In that year, there were 30 automobile firms. An early automobile man in Detroit remarked, "Every factory here...has its entire output sold and cannot begin to fill orders... and it is all spot cash on delivery, and no guarantee or string attached of any kind" (Hillstrom, K., 2007). The infant industry that soon comprised hundreds of new companies was easy to enter, had no government restrictions, and had access to a variety of sources of capital — varying from giants like J. P. Morgan to local banks and patrons (Heitmann, 2009). In this paper, the rise of the automobile will be seen as stretching through what will be described as an upward Kondratieff wave (in this case the K-Spring and early K- Summer of the Fourth W ave), where innovations that were developed in the recession-prone winter of the previous wave are taken advantage of and enthusiastically financed. Like all upward phases of the wave, the automobile's Kondratieff Summer experienced profitable fruition in spite of wars (in this wave, World War I).

The earliest movers in the automobile cluster got in cheap; Henry Ford started with a dozen workers and $28,000 in cash. "Low capitalizations made it difficult to achieve quality,"

Bernstein writes, but "mindless demand made it unnecessary." Though the entrepreneurs that had moved to Detroit would make it the hub of the motoring world, they were quick in 1909 to make use of an Ohio innovation: the ignition system developed by Charles Kettering, who had been tinkering with the invention on his off-hours away from NCR. Kettering would later become vice president of research at General Motors in 1919 (Bernstein, 1996). When mass-production started, engineers like him were needed to tool all the new standardized parts that needed work together, in the process becoming specialized knowledge workers, or in the description of Robert Lacey in writing the history of Ford, "veritable princes of the production processes — the elite of the elite" (Lacey, 1986). They would replace the machine shop owners and factory foremen of an earlier era of craft (Liu, et al., 2015).

This overwhelming opportunity beckoned the mechanically adept and the entrepreneurial eager. Sometimes overlooked are the European immigrants who arrived in Detroit to offer their expertise in the complex technological issues faced by early auto engineering and manufacture. The Thomas automobile company, for example, hired many French engineers. By 1910, firms in the Detroit area accounted for 65 percent of the output of the American auto industry, displacing the early Ohio and New England automobile clusters. By that year, the industry had consolidated into 11 firms, which included the fantastically successful Ford, the celebrated Cadillac and the outstanding Packard companies. By 1925, Detroit's slice of the industry had expanded to 80 percent (Klepper, 2011). In 1921, the U.S. government acknowledged the automobile as a staple industry in the country by agreeing to match the investment in highways of states along the route the modern U.S. highway would take, eventually becoming the national highway system (Dzialo, 2018).

Cadillac final inspection department, 1912
Wayne State University Digital Archives

At General Motors, Alfred P. Sloan added professional development to Ford's basic concept of a durable, affordable car that could be mass-produced for millions (Liu, et al., 2015). A key observation Sloan made was that automobile firms based on the personal preferences and prejudices of their owners were not going to survive the coming years. Sloan knew that automobile companies had to be less personal affairs, offering more variety to bolster adaptability (Davis, 1988). Indeed, companies frequently outgrew their founders' operational styles, and corporate operations sometimes distanced themselves from owners and founders (Laird, 1996). General Motors' innovations in business management, along with those of NCR, set the pace for businesses in other domains, bringing together professional, financial and marketing specialists while standardizing internal systems along with the components of cars. Even Albert Kahn, the architect of the Detroit's massive "daylight" plants that produced cars, exhibited a remarkable lack of personal pretension in his work, going about the design of mold-breaking plants with a systematic professionalism. He declared that architecture is "90 percent business, 10 percent art," and subdivided work in the studio among engineers in a manner that calls to mind the division of labour of a model industrial cluster (Hyde, 1996).

Ford's factory practices, Sloan's marketing and management, plus the eventual addition of a union for auto workers created the final maturation of mass production (Liu, et al., 2015). Detroit automobile companies, beginning with General Motors, had established a yearly model change to combat the threat of customers keeping their cars for too long. It could be stated that this was a strategy of planned obsolescence that was the first conscious disregarding of sustainable practices in major American industry and disregard for such practices even when an opportunity arises to go in a sustainable direction (Dzialo, 2018). At any rate, these developments in the automotive cluster align to the first stage of a cluster, where agglomeration benefits include firms learning through proximity, innovation accelerated, isolated firms out-competed, and a dominant design pattern and way of doing business is formalized. These agglomeration benefits would, however, be inverted to cause a decline in the following decades.

1925-1926 Packard touring car and in a Detroit showroom at night, 1925
Wayne State University Digital Archives

THE DETROIT CLUSTER FROM THE 1950s ON

If NCR's history can be traced in a narrative of ascension and decline, Detroit's story does not quite follow this bifurcation, but experienced two major declines — one during the Kondratieff Winter of the Great Depression that only became a Spring beginning in 1950, and the other that began around the year 2000, and continues to this day. This second decline is occurring in what is likely the third stage of the Detroit industrial cluster, where decreased benefits of operating in a cluster become apparent, new locations are started by disruptive upstarts, and decline is brought about by internal inflexibilities and changes in transportation options. This second decline, however, actually takes place within a complete Kondratieff wave (the fifth K-Wave, the so-called Information and Telecom Revolution), with the upswing, leveling and decline of a K-Spring, Summer, Autumn and Winter. The insight here is that during the post-World War II boom of the K-Spring-Summer upswing of the 1950s to the 1980, the seeds for decline during the K-Winter were sewn. Another cycle framework put forward in the literature detailing Detroit's decline is yet another set of phases. Thomas Klier has found three distinct phases of the demise of Detroit's dominance in the auto industry: the mid-1950s to 1980, 1980 to 1996, and 1996 to 2008, which match the fifth Kondratieff wave (it can be argued that the end point of the 2008 phase is still extending into the end of the present decade). In describing these phases, or waves, Klier's aim is to provide a historical frame of reference for the ongoing debate about the future of the auto industry (Klier, 2009). One can chart the latest developments of the industry where Klier left off with his 2009 paper on K-Waves or Schumpeter waves.

First phase

After World War II, the Detroit Big Three were large, successful companies, basking in the post-war boom; by the mid-1950s, they had become convinced that they knew what customers wanted. It would take them many decades to come to terms with reality (Liu, et al., 2015). When the very first small foreign cars made their appearance on American shores, the Big Three agreed among themselves that if they were to ever compete in the small car market, they would all need to build small cars together (demonstrating cluster behavioral restraints and acceptable business practice described by Press). The Big Three then dawdled on this basis for long stretches for the next 50 years, punctuated by moments of crisis which half-heartedly galvanized them into concentrating on small cars, if only for a time. The independent makes (Nash, Hudson, Kaiser and Willys) had built small cars, but they were expensive for the value offered. The benefits of building large cars were ingrained in the business: high per-capita profits, low gas prices, and longer drives made possible by the expansive new interstate system with wide roads (Klier, 2009).

A recession from 1957–59 proved the '50s to not be without challenges (though the recession happened at the beginning of a long K-Spring and Summer that would last until 1980). It was during this time that the Volkswagen Beetle was introduced to U.S. shores. After Volkswagen had made this initial step into the new market, it had a 10 percent U.S. market share, with 75 percent–80 percent of the U.S. small car market. The American public would come to realize that the German low-cost car was better-made and drove

more directly down the road. The Big Three first responded by importing their own foreign-built cars from their European subsidiaries, and in 1959 began selling domestically-built small cars. These American small cars were successful, and the market share for foreign makes in the U.S. fell to 4.9 percent by 1962. They were frequently ordered with deluxe trim, however, and within a few short years the American small cars grew larger, having fought back the inroads made by the foreign makes (Klier, 2009).

During the mid-1960s K-Spring and Summer, continued interest in small cars saw a new wave of imports to the U.S., which saw their market share level back up to over 10 percent. As they had tried in the late 1950s, the Big Three responded by importing their own small cars from Europe. In the late 1960s, the Chevrolet Vega, Ford Maverick and Pinto and American Motors Hornet and Gremlin were introduced, but this time to a less-enthusiastic reception. The small cars made by foreign car makers had by this time established themselves with a reputation for quality, and now had a strong dealer network that allowed their popularity to steadily increase (Klier, 2009). By the early 1970s, the Japanese car makers were outselling the original Volkswagen Beetle, while the American small cars introduced a few short years earlier had once again grown in size. By this time, new safety and environmental regulations coupled with a gas crisis that began in 1973 made operations harder for the Big Three, and was made worse by a deteriorating economy. By the point where the Kondratieff Summer was flat-lining into Autumn (where credit becomes increasingly important), Chrysler almost went bankrupt, and needed a $1.5 billion government bailout. By 1980, foreign makes had taken a 25 percent market share in the U.S., helped by the experience gained by perfecting cars in their home markets. The end of the 1970s saw Japanese automakers dominating quality ratings in every segment in which they participated, giving them a big competitive advantage (Klier, 2009).

Another perspective on the ascent of the Japanese automakers centers on the country's attitude towards workers. As well as perfecting lean production methods, Japanese businesses believed in — and expected — lifelong employment, and made a point of investing in employees to protect business stability, compared to the large layoffs typical of Detroit mass production. Given that people were employed for life, it only made sense to invest in them so that they had multiple skills that would benefit the company. Typical of this spirit was Toyota, with its internal flat team concept — a concept of togetherness and trust that extended to suppliers, who also enjoyed close relationships and long-term commitment (Liu, et al., 2015). One antecedent of this attitude towards workers can be found in NCR's story, which was one factor in allowing that firm to thrive for more than half a century in Dayton.

Second phase

The fortunes of American car makers improved by the mid-'80s (Following a severe recession typical of an early K-Autumn) with improved sales and cheaper gas prices. Japanese car makers by this time had started to manufacture vehicles in North America while continuing to concentrate on perfecting small cars. During this time, Japan was distracted by a weak domestic economy, with Nissan and Mazda in a particularly difficult situa-

tion, needing financial and management assistance from non-Japanese car companies. Major American innovations were introduced in the minivan and future forward-looking Ford Taurus. But longer-term success was hampered by the Big Three dabbling in mergers and acquisitions in the late 1980s, which cost them much time and attention.

This was also a period where the Detroit Big Three were increasingly leveraging the active credit market characteristic of K-Autumns. When these business adventures ran their course, GM struggled to break even, and the investment quality of the company dropped. From 1986 to 1991, GM downsized their operations significantly as they sloped down an ever-slightly descending K-Autumn towards the steep drop-off of the K-Winter. During this second phase, the Big Three found success in developing a variety of light trucks, notably the Ford Explorer, which in 1990 caused Ford to produce more light trucks than cars in their U.S. assembly plants. Charging forward with a greater-margin product seemed to make sense, with less-stringent fuel economy regulations for light trucks — a category which included minivans and SUVs (Klier, 2009).

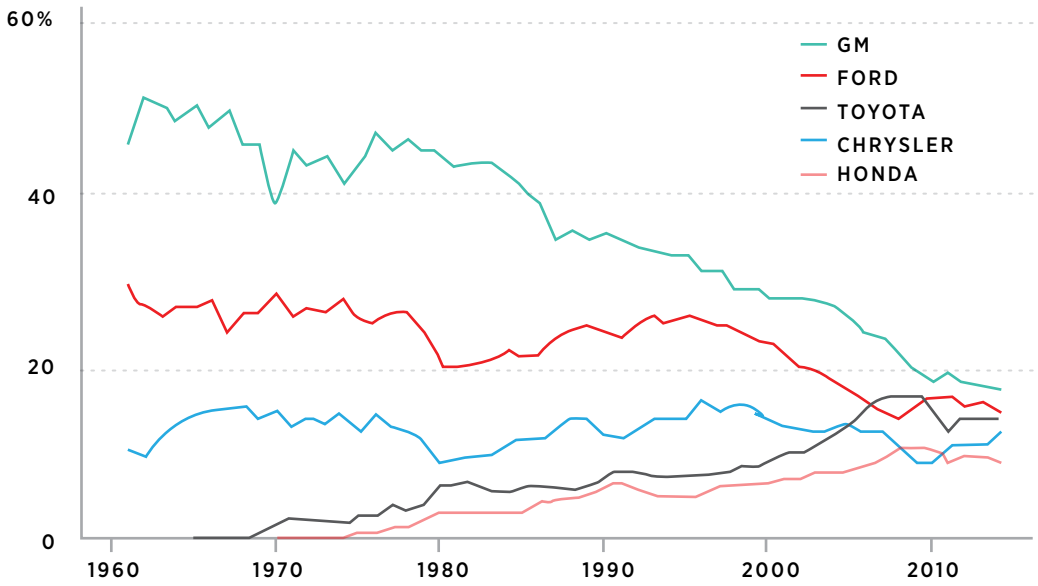
Toyota demonstrating its dealership and service presence in America, 1975
Hemmings Motor News

Third phase

In the mid-1990s, foreign car makers went into light trucks in a big way, with Honda introducing the Odyssey minivan in 1995, and Toyota introducing their North American-sized Tundra pickup truck in 1999. In this phase, Japanese and other foreign car makers would flourish in North America, while the fortunes of the Big Three would fall by 26 percentage points between 1996 and 2008. By 2004, when the Kondratieff Winter had just begun and maintenance of growth had run its course, the light truck run was at its end, and bond ratings had fallen for all three Detroit car makers. In addition, Detroit now employed a large force of workers with long tenure at a higher wage rate (resulting from years of shedding jobs), and the structural cost of many retirees increasingly siphoned off a magnitude of the Detroit car makers' affluence (Klier, 2009).

Looking back, 2007 was the final year of a long plateau of U.S. auto sales — nine straight years of at least 16 million light vehicles starting in 1999, an artificially-prolonged stability financed by a K-Winter dependance on finance and credit. It was, in fact, a profit-draining pairing of chronic overproduction with frantic rounds of heavy factory incentives to clear excess inventory (Snyder, 2017). The 2008 recession saw major upheavals for the Detroit auto makers, while the price of gas rose dramatically. The Japanese could now import small cars from all over the world, transforming the Big Three into what could now be called a global Big Six. Ten foreign headquartered automakers were now producing light vehicles in the United States (Klier, 2009). Meanwhile, the Kondratieff Winter may continue until perhaps the 2030s.

Fig. 9 PERCENT OF TOTAL U.S. AUTO INDUSTRY MARKET SHARE BY AUTOMAKER 1961-2014 (WardsAuto (various years)



Recent signals and trends

Unlike Silicon Valley, which can obscure poor performance within a bubble of promising technology and relatively easy capital, the auto companies have been floundering in the long Kondratieff Winter of the Fifth Wave. The four best-selling automakers have bled share, while four smaller makes have soaked up the remainder. Sales competition has tightened considerably among brands, surprising new winners have emerged and light-truck sales have dominated sales at the expense of cars. In November, 2018, General Motors announced that it planned to idle five factories in North America and cut roughly 14,000 jobs in a bid to trim costs. The *New York Times* called it "a jarring reflection of the auto industry's adjustment to changing consumer tastes and sluggish sales." The cuts affect an assembly plant Ohio, factories in Michigan, Maryland and Ontario. This follows another stage of Detroit attempting to lure buyers to domestic small cars — this time in the form of electric and hybrid options — but finding that consumers are attracted to pickup trucks and sport utility vehicles. On top of this, automakers have paid a price for the trade battle that the Trump administration has set in motion. As of June, 2018, GM slashed its profit outlook for the year, with tariffs driving up production costs, raising prices even on domestic steel (Bluestein, 2018). While Oshawa, like many Canadian cities, is trying to turn itself into a hub for technology industries, even successful measures are unlikely to help many former GM workers. Toyota's Woodstock plant, which opened ten years ago, is the last new car factory Canada has seen (Austen, 2018).

One strategy for dealing with the collapsing car market in the past has been to stuff unwanted sedans into rental lots and other commercial fleets. That has only delayed today's capacity crisis. Those lower-profit fleet sales have inflated the market, keeping U.S. vehicle deliveries above 17 million for the last four years, even as sales to individual retail customers peaked three years ago. Over all, the American auto industry has added nearly 350,000 jobs since the industry bottomed out in the wake of the recession. But the industry still employs tens of thousands fewer people than before the crisis, and hundreds of thousands fewer than in 2000. Even though they are facing a potential slump, car makers continue to spend heavily to develop electric vehicles and self-driving technology, both to meet regulatory mandates and to anticipate the future of driving. This shift is expected to remake the global industry, while enabling companies to enter new and potentially lucrative businesses, such as driverless taxi and delivery services (Bluestein, 2018), which may only see true fruition in the Kondratieff 6th Wave.

In summing up the Detroit narrative of The Big Three, one finds that they declined for a number of reasons: they were unable to balance the tension between differentiated offerings and market demands, the presence of rigidities and hubris similar to that of NCR, the inability to effectively meet the challenge of competitive newcomers, similar to how the Pope Manufacturing Company suffered at the hands of far-away challengers, as well as economic adversity characteristic of the fifth Kondratieff Winter that the industry continues to suffer under. Strategically, offering the market completely undifferentiated, poor quality vehicles was obviously undesirable in the long run, and it undermined perceptions of vehicle offerings. This mindset, developed during the fifth K-Spring and Summer of the 1950s through to 1980, led these companies to fail to identify their true strategic

positions. Kondratieff upswings (car makers experienced two of these in the fourth and fifth K-Waves) was followed by an Autumn, which lasted 10–20 years, and sloped down in Winters lasting about 20 years. A big question is if the current Kondratieff Winter (starting in 2000) is expected to last more than 20 years. Complicating this is that enormous amounts and goodwill and money have been squandered in for so long (Liu, et al., 2015). If it is to last longer, how can the innovations being developed today be implemented in a thoughtful way in the next upswing to benefit the planet environmentally and socially? If the next Spring occurs earlier (in the 2020s), an upswing with see the digital systems of connectivity and the 4th industrial revolution flower into profitable economies, which will hopefully bring several regions — Detroit included — dispersed throughout North America along on the journey upward.

Abandoned auto plant, Detroit, Michigan
Andrew Burton/ Getty Images

Abandoned Ohio car dealership
Jalopnik

FALLING BETWEEN THE CRACKS: U.S. POLICY

So far, theory, strategic models and lessons of history have been proposed to assist firms and clusters to better-adapt to their own time and the near or distant future. In the GEMS model, public policy and business climate also play a role in the sustaining of healthy industrial clusters. This paper will draw some attention to the role of government and the powerful sway of major centers of creativity over the past several decades in creating undesirable conditions for many regional clusters and populations who have been left behind. More than ever before, economic opportunity is tied to location, according to a report by the Economic Innovation Group. The U.S.'s most prosperous areas enjoy the clustering of new jobs, leaving a quarter of the remaining new jobs for the other 60 percent of the country's regions. Many of the nation's communities that were worse off saw zero net gains in employment and new businesses since the beginning of the 21st century, with more than half experiencing net losses for both measures. Meanwhile, America's labor force has become increasingly employed by large companies, narrowing geographic diversity and, arguably, limiting wage growth (Hart, 2018).

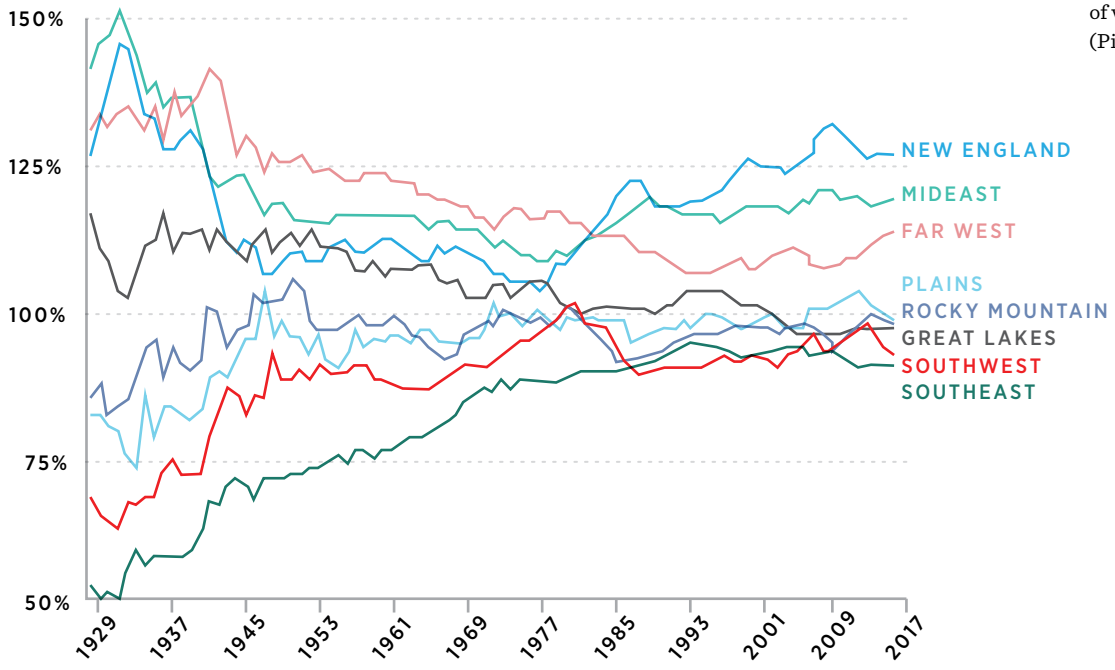
How productive a state's industries are plays a major role in economic distribution, rather than a state's geographic size. A 2007 examination found that California's share of U.S. GNP was 14 percent, Texas' 8 percent, and states such as South Dakota and Kansas less than 1 percent. An outsized success in a single state could mean visible growth for the entire country; the computer and electronics boom in California from 2000 to 2007 and the corresponding state's rise in productivity boosted U.S. prosperity by 0.2 percent per year (Caliendo, 2018). For many decades in America's economic landscape, differences in the economic fortunes among states were not nearly as dramatic. A gradual convergence of prosperity among the states was once the rule for generations, particularly in the middle of the 20th century, when the southern states caught up with the North in economic development. Mississippians, for example, saw their incomes (comparable with those of the north) rise to a level in 1980 that would have been unimaginable in 1940 (Longman, 2015).

Decades before the term "flyover states" could be used to describe the Midwest, the average per-capita income of that vast region was only somewhat less than that of New York City. Cities in Illinois, Wisconsin, Michigan, Iowa and Ohio were ranked among the top-performing economies in the country. This convergence of income across regions lead to what would be accepted by most as a single American standard of living, made possible by a 30 percent increase in hourly wage equality gained between 1940 and 1980. In the years since, however, the San Francisco Bay Area and New York City saw an enormous rise in income, 88–172 percent greater than that of the average American. Richard Florida describes how some major cities (even if they are not geographically in proximity) are beginning to be seen as 'mega regions' — vast regions of wealth and activity that number in the tens of millions of people and billions of dollars in economic output. In these su-

per-regions, cities like New York and London have more in common with each other than neighboring American cities (Florida, 2008).

With this intensifying of commerce and affluence in these contained international regions comes a pattern of migration which is untypical and unpredicted for Americans: a widespread move of a large population of workers from wealth-producing regions to those which have been showing far less growth. And while Gross Domestic Product of a ostensibly busy region may be high, wages within that region may be comparatively low (Florida states that socio-economic mobility and geographic mobility are not identical in meaning or opportunity, and that people may overestimate the benefits of moving)*. This phenomenon can be observed in cities like Atlanta and Houston, which on paper are thriving, but have a working population that earns increasingly less than that of Washington, New York or San Francisco (Longman, 2015). In the Sun Belt, where much of the auto industry has relocated from factories in the North, per-capita income has fallen behind that of America's coastal cities. Florida writes of the U.S. as splitting into two distinct labour groups: the "geeks", who enjoy high-paying, higher-skill work and the "grunts", who with fewer skills labour in the service sector for less pay** (Florida, 2008).

Fig. 11 REGIONAL PER CAPITA INCOME AS A PERCENTAGE OF THE NATIONAL AVARAGE, 1929–2017 (Brookings Institution)

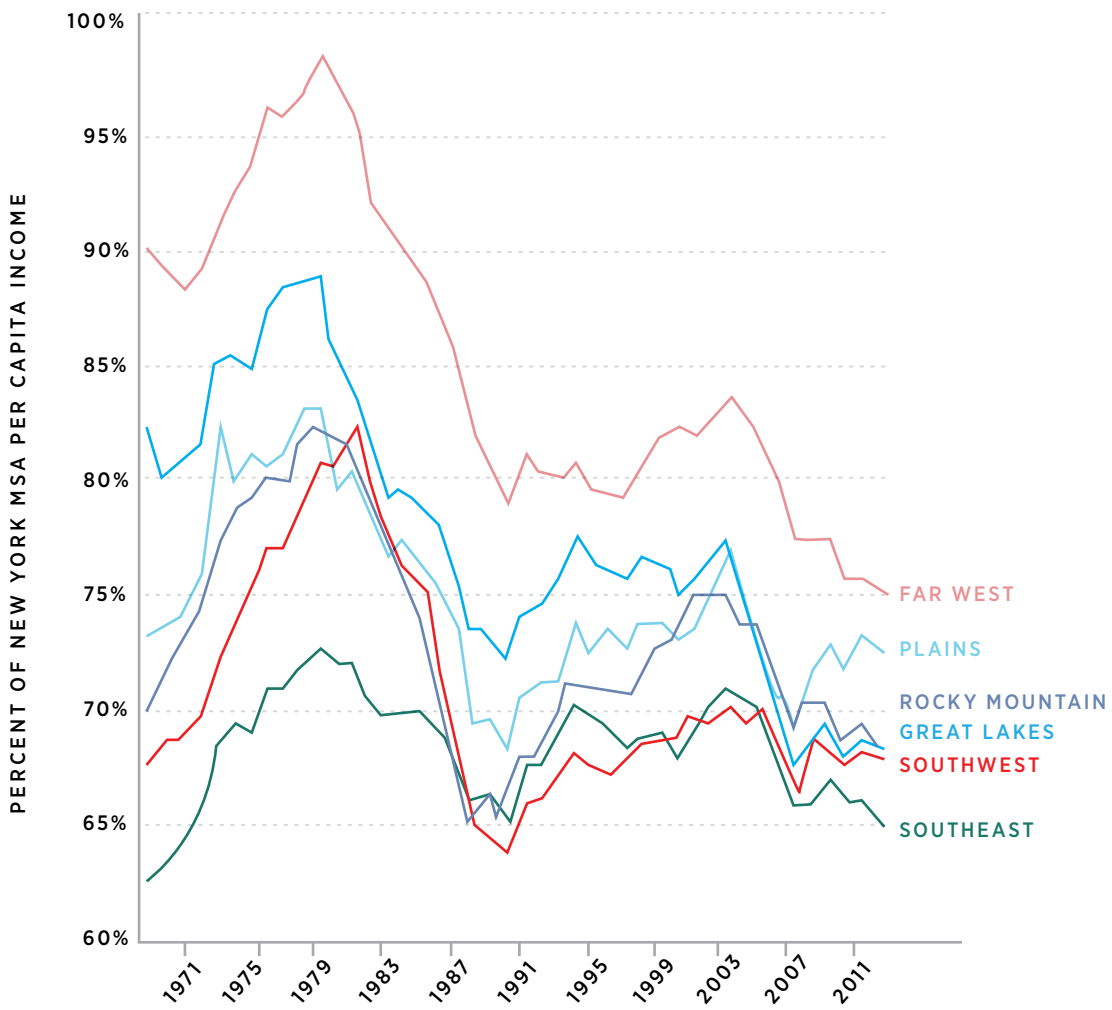


* This is in contrast to a more creative and 'open' personality type of mobile worker that is moving back to the older cities, with their gentrification and catered to by service workers living farther and farther away (Florida, 2008).

** Interestingly, Florida shows that in spite of lower pay in comparison to higher-paying work in a factory or as a machinist, many people choose to work in service sector for its flexibility and potential for creativity. This underlines the necessity for a re-think in how services should be compensated to develop a more stable (less likely to be outsourced) and middle-class service sector, who can use their creative tools to serve customers better and increase the bottom line (Florida, 2008).

Service, as an intangible asset, can create value by anticipating, responding to and shape the ever-changing demand of customers; businesses should pay more attention to this potential arsenal of value-creating assets (Pitts, 2015).

Fig. 12 PER CAPITA INCOME OF VARIOUS REGIONS COMPARED TO NEW YORK METROPOLITAN AREA (Brookings Institution)



East Austin, Texas 'gentrification' *Ralph Barrera / American-Statesman*

For many decades, the U.S. tried to guard against the oversized influence of a select few geographic areas, but the inequality of regional opportunity has grown to be more pronounced since the 1970s, and even more so since the recession of 2008–10 (Fleming, Mantel, 2018). Phillip Longman, writing in The Atlantic, argues that public policy is the 'missing piece' in moving toward regional economic parity. The point at issue is that the American government no longer takes the appropriate steps to check the unwarranted competitive advantage of a few dominant cities to monopolize power over the rest of the country. These checks once rested at the federal level, having been established in the late 19th century, reaching their peak power by the 1960s and '70s, and falling to deregulation in the years since. Early regulations and anti-trust efforts, meant to curb railroads, grain distribution and the country's manufacturing base from benefiting only a few key eastern states, had the goal of maximizing local control over local businesses. Public measures "helped to contain the forces pushing toward greater regional concentrations of wealth and power that inevitably occurred as the country industrialized" (Longman, 2015).

A policy of that earlier era that seems to hold significance in today's tech world is a Roosevelt-era policy that limited patent monopolies, mandating that America's largest corporations licence their patents for light bulbs and transistor technology for the benefit of a wider swath of economic regions (transistor technology would become the basis for the digital revolution). These anti-trust laws kept small communities from being swallowed up by a small number of 'Frankenstein' companies which would otherwise control the local economic affairs and destinies of its citizens. The better scenario, it was argued, freed thousands of small entrepreneurs and independent businessmen to be part of enacting policies that would benefit their region. For many years, American businesses followed the rules, and businesses that controlled more than a double digit percentage of a regional sector were severely curbed (in contrast to the Walmart of today, for example, that controls half or more of all grocery sales) (Longman, 2015).

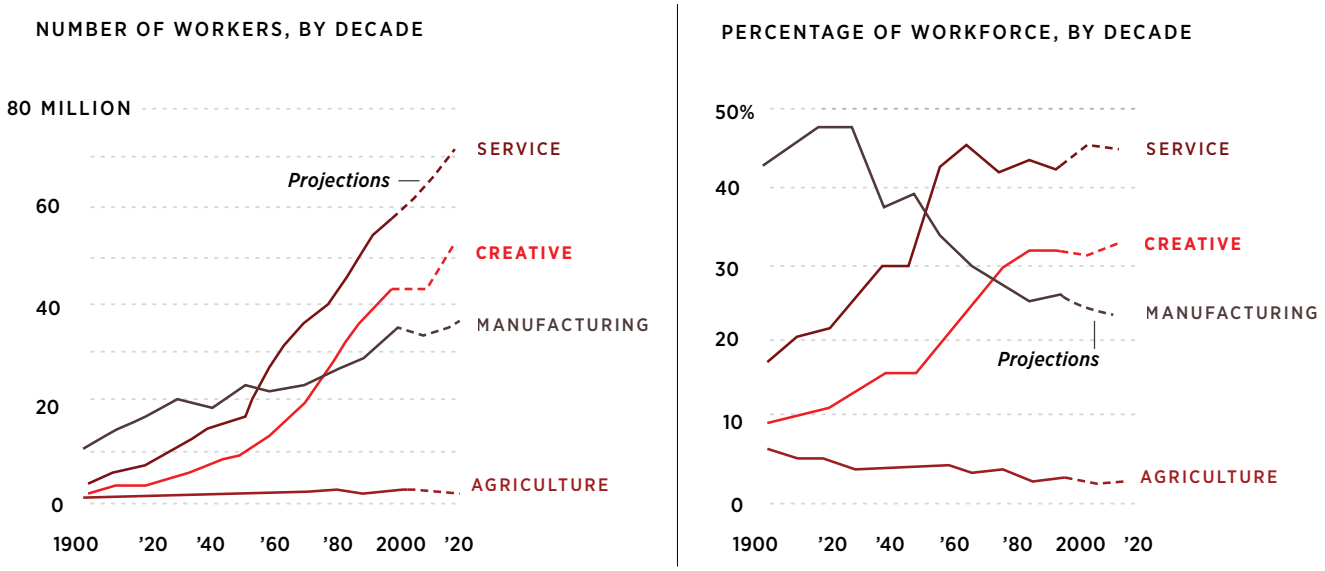
These regulations began to be relaxed, first in inter-state transportation which allowed for more affordable pricing in air travel that benefited coastal cities, but in the long term stifled access to smaller and mid-sized cities. In time, a small handful of companies located in large cities would control shipping and electricity, making the operating of a business hard for many smaller companies. Meanwhile, the middle-class living in the centers of larger cities that once had access to an efficient and growing network of rail and highways, found their lifestyles no longer tenable because of a failure of investing in these networks. Many eventually picked up and left, moving to gridlock-free regions where freedom of movement was thought to be better. In Who's Your City, Richard Florida tries to define why certain groups of people move from one region to another, calling the concept of place "the central axis of our time". In moving to places with few options for high-quality employment, there is a risk for things to become worse when faced with a downturn in one's situation — in contrast to the faith of many in a 'flat' world where everybody is connected and is a beneficiary of equal access to prosperity (Florida, 2008).

Returning to public policy, a major shift in how anti-trust cases could be prosecuted now ruled out any consideration of social cost, regional equity or local control in deciding

whether to block mergers or stop the proliferation of monopolies. The loss of local control over countless regional businesses in favour of absentee management has seen a marked decline in the benefits of corporate involvement and social capital in the civic life of those places, again in contrast to the social capital that Patterson felt important in building up NCR (Longman, 2015). A collapse of regulation in commercial businesses like retail was mirrored in the banking industry, where once-strong regional money centers such as Philadelphia and St. Louis were eclipsed by a handful of elite cities such as New York and London, bringing the geography of finance close to the patterns of the Gilded Age on the 19th century.

The digital technology sector, once distributed across multiple regions through the licencing of transistor patents, was now highly protected under the guise of "intellectual property" rather than engineering, allowing for the geographic concentration of monopolistic power in this sector than before. The new business model for startups would soon include the eventual selling off of their platform to one of the large tech giants before competing with them could doom the enterprise. In order to be in a position to sell the innovation when the opportunity arises, inventors need to be physically located where large concentrations of the creative class are seeking to be acquired or can help with selling these acquisitions — places like Silicon Valley or Seattle. Longman writes that understanding this change from a leveling policy of dispersion of the opportunity and wealth among regions to the winner-take-all world of tech, retail and commerce today is important to turning the problem of regional inequality around (Longman, 2015).

Fig. 13 RISE OF THE CREATIVE CLASS ECONOMY (Florida, 2008)



A Wright Brothers Institute Catalyst Event artifact
Wright Brothers Institute

ANALYSIS

Given the insights of the theories of industrial clusters, as well as knowledge of different models and frameworks for cluster success and lessons from historical waves of innovation, we are in a position to bring analysis to two emerging clusters and an established cluster that is experiencing maturity and possible decline.

EMERGENCE AND MATURESENCE

Having looked at strategies, government policies, and theoretical structures and cycles in the discussion of clusters of innovation, we will now analyze some of these factors in one dominant tech cluster, that two that are up-and-coming: dominant Silicon Valley, and up-and-coming Dayton and New York City.

THE SMARTEST CLUSTER SEES MATURITY: SILICON VALLEY

The pattern of success followed by cluster spin-offs has been an important feature of the innovation narrative for Silicon Valley, as it was for Detroit and Dayton. In the 1930s, William Hewlett and David Packard were given a loan to start a company in Palo Alto, California that would rise to national prominence when it entered the computer business in the 1960s. Hewlett-Packard pioneered one electronic device after another over the decades, sometimes selling to consumers, similar to the NCR tradition. The company eventually employed 100,000 people, and importantly, retained the ability to reinvent itself in taking on new technologies, redefining what computing could be (McCraw, 2000, Gandy, 2012). "The HP Way" of systematic innovation was widely copied, spawning spin-offs as numerous HP alumni went on to start their own firms — among them, Steve Wozniak, co-founder of Apple Computers.

In the 1950s, the large Stanford Industrial Park dedicated to the development of high-tech firms took root, giving rise to more than a thousand companies. Several dozen of these made their home in the Park, including the Shockley Semiconductor Laboratory, which spawned Fairchild Semiconductor, and later Intel. These companies ushered in the Third Industrial Revolution (scientific), which followed the Second (the internal combustion engine), which followed the First (the steam engine) (McCraw, 2000). From the beginning, Silicon Valley followed the pattern of the first stage in cluster development: shared sources of technical knowledge, the ability of firms to manage their size (as HP did in launching new products as needed), and an accelerated flow of innovation.

These events flourished in a Kondratieff Spring of the Fifth Wave, which saw the coming of an information and telecom revolution. This wave started with the invention of the transistor in 1949 and continued on to the K Summer with the introduction of the microprocessor in 1970. Personal computers, the internet and mobile phones would enjoy a tremendous amount of capitalization through these years. By the 1990s, the factors that made up Silicon Valley's success were celebrated as creative destruction, the release of

economic energy by resourceful individuals, and the balancing of centralized and decentralized management within organizations. A more effective division of labour allowing for the survival of the Silicon Valley model can be compared to that of the industrial tech cluster of Boston Route 128 when these regions faced the newly-emerging demand for low-priced, customized digital products. The small, cooperative networked firms of Silicon Valley were better able to address this challenge compared to the inflexibility of Boston's structure, which encountered difficulties because of its closely-integrated nature, hindering adaptation. The author of an *Economist* article at the time argued that the chief contribution of the Valley was organizational innovation, rather than merely the technological. Silicon Valley allowed risk taking, tolerance for temporary failure, tolerance for job-hopping, a rigorous meritocracy, inter-firm cooperation and flexible organizational structures. It was also individual in its lax enforcement of non-disclosure laws as described earlier, which allowed for the much more frequent hopping of employees from one firm to another. In this way, the Valley was again more hospitable in comparison to Route 128, with its strict non-compete violations (McCraw, 2000).

Staff at Fairchild Semiconductor in the 1950s, California *New York Times*

IBM's first plant in San Jose, California accommodated just over 100 IBM employees. *Arkenia.com*

SILICON VALLEY AND THE RISE OF TESLA

A study of Tesla's emergence in Silicon Valley is helpful in comparing the strategies and innovation milestones for modern electric vehicles versus the status-quo rigidities of the Detroit car makers. In a study that first included the phrase 'disruptive technology', Clayton Christensen (1997) studied the possibility of the electric car becoming a key transformative innovation (Tyfield, 2018). The new age of electric cars (and especially self-driving cars) will bring with it new standards of engineering and digital infrastructure to vehicles. As in the early automotive industry, a new organizational form characterized by considerable ambiguity faces automotive firms once again.*

* At the turn of the century, consumers were initially confused in deciding the ideal source of power, the number of cylinders, systems of steering and control and mode of stopping (Rau, 1994).

Tesla's notable achievement is that along with making electric vehicles desirable for many, it succeeded in bringing the automobile into the digital world in a way that the Detroit car makers could not. It broke into an auto industry which was assumed to be off-limits to anybody that was not one of the global car giants. For the Big Three — and for NCR in Dayton — cluster rigidities shaped the manufacture and marketing of its products. A focus on internal combustion vehicles, regardless of the possibilities of modern alternative drive-trains, as well as increasing dependence on the technological limitations of third-party suppliers, seems to have put an end to American car makers as perceived innovators (Dzialo, 2018).

Tesla started out as a spin-off of a small company called AC Propulsion, which turned out experimental electric technology and vehicle concepts for established automakers pressed into electric vehicle research. Observing his Valley colleagues investing heavily in research and development for lithium-ion batteries, tech entrepreneur Martin Eberhard wondered if similar technology could be transferred to cars. He convinced AC Propulsion to help him build a prototype car that could one day be sold in quantity. Eberhard and his colleagues would soon discover that the Detroit cluster had "quietly made itself inviting to startups" (Dzialo, 2018). The tech community was skilled at a particular kind of sourcing that Detroit was not as adept at: sourcing the kinds of electronics that could be combined to make a desirable E.V. It was from this skilled sourcing that Silicon Valley could take advantage of the rigidities of the automotive establishment to try to out-cluster the incumbent region. In this case, it was the promise of particular agglomeration benefits — and perhaps an impassioned Silicon Valley attitude against the status quo — that made this first stage of this electric vehicle cluster in the Bay Area come to fruition.

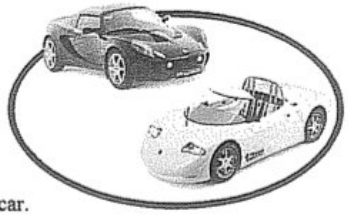
An interesting strategic innovation pursued by Tesla was to eliminate dealerships, so that feedback could be gleaned straight from the users. With the exception of a light-weight frame made by the long-established Lotus, the other components sourced by the team were far more advanced than what most car makers could get their hands on. In Detroit, both car makers and suppliers used long-established approaches to developing technology for cars; it can be considered that the Big Three were weakened by rigidities causing, as Bryce Dzialo observed in an historical analysis of Tesla, "complacency and stagnation of innovation in accordance with Porter's writing" (Dzialo, 2018). These elements of the Porter Diamond that were allowed to become ineffectual can be defined as 1) firm strat-

egy, structure and rivalry and 2) related and supporting industries. The apparent value of Silicon Valley's offering was very strong: the first Teslas sold to the public changed the opinion of electric cars overnight. They were to no longer be the slow, ugly electric 'golf carts' that had often represented an E.V. future. Tesla would be a striking and stylish sports car that would consumers would love, albeit in the pursuance of high-end display, not as a 'green' car that embodies self-sacrifice and sobriety (Tyfield, 2016). By this time, Elon Musk had become the major investor in the company (Dzialo, 2018).

Executive Summary

Tesla Motors will build high-performance electric sports cars. This sounds impossible – both the idea of building cars in the first place, and further, the idea of building a *high performance* electric car. But key technologies have recently been developed that make electric cars suddenly very attractive, and the international business climate makes it now possible to build a "fab-less" car company – a car company without a factory.

The Tesla Roadster



- 0-60 mph in less than 3.9 seconds
- World-class handling
- 100 mpg equivalent
- Zero tailpipe emissions
- 300 mile range
- Zero maintenance for 100,000 miles (other than tires).
- A selling price less than half that of the cheapest competitive sportscar.

Yes, it's electric. No, it is not a dream waiting for battery or drivetrain technology to be developed, or for some new fuel/power distribution infrastructure to be deployed. It uses commodity lithium-ion batteries that are already manufactured in the millions per year.

You can drive one today. An impressive proof-of-concept car has been built to demonstrate the performance of this battery and drivetrain technology. The Tesla Roadster will be a production sportscar based on this prototype. Using outsourced design and manufacturing, the company will break even selling about 300 cars per year.

Tesla's original value proposition to investors
Business Insider

Elon Musk, 2008
Fortune

Tesla quickly went public — the first automaker to do so since Ford, 54 years earlier. Tesla itself is unique in that it began as a technology company with the challenge of building hardware not yet mastered by Silicon Valley engineers, including those at Tesla. This allowed Tesla the freedom to stretch free of local competition but with all the tech support it could possibly need. Tesla even boasted investment from Google co-founders Larry Page and Sergey Brin (Kolakowski, 2009) (Dzialo, 2018). While Tesla tried to solve these new and interesting problems in establishing itself as an automotive force, the Detroit cluster seemed willing to explore only how to avoid emissions regulations, while doing the bare-minimum in electric vehicle research. The difference between the established cluster and Tesla's vision is stark; If Elon Musk is to be believed, Tesla is trying to reduce oil dependency for cars as a big-picture motivation — to change the world. At the very least, "Tesla generates awareness, perhaps even fear, about where the evolution of energy and sustainability in business and society is leading the automotive industry." Tesla will certainly be seen as a watershed moment in automobile history, but caution should be exercised as to whether it will lead to a complete transition to electric vehicles over internal combustion in the time frame they believe it will (Dzialo, 2018).

THE NEW RISE OF ENGINEERS AND CODERS

Years from now, Elon Musk will probably be recognized as providing an important service in sharing Tesla's technology in an open-source spirit of cooperation to get the electric vehicle industry off the ground (somewhat reminiscent of Nikola Tesla, who in 1891 ripped up his royalty contract with George Westinghouse, partly so that his electric technology could continue to be championed). If the former tinkerers of Detroit could become millionaires within a decade of their first mechanical experiments, the modern digital coders have found similar success. A new measure of power and prestige for engineers in the early 20th century, for example, brought a massive increase in engineering programs, with the number of American engineering graduates increasing from 100 a year in 1870 to 4,300 a year in 1914. What had been a trade became a profession.

In fact, many engineers believed that their systematic view of life would benefit the country in ways politicians could not effectively contribute. Along with American economist and sociologist Thorstien Veblen, they believed that the solution was to turn policy and administration over to skilled technologists who would exercise systematic control over the economy. In the recent past, Silicon Valley's hacker mindset — rebellious, but narrowly focused — has shown the programming elite of the region to not be especially active politically, which, Doug Hill in Medium writes, "isn't to say that faith in technocracy isn't alive and well there". Google's Eric Schmidt and Netscape founder Marc Andreessen are among those who believe that technology is quite capable of solving all of the world's problems, if only government will get out the way — and government increasingly shows signs of agreeing with them (Hill, 2015). Meanwhile, it's becoming difficult to separate scientists and technicians from the captains of industry. It will be interesting how the generation of coders and engineers ('heroes' endowed, as the Fourth Turning describes, with a mindset favouring community, affluence and technology) will produce cars for their contemporaries in the sixth Kondratieff wave, represented by psychosocial health and biotechnology and the new economy that follows.

TESLA'S MISSTEPS

Unfortunately, news stories from recent years show a firm struggling to succeed in the basics of running a car company. One of the more dramatic examples of this problem was made famous when Elon Musk seemed to try to get the better of shareholders with his famous tweet, "Am considering taking Tesla private at $420. Funding secured." This instigation is similar to Henry Ford's 1918 announcement, made upon his (demonstrably insincere) early retirement from the business, that he would organize a "huge new company to build a better, cheaper car", to be set up in direct competition with the old Ford Motor Company, seemingly indifferent to the business he had built over a decade. When asked about the current company, Ford replied "I don't know exactly what will become of that." Interestingly, upon this news, fifty-one Chambers of Commerce across the U.S. sent telegrams to Detroit urging the advantages of their community as the site for new Ford plants (Lacey, 1986).

Tesla's vehicles are limited in that their very success depends on being targeted precisely to what is by definition a small fraction of demand. To improve upon this small fraction, Tesla created the Model 3, which is failing to keep up with demand, quality and possibly the company's chances of remaining profitable (Boudette, 2019). The management of the organizational challenges of a such a quantum leap in manufacturing have already been proven to be daunting and problematic for Tesla, especially when positioned against an industry with a fast-moving and extremely advanced manufacturing model (Tyfield, 2018). Efforts to supply hungry buyers with the Model 3 has also been hindered by logistical challenges. It can also be argued that gasoline has advantages in energy density, cost, infrastructure and transportability that electricity doesn't have and won't for decades (Stephens, 2018) In March, 2019, Tesla was forced to close many of its retail stores in an attempt to cut costs, signaling broader problems with the company (Boudette, 2019).

A similar problem relating to a luxury car maker attempting to enter the middle-class range happened with the Packard Motor Car Company in the 1940s and '50s. When that firm made the decision to incorporate a mass-produced medium-priced car in their traditional senior car lineup after World War II, they found that they could not compete with the price cutting, yearly model changes and manufacturing efficiencies of the Big Three. They soon disappeared from the automotive landscape (Tyfield, 2018). Tesla has rarely turned a profit in its nearly 15-year existence, and has suffered the bailing out of many executives (41 in 2018). It's Model 3 did not impress *Consumer Reports*, who cited long stopping distances in emergency braking test and difficult-to-use controls in not recommending the car (Stephens, 2018). The heart of the auto industry's future are likely the labs of existing automakers and suppliers who design and supply components to automakers. These shops have become the engines of the future for the auto world. Because of all this, the cars of 2020 and 2030 "may be manufactured in Detroit, or Stuttgart or Hiroshima, but their brains will probably have originated in Silicon Valley" (*Innovation & Tech Today*, 2018). Tesla's coming of age has occurred in a Kondratieff Winter, characterized by a collapse of capital and a difficult economy, leaving the company little elbow room to thrive. Time will tell if the company will be around to enjoy the fruits of its patents and innovations in the rise of a K-Spring, sometime in the 2020s.

THE DOWNSIDE OF SILICON VALLEY

The uncertainty of Tesla lives in a larger story critical of Silicon Valley's excesses and shortcomings. Thorstein Veblen (who coined the term "conspicuous consumption,") observed in 1899 a chasm between business and industry that anticipates the differences between Wall Street and Main Street. In his work, "pecuniary classes" have no other aim or motivation than maximizing profit, which can easily be achieved through restricting output, reducing competition and manipulating monopolistic power — as opposed to contributing to the economic success of society. This can be considered a mindset and motivation in the Kondratieff Winter. Thorstein also complained about the over-selling of useless goods that he felt were ruining society (Hill, 2015). The modern parallel can be seen in time-wasting recreational technology and 'casino capitalism,' in which tech is exploited to the full in order to benefit individuals who make no contribution in enhancing productivity or developing needed goods and services. There is also criticism of Silicon Valley's cult of disruption as increasingly destructive and amoral, and venture capital's speculative rent-seeking as shortsighted and exploitive of prior state investment. Moreover, disruption's acceleration of obsolescence has generated mountains of electronic waste, a major contradiction in Silicon Valley's green claims (Knuth, 2018)

Many of the tech startups set up in Silicon Valley, ostensibly to be near angel investors, venture capitalists, investment banks, and tech talent are increasingly keeping only small teams there. Utilizing less-costly satellite offices, remote co-working spaces, or other remote-work options are valued by the majority of their employees. The operating costs for a tech startup in Silicon Valley can be three or four times that of one in emerging tech hubs such as Austin, Pittsburgh, Columbus, Ohio, the Charlotte-Durham North Carolina area, Wilmington, Delaware, and Boise, Idaho. A private equity investor recently observed that a tech company in his portfolio relocated to a Midwest tech hub and added six months of cash burn onto its balance sheet. Doubtless, many tech companies are already looking closely at Apple's own satellite strategy as they seek ways to grow faster and run their operations more efficiently while still attracting and retaining the best available tech talent. Inevitably, that examination and scrutiny of Silicon Valley living will lead to more innovative, remote working opportunities (Shipley, 2019). "You can create that distinct community just by leaning into your own community." A promising tech worker might go to Silicon Valley for deep training with a mentor (in the same way young executives went to NCR in Dayton for 'the training'), and then move back home to invest in their community or to a city where they can conceivably raise a family. Solutions to the problems of varied regions cannot all be solved in Silicon Valley — they have to be solved through the lived experiences of people in their respective regions (Rosenbaum, 2018)

Even in 1997, *The Economist* called attention to the "remarkable insensitivity of 'Silicon Valley nerds' to the problems of government and the broader needs of society." A threat from within seemed to be manifest in their apparent care for nothing but money and the next breakthrough idea (McCraw, 2000). Silicon may also be facing problems with capital. Corpulent venture capital funds, searching for the next billion dollar opportunity, are investing "in any team with a half-decent pitch and the right connections". Tellingly, U.S. investment recently hit its highest level since the dotcom era. This is interesting, as the

Kondratieff Winter is meant to see a collapse of capital. Silicon Valley's current dependance on finance and credit may be of the type that is not conducive to funding quality innovations of the K-Spring and Summer investments. Pointing to the apparent bubble as merely unprecedented innovation, Wendy Liu writes in *The New Internationalist*, that their entrepreneurial hubris overlooks the role of larger economic trends:

> The current low-interest-rate environment post-2008, combined with general economic stagnation, has led to a situation of 'over accumulation' — too much capital sloshing around, needing a place to go. At the moment, technology seems like a good bet and investors are jumping on anything remotely tech-related in the hope that it will eventually provide a return. Is this sustainable? Unlikely. I would categorize the threats to Silicon Valley into three main areas: consumer backlash, mismanagement, and worker organization.

Privacy concerns are the current focus of consumer backlash, with the Cambridge Analytica scandal spurring closer looks into Facebook's business model. Consumer boycotts are materializing, and there is the possibility of regulatory intervention, as Facebook recently has proposed to change its business model. Companies once valued at billions are on the verge of liquidation in the midst of the exposing of fraudulent technology, or fines being exacted for flouting laws. There is now an endless parade of once-glorified tech start-ups failing. "If this trend continues," Liu warns, "there could be reverberations throughout the economy, given that venture capital typically comes from pooled sources such as pensions and university endowments". Lastly, the possibility of worker organization in the industry is starting to threaten business models. Companies like Amazon, Deliveroo, and Uber maintain low consumer costs through exploiting underpaid, overworked and precarious workers. But these workers are starting to strike back through direct action and legal challenges. Though it's yet unclear whether workers can extract lasting concessions before jobs are automated away, there is potential for massive disruption of existing business models. The bottom line Liu states, is that Silicon Valley will not magically solve the problem of over-accumulation. Just like the financial frenzy pre-2008, it's a temporary fix, and it can soon come crashing down (Liu, 2018).

Smog in Oakland, California, 2017
SFGate

THE CENTRE OF CAPITAL THAT WANTS TO BE MORE:
NEW YORK CITY

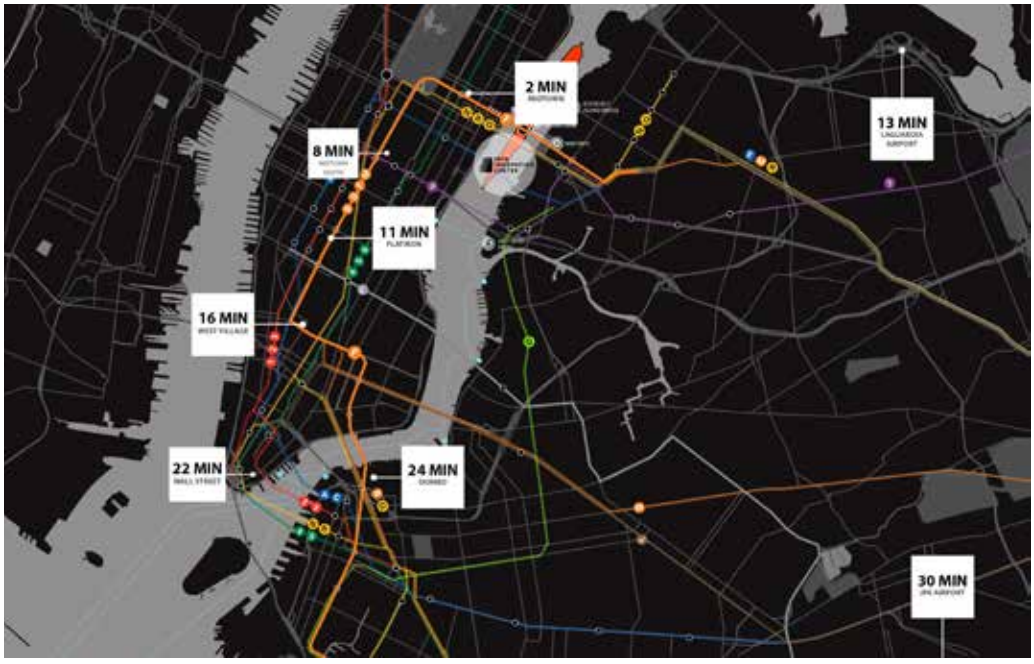
There are examples of a number of towns and cities all over America that are attempting to become the newest cluster; many will struggle to be noticed by the kind of talented people who want to live and work in a vibrant place and start companies that will spin off other companies that form clusters. New York City has no problem being noticed, but not always for desirable things, and until recently, not often for being a tech cluster. New York City was home to a very early cluster that found immense profit in the Stock Exchange, with numerous banks and brokerage houses springing up in offices in the vicinity of Wall Street. As a city of vast wealth and population, New York City may not seem like an underdog in becoming a tech center. But in the wake of the financial crisis of 2008, the city's leaders realized that a new path for the city's economic security should be forged that does not involve destructive forms of finance. A plan emerged to develop tech start-ups and tech workers, making it a talent engine comparable with Silicon Valley. Though Amazon has recently pulled out of the city, New York will continue to advance its pool of tech experts and regional capabilities — it was, after all, its talent pool of 5000 tech workers that lured Amazon to the city in the first place. The *New York Times* reported that "in December [2018], Google announced a major expansion that could double its New York workforce to 14,000 over the next decade, without the rich government incentives that proved a lightning rod for the Amazon deal."

Tech's rise in New York goes back nearly two decades, with long-established internet ventures (especially Google) making early bets on the city. To this, the Bloomberg administration also made smart policy moves that welcomed tech activity, fulfilling the Public Policy and Business Climate elements necessary for the GEMS model to function for cluster adaptability. Entrepreneurs, technologists and corporations in significant numbers chose the city as a place to work and live, just as the city's industries were undergoing digital transformations. Industry-leading firms in the city, such as finance, advertising and media had to become adept at digitization in spite of not being tech firms. When they adapted to compete, they helped to revitalize the city's economy in the process (adaptation by arbitrage). The city has begun to nurture a homegrown talent engine, while expanding graduate schools that focus on science, technology and entrepreneurial innovation as part of the city's development plan. As can be seen time and again, it is the urban amenities — museums, theater, opera, dance, jazz clubs, art galleries, bars and restaurants — that offer a clear alternative to life in suburban Silicon Valley.

Like Chicago, New York City tech prides itself on solving real-world problems, rather than developing new technology and then waiting to find a market (the mistake Dayton realized it was making with its own technological innovation, and, it can be charged, Silicon Valley is recently guilty of). The city is also starting to demonstrate the pattern of cluster growth, with entrepreneurs building on success stories with spin-offs, human networks

and self-confidence that inspire risk taking that in turn can be copied. A New York tech entrepreneur marvels at how much the tech scene has changed since she moved to the city a decade ago: "Now, you just step out onto the street and you hear tech product discussions all the time." A faculty member of Cornell claims that the big problems of industry and important concerns are to be solved in New York: "If you're doing pure tech — a super-fast chip or advanced systems software — Silicon Valley is still the place to be," she said. "But when it comes to everything else, New York really has a chance to be the place to be." (Lohr, 2019). There is an underlying sentiment in the narratives of Ohio and New York that suggest there is, as Florida described, a "sorting" of population according to values, culture and politics in the U.S., where smart and talented people are making decisions on which region should win their allegiance, with the expectation that the like-minded will multiply into the region. It is believed that this shift is greater than that occurred from farms to factories (Florida, 2008).

In the paper *Surfing the Sixth Wave*, Stephen Aguilar-Millan recognizes that "we have reached a point where locations do not wish to compete with the epicenter of the newly emerging paradigm, but to copy it". Ever since Silicon Valley established itself as the epicenter for the emerging technological paradigm, a host of imitators arose around the world. Along with the "Silicon Alley" in New York, emerged a "Silicon Fen" in eastern England, "Silicon Roundabout" in London, and so on. All of these were pale imitations of the original Silicon Valley. However, they did serve to diffuse technology in their various localities. This process of diffusion of technology developed in the Valley happens at a much faster pace than the initial development of the technology, owing to the degree to which the global economy is presently more integrated than in earlier periods in history (Aguilar-Millan, 2012). It can be expected that technology will be put into faster and faster practice as the Fifth K-Wave ends and the Sixth Wave begins.



Tata Innovation Centre on Roosevelt Island, extolling its proximity to key points in New York City
Tata Innovation Centre

A BETTER MODEL OF INNOVATION FOR DAYTON:
THE WRIGHT BROTHERS INSTITUTE

This paper analyzed Silicon Valley as a cluster that enjoyed over half a century of growth and veneration but is now lagging as a place of social, capital and environmental integrity. It then focused on New York City's wise repositioning strategy from calculating plunderer responsible for the Great Recession to inventive up-and-coming tech center producing meaningful innovation. I will now turn back to Dayton and one group's attempt to harness the region's ongoing technological research into a cluster that can meaningfully recapture some of its former glory. It has been observed that regions that excel in scientific research may not always exhibit commercial adaptation (Florida, 2008). In American business history, Thomas K. McCraw states that leading-edge technology companies by the mid-20th century "funded expensive research laboratories, many whose projects had only tenuous connections to future commercial products" (McCraw, 2000). For the past decades, scientific research and development capabilities at Dayton's Air Force Research Laboratory remained strong, with a largely civilian workforce of 21,000 minds that are extensive in their creativity and talent. But the result of all this research could not bring about the vibrant commercial possibilities comparable to the culture of innovation in the era of the Wright brothers and Charles Kettering.

In the last couple of years, however, a new culture of innovation has been awakened, according to the Wright Brothers Institute (WBI), an "innovation runway for the Air Force Research Laboratory". Several years ago, WBI — an organization that serves as a partnership intermediary with the Air Force Research Laboratory — began assessing why so little technology from the laboratory group and the region as a whole made it to commercial markets. The Institute concluded that the region lacks a strong integrated commercialization process. Though capable of developing technology, the region's workforce could offer little value to the region in economic output, as most of this effort was not converted into economic output. "Solutions looking for a problem," was frequently expressed as the problem by technology developers. The Stanford Research Institute, on the other hand, was known to possess a high-performing technology commercialization model with an impressive success rate. The two groups teamed up to share knowledge, and the two-year effort funded by a grant by the Department of Defence saw WBI partner with consulting and analysis firms to bring new model of commerce to Dayton. As described in their promotional piece,

> Various market concepts were piloted which ultimately yielded a variety of start-up businesses and new product lines within existing businesses that are in various stages of maturity. The grant provided a proof-of-concept for a commercialization model, unique to the State of Ohio. Rather than expecting entrepreneurs to "go it alone",

> or mimicking a Silicon Valley approach to commercialization, this model provides a balance between the agile flexibility needed to start a new venture, with the structure that matches Midwestern values and risk tolerance...[while transitioning from] "Rust Belt" to "Innovation District".

WBI discovered that typical technology commercialization, funded primarily by venture capitalists, had a success rate of ten percent. In contrast, an ideal market-pull methodology uses future customers in the product development process, resulting in a much higher success rate — proven in startup examples such as Apple's Siri technology and the Da Vinci surgical system. This model is reflective of practices used in the Lean Startup movement, which WBI explored as a model for application to the Dayton region in 2014. The improved commercialization model showed tremendous promise to shorten time-to-market and reduce the capital investment needed to reach break-even points. It also promised to achieve commercialization success rates of over 80 percent on business that can achieve $100M valuation within five years of launch.

Their market-pull model's intelligence comes from assuming that buyers do not care about technology but do care about what value it can bring to them. This model features research such as market analysis and tech mining, which is completed prior to launching a business. This ensures that start-ups have strong market pull, the right technology and a unique value proposition that allows for rapid capitalization. Additionally, constant refinement and iteration is considered critical components to success, allowing for modification of a product or service during the development of the business. Feedback from user groups, technical experts and business professionals can be incorporated iteratively while the product can get to market faster, and with fewer pitfalls. An interesting analysis compared Dayton's then-current Defence Contractor mindset — which did not have the ability to take the region into the desired future — to the mindset of an innovation culture.

DEFENCE CONTRACTOR CULTURE	INNOVATION CULTURE
Technical talent	Entrepreneurial/business talent
Top-down needs requirement	Market assessment
Compete	Collaborate with competitors
Looking for threats	Looking for opportunities
Solve an engineering/scientific problem	Solve a market problem
Secure environment	Open environment
Patent for professional accomplishment	Patent for market protection
Stove-pipe solution	System integration
Avoid risk	Embrace risk
Failure is not an option	Fail forward
Scarcity	Abundance

After this journey of reassessing the processes of innovation and marketing in the region, the partnership determined that there is a capacity in the region to commercialize technology coming from the Air Force Research Laboratory and local universities, if they could understand the market and win readily-available capital investment funds. The Market-Pull Commercialization Model allowed them to begin assessing needs of the market and integrate those needs into their thinking, thus providing needed alignment between the desire to "tech push" and the "market pull". Importantly, the traditional stage-gate process was modified during the course of the program to incorporate findings uncovered by exercising the model. They found success in folding new ventures into an existing start-up under a common umbrella, which provided synergies that benefited both ventures by vastly increasing the market potential. In addition, several ventures resulted in a new product line or a spin-off for an existing business. This often proved much easier and quicker than starting a company for scratch (Wright Brothers Institute, 2018).

In their conclusion to the initial partnering project, it was noted:

> This commercialization model is giving Dayton the confidence it needs to attract investors and embolden entrepreneurs. While many have tried to replicate commercialization models from other large cities, mid-size Midwestern communities like Dayton have had minimal success in adopting those cultural principles. There are still areas that need improvement. Cultivating a pool of experienced entrepreneurs will help integrate Air Force technologies into commercial products, faster. More access to capital, especially early pre-seed and seed capital, will enable start-ups to focus on tech development and delivering high-quality products, rather than fundraising. Evangelizing "market pull" over "tech push", through words and actions, is needed to make this the norm (Wright Brothers Institute, 2018).

WBI is one of a number of public, private, and university partnerships that have supported Ohio's recent surge in homegrown start-ups. If quality of life where one works is considered important to a thriving cluster (apparent in places like Austin and Seattle), many are seeing this ingredient in Ohio. In the *Forbes* article "Why Ohio Is The Best State In America To Launch A Start-Up", Peter Taylor writes, "Manhattan has the nightlife. San Francisco has the lifestyle. But Ohio has both for a fraction of the price". Ohio also has exciting, vibrant, diverse cultures, where people traditionally have a loyal work ethic, which is harder to find on the coasts. Start-up costs such as overhead are far less, allowing the investment dollar to count for more towards a goal. An Ohio-based venture capitalist suggested that the Midwest is a kinder, gentler venture capitalist culture compared with Silicon Valley: "we are entrepreneur-centric, but we still appreciate having our friends out West joins us as we find a great entrepreneur with lots of upside potential." Taylor also describes Ohio attitudes of innovation as better for mentoring (Taylor, 2017).

If a region like Ohio can establish the basis for a healthy industrial cluster that creates value for the world, Porter shows that the economic power and efficiency of a cluster can offset mounting pressures to relocate abroad: clusters, in other words, get more focused

(Florida, 2008). To the thoughtful business model that WBI is now using to make Dayton's technology commercially viable, it could suggested that this great project can be enhanced by considering some of the methods and insights brought forward in this paper: understanding their cluster as a complex system which demands ever-more comprehensive problem solving methodologies critical for the 21st century; recognizing that positive agglomeration externalities can become problematic elements if a proper balance between the higher and lower-level cluster agents are not working with optimal synergy; using the GEMS model to monitor all the aspects of a cluster that need to be in good health and working together; the historical long cycles of innovation and capital that reflect on the past and portend the future; and finally, the Three Horizons framework that can bring people together to coalesce for a shared understanding and future-focused change.

The Wright Brothers Institute
Wright Brothers Institute

Table 2: THE FIVE INDUSTRIAL CLUSTERS COMPARED

THE THREE STAGES OF CLUSTERS

CLUSTER STAGE	DAYTON	DETROIT	HARTFORD	SILICON VALLEY	NEW YORK TECH
First stage	• Little geographical or educational infrastructure present • Cluster emerges with manufacture of simple implements • Key leaders move to Dayton from Ohio region to challenge problems of the age • Cross-border industry network established between Delco and Detroit	• Well-positioned on Great Lakes for industry • Arrival of mechanically adept from Northeast to integrate bicycle and carriage trade for emerging automobile • Intense learning and spin-off activity among firms • Other automobile regions outpaced • Chance convergence of notable personalities	• Cluster emerges with heavy concentration of manufacturing – lessons learned from gunmaking made advanced manufacture possible • Precision metal working industries would account for 12 percent of regional employment in 1880 • Adept at absorbing innovations that arose in other parts of the country	• Universities collaborated with private industry helped high-tech firms flourish • Military contracts helped build key organizations • Early entrepreneurs willing to take big risks for big gains • Emergence of local networks that allow firms to make use of diverse available skills • Out-competes Boston's Route 128 with greater flexibility of structure	• Weaknesses of banking and finance as main industry motivates city to invest in tech • Built tech capabilities on nascent strengths in advertising's use of tech • Well-funded universities and smart public policies will allow tech to flourish in the future • New York City is likely in first stage of cluster development
Second stage	• Dominant business machine design emerges • The NCR way of doing business becomes standard practice throughout the nation; training in Dayton becomes mandatory for many, even if Dayton cluster becomes less important over time • External push of electronics is embraced early on, but fails to influence major change of strategy	• Dominant auto design emerges; growing demand for cars allow for greater integration of production and growth • Mode of manufacture and business practices become standardized, led by General Motors • Major 1950s consolidation of firm numbers • Importance of proximity for knowledge transfer declines (foreign makes set up in other parts of the nation)	• Consolidation of many firms under Pope Manufacturing Co. in becoming the largest bicycle manufacturer in U.S. • Production of steel tubing, rubber etc integrated • Increased competition upon invention of the safety bicycle and Midwest-derived efficiencies of production	• Consolidation of semiconductor industry from mass-producing chip makers results in more diverse spin-offs • Cluster grows to encompass several counties • Silicon Valley likely in second stage of cluster development, before decreased benefits of agglomeration and capital strategy take hold and lead to decline	
Third stage	• Increased standardization of digital point-of-sale retail systems make NCR's mechanical manufacturing irrelevant • Decreased benefits of Dayton cluster with globalization • Internal rigidities do not allow for exploration of new strategies until late	• Like Dayton, Detroit became a mono-structured "company town" unable to adequately adapt to external threats • Lack of diversity to generate new ideas • Lost their ability to adjust to changing environment • Hobbled by recessions and poor product quality	• Major competition from low-cost producers all over country extinguishes bicycle cluster and manufacturing cluster as a whole • Poor transportation links to growing interior population		

Table 3: HOW THE CASE STUDIES AT THEIR BEST FOLLOWED THE GEMS MODEL OF CLUSTER FORMATION AND STABILITY

CLUSTER STAGE	DAYTON	DETROIT	HARTFORD	SILICON VALLEY	NEW YORK TECH
Anchor effect	• Major supplier firms of automotive parts in Dayton anchored by Delco • Influence of NCR on many aspects of life in Dayton	• Oldsmobile first anchor firm in Detroit that led to spin-offs • Thriving cluster of parts suppliers throughout the region	Pope Manufacturing Co. the innovator in bicycles, supporting many suppliers who were eventually folded into the company	• Early semiconductor labs, HP anchors • Outside multinational firms and military • Later influence of Apple in regional app proliferation	• Google a major anchor firm that brought tech to NY • Key local advertising and financial firms were early sponsors of digitization in city
Business climate	Business climate in early period was favourable, with no state income tax until 1926, and relatively light franchise tax on corporations	• Banks quick to finance early auto industry • Auto leaders drove firms to rapid growth and sophistication in spite of sluggish and conservative 'old money' investor families of the city	Typical unregulated business climate of the Gilded Age, creating enormous wealth	• Low marginal tax rate • Climate for risk taking • Business innovation • Results-oriented meritocracy • Open business environment with heavy collaboration	• Entrepreneurs, technologists and corporations increasingly choose NYC as a base • City nurturing talent • Pride in solving real-world problems
Industry networks	• Heavy collaboration among engineering leaders (Dayton Engineering Club) • Many companies linked by auto supply business	Strong linkages between auto makers and suppliers, national dealer network	• Pope Manufacturing Co. developed a sales network that was flexible in weathering slumps • A strong network of suppliers	• Highly-collaborative industry network • Non-proprietary professional + tech information shared • Social meeting of tech • High job mobility	• Many linkages in creative industry • Similar collaborative mindset to Silicon Valley among tech workers
Public policy	Home rule' governance: business leaders reform Dayton's government against corruption and inefficiency	Public policy automobile oriented. Funds directed to the building of expressways to get to factories and the downtown offices	Bicycle and Pope's recommendations helped change public policy in favour of roads for bicycling	California prohibited non-compete covenants in employment contracts; fostered a less loyal, more footloose talent pool that moves fast	NYC fosters initiatives to lessen economy's dependence on finance and bolsters tech programs in New york
Concentration of firms	Heavy concentration of business machine, auto and electronic firms	By 1938, two-thirds of U.S. car makers were headquartered in Detroit	Bicycle makers drawn to Hartford because of its concentration of sophisticated manufacturing technology, skilled labor	Positive agglomeration benefits were quickly realized by tech firms clustering into Silicon Valley	As tech firms continue to increase in NY, the energy of innovation is markedly increasing
Innovation and entrepreneurship	NCR led innovative business, manufacturing, sales strategies, + progressive community spirit, worker support	• High entrepreneurial firms 'put America on wheels' • Huge influence of automotive business and manufacturing practices	Important innovation in precision manufacture that would lead to automobile being possible	Innovative commercialization of tech in the move from transistors to consumer devices	Strong academic, advertising and tech relationships will foster much innovation and entrepreneurship
Historical factors and elements of chance	Meeting of mechanical, electrical and business innovators in Dayton at the time was unique	Automobiles benefited from key personalities that arrives in Detroit, major oil discoveries and the flowering of technical innovations in a K-Spring	Development of bicycles made possible of key learnings from precision engineering elsewhere in America + great advertising insight by Pope	• Chance meeting of tech brought together at Stanford Industrial Park • Government's need for transistor technology to fight Cold War	New drive for tech activity driven by 2008 crash

Memphis, Tennessee
GoNext.com

Source:
The Daily Beast

SCANNING THE PRESENT

A collection of signals, trends, risks and implications bundled into social, technological, economic, environmental and values-based criteria (STEEP-V) can assist the construction of different possible futures for industrial clusters. These signals and trends point to larger critical uncertainties, which will be explored.

SOCIAL

THE OLD CITY AS CLUSTER OF INNOVATION

Where the talent goes: the question to exit the industrial campus for the lure of the hip downtown location

SIGNALS

Source: *Boston Globe*

In 2016, General Electric's headquarters left Fairfield, Connecticut for downtown Boston. The company valued the idea of being near the urban high-tech young ventures and talent in order to become more innovative and digital, while avoiding the dreaded situation of being disrupted. G.E.'s CEO: "I can walk out my door and visit four start-ups. In Fairfield I couldn't even walk out my door and get a sandwich." Talented young people love working downtown, less so the "aging suburban complexes with lots of parking" (Kerr, 2018).

Source: *Linkedin: Chattanooga EPB*

Chattanooga is experiencing a boom in entrepreneurship. Over the past several decades, the downtown particularly has become a lively mixed-use district. Unlike many innovation districts, which have major corporations or research universities as their primary anchors, Chattanooga's energy revolves around EPB, the city's public electric and telecommunications utility, and the Edney Innovation Center, an 11-story building that combines community programming, business services, co-working and private office spaces. The district's vision plan focuses on six key values, including innovation, education, culture and history, public life, and treating the district as an urban lab (Benz, Storring, 2018).

Source: *Commercial Café*

Columbia Gateway, a once-revolutionary suburban park in Maryland, is rejuvenating itself as an innovation hub rather than succumbing to an exodus of workers who prefer walkable, livelier business environments. It's to be a dense mixed-use transit-connected area where startups, institutions and research-intensive corporations cluster together and connect through community-oriented places and programs (Benz, 2018).

Source: *National Trust for Historic Preservation*

Bronzeville, Chicago, has been a tough place to live for African Americans for 80 years. But its proximity to downtown, ample public transit options, rich cultural history, and lakefront access have fueled a resurgence in recent years. Major new developments serve growing demand for housing and affordable retail, while smaller-scale placemaking efforts are helping to support local entrepreneurship, create inviting streetscapes, and enhance public spaces (White, 2018).

Source: *Nationsonline.org*

Columbus, Ohio is being recognized as a successful cluster where many highly-educated people and businesses call home by existing around a good, well-funded university, exhibiting smart urban planning and a welcoming business climate (Smith, 2018). Columbus took the No. 1 spot on *Forbes* magazine's list of emerging venture capital startup cities edging out the more traditional major cities (Yates, 2018).

Source: *City Journal*

Columbus, Ohio is experiencing a form of tech growth with the rise of 'mid-tech' businesses, which may entail intense training but without the need for the kind of skills required in high-flying Silicon Valley. These tech jobs seem to have a lot in common with the older style of blue collar jobs. Mid-tech jobs now compose more than a quarter of all tech employment in major Midwestern metropolitan areas, including Columbus, Ohio; Cincinnati, Ohio; St. Louis, Missouri; Detroit, Michigan; Nashville, Tennessee; and Minneapolis-St. Paul, Minnesota-Wisconsin (Coren, 2018).

Source: *Timeout.com*

Over the last three to five years, there's been a growing buzz in Chicago's technology community — a renewed creative culture is manifesting into global recognition. Among other up and coming cities, a new KPMG report lists Chicago as a contender to be an international hub for innovation because of its talent and infrastructure (Akkawi, 2017).

Source: *WBUR*

Even before its selection of a second headquarters, Amazon in late February added 2,000 jobs to its workforce in Boston, a center of specialized tech workers (Ecker, 2018).

RISKS

For organizations contemplating moving their leaders from the old location to the downtown 'innovation' office, the need to uproot an existing workforce, change legacy customer locations, and establish new local political connections and responsibilities means that any relocation will be disruptive, offsetting the advantages a talent cluster might offer (Kerr, 2018).

While drivers of job growth and revitalization, urban innovation districts tend to reflect the knowledge-based industries that comprise them, and thus often lack diversity in terms of workforce, business ownership, and decision-making (Benz, Storring, 2018).

For all their positive impacts, efforts at "placemaking" (strategies for livable, forward-thinking sustainable business clusters) are constrained by policies, practices, and investment structures that are failing to keep pace with the changing needs of firms, institutions, and workers, hampering the scope and scale of their impact.

Local and regional planning organizations may advocate for transportation, economic development, and land use policies and investments to support existing economic districts. But in practice, these investments are often more reactive than strategic, triggered by government or philanthropic programs — like Enterprise Zones, Promise Zones, and most recently, Opportunity Zones — or by private firms, anchor institutions, or other organizations looking for a development site. Add to this mix the competition for resources and revenues among and within jurisdictions, and you get the sort of scattered, transactional, and uncoordinated development projects that don't "add up," in form or function, in ways that help achieve larger economic goals. Further, when public and private sector leaders do more strategically prioritize place-based investments, they often focus on either mitigating the symptoms of entrenched poverty, or on attracting "talent" from out of town. In neither case is inclusive economic growth — that is, business and job growth that benefits everyone — the main objective (Vey, 2018).

Companies may overinvest in downtown locations and be at risk of having to pull out for the same reasons that former talent hot spots have deteriorated in the past (Kerr, 2018).

Ideas generated within the urban talent hub may fail to spread to the rest of the organization (Kerr, 2018).

Ill will generated both from the location the head office is moving from, but also from the new location where the organization might have sought excessive tax breaks (Kerr, 2018).

Talent may flow into an organization in a new creative urban hub, but it can just as easily flow out of the organization and into neighboring competitors or other businesses (Kerr, 2018).

Clustering of companies and talent in urban areas can generate distinct winners and losers both across and within cities and metros. The wage gap between creative and routine workers — and between creative and routine metros — has increased considerably over time (Florida, 2016).

Increased cost of living: fast rising food prices, utility costs, basic services, costs of housing and rental. Addressing these concerns is a major priority for future growth and prosperity of the urban innovation hub (Engla, et. al, 2018).

MATURITY

Emerging

Over the last 20 years, downtown centers have accounted for considerably more tech hires in metropolitan areas, compared with their smaller influence two decades ago. Cities like Columbus have seen impressive growth via tech cluster activity over the past two years. Also, for the first time since 2011, net domestic migration in Silicon Valley was negative, meaning that more Silicon Valley residents left the region for other parts of the U.S. than arrived from other parts of the U.S. (Reback, 2017).

Essex Crossing, Lower East Side, Manhattan, New York City: a mix of housing, retail, entertainment, food, job training and office space that will serve both low income people who live there and newcomers to the area.
SocoalWorkDegreeGuide

IMPLICATIONS

More formerly-suburban companies will move to urban centers to take advantage of a technologically-fluent workforce and get in front of potentially disruptive futures or have a better vantage of new advances; they will find the move very expensive unless city centers can manage the resulting density of activity and stressors on relevant elements of its infrastructure. Businesses will feel pressured to relocate their headquarters, or set up urban innovation labs where organizations small and large will act like innovation start-ups, which will be a major challenge for some.

The best talent may appreciate centers of work where there are industry-academic partnerships that satisfy the curiosity of the brightest creative workers. All regional economies will continue to face global competition to attract entrepreneurs and create jobs, and will have to find new strategies to kickstart their own innovation economies that mean vibrant social cultures of investment and national and global leadership.

Robots and AI will continue to become a part of the daily lives of people, and its implications for industry clusters in urban environments will have influence relative to the kinds of jobs that can make valuable use of the technology. Perhaps those that can make valuable use of strategic skills and can evolve their skill set quickly will have a more positive experience with AI, while tech workers/routine workers who are less at the forefront of policy making or invention/innovation activities (and perhaps less frequently living in the downtown innovation hub) will have an uneasy relationship with AI (Florida, 2018).

Emerging development of denser, more creative downtown holds promise for improving accessibility, fostering increased sociability and civic engagement, while generating job growth and innovation. Leaders in urban, suburban, and rural communities are understandably hungry to better understand and harness the forces behind them to benefit more people and places. They are seeking strategies that scale beyond individual lots or blocks to reinvigorate arts and creative districts, university and medical districts, suburban business parks, Main Streets, and other economic districts. And they want to employ those strategies in ways that help strengthen the broader regional economy and ensure that all citizens can participate in its growth (Vey, 2018).

Globalization will see two sides: the geographic spread of routine service and manufacturing work in some regions, and a smaller number of high-level clusters where the creative and ambitious flock to achieve success in design, finance and media (Florida, 2008)

TECHNOLOGICAL

FURTHER WEALTH/FURTHER DAMAGE: ROBOTS AND AI ARE ON THE VERGE OF BRINGING ABOUT THE NEWEST SHIFT IN INDUSTRIAL CLUSTERS

The growing ubiquity of robots will transform industry in both tech and legacy industrial clusters. Will robotics correct or reinforce America's growing spatial inequality?

STEEP-V

SIGNALS

Source: *Mediapool.bmwgroup.com*

The U.S. is still the leader in robotics innovation, but applications of robotics and AI are coming from around the world. At a 2017 robotics exhibition, the sheer number of exhibiting companies with "Shenzhen" in their name indicates that China is deadly serious about taking the lead of the consumer electronics industry. But South Korea, Japan, Taiwan, France, Israel, and a host of other countries are just as eagerly working to find their own niches in AI, robotics, and related technologies (Demaitre, 2017).

Source: *RoboticsBusinessReview.com*

New offerings from robot manufacturers are making the process of buying and setting up robots easier than ever. The online marketplace used in combination with a variety of third-party hardware and software platforms offer flexibility that can make the process of adopting and implementing automation easier for manufacturers across a variety of industries. These robots can be customized for multiple jobs during their lifespan, helping smaller companies just getting into automation, providing much more security than a larger robot installation whose an upfront price tag may be a hindrance to its implementation (Wagner, 2017).

Source: *Financial Times*

A new *Regional Studies* paper shows that half of the 30 robotic regions in the U.S. are in Rust Belt metros, lead by Detroit, Chicago and Boston (care of MIT research), with a few smaller metros in Ohio, Iowa and Colorado having high concentrations of robotics for their size. Places that serve as robotic integrators (designing and implementing robotic systems) are also old Rust Belt manufacturing hubs. TIn Shanghai, a massive new container port has already eliminated 70 percent of the labour costs associated with older facilities (Lorinc, 2018).

RISKS

There is little evidence of a rise of tech centers anywhere in the U.S. other than a narrow group of cities, while other parts of the world are stepping up, partly as a result of the exclusionary and anti-innovation policies of the Trump administration, which may have lasting effects. The rise of the rest of the world is the biggest challenge to America's dominance in decades (Florida, 2018).

MATURITY

Growing
In the way of Moore's Law, robotics are becoming more complex and at the same time cheaper, making them increasingly attractive to many types of manufacturing businesses. Aided by a growing presence of robotics industries and innovation happening throughout the world, the influence of robots is steadily growing.

IMPLICATIONS

Automakers are turning to new suppliers that employ data analytics to identify components at risk of failure. Faulty parts are yanked off the line before they can be installed. All this happens remotely, with clients simply subscribing to the system, which analyzes a continual flow of data transmitted from factory floors. It is part of a vast machine of connected technologies collectively dubbed Industry 4.0, which entails data analytics, AI, and wireless connectivity (Lorinc, 2018).

Digital technologies can reap huge rewards. Cities that mastering AI can enable industrial-equipment manufacturers to boost their market capitalization by as much as 25 percent (*Business Wire* 2018).

Although the automotive industry has been using robots for decades, the rise of collaborative robots or cobots has made automation more flexible and useful to small and midsize enterprises (*RBR Insider*, 2018). Multiple industries can benefit from adoption or expansion of automation, but only if they understand their own processes and needs and can work well with partners (*RBR Insider*, 2018).

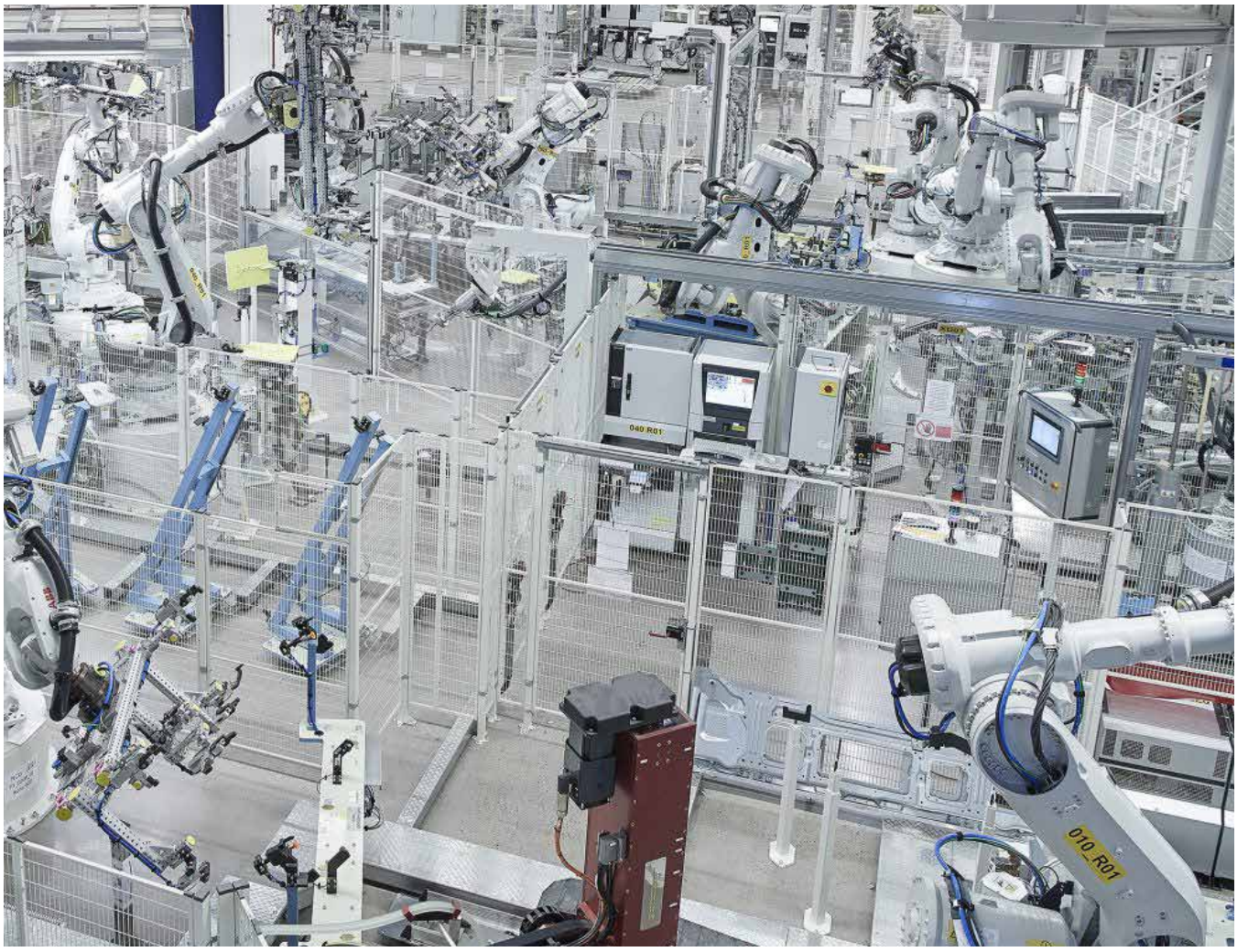
The future may still favour the human mind, as most jobs consist of multiple sub-sets of tasks from different domains, requiring a multitude of skills. A job could require communication, numerical calculations, logical reasoning, data aggregation, analytics, creativity, social skills, dexterity, processing of auditive, olfactory or visual stimuli and much more. Balanced automation will progress slower and will not be as disruptive as currently predicted (Weber, 2018).

Our society could also shift away from its technological innovation trajectory, because of potential resource scarcity, pollution, conflicts or other external influences. Cultural change would not be as fast as technological transformation (Weber, 2018).

Another direction could involve a general use of widespread planned automation, where a great many tasks are recognized by the general public to be better when automated, while many human-only experiences are still valued. An alternative political, social and economic system, which is compatible with the future status quo (Weber, 2018).

A more dramatic scenario would be rapid automation, where human labour and our value system, as capitalism as an underlying theory for innovation might be called into question. In the case of full-automation, corporate monopolies that will have created these automated systems or amassed the most data, would eventually aggregate power and money, while breaking the logical implication from productivity gains to higher wages, because there would not be enough human jobs. In consequence the driver of growth, consumption, would be inhibited. Social inequity in the extreme or a universal basic income could be a way of life (Weber, 2018).

Scania of Sweden's new generation of trucks will be built care of the company's biggest industrial investment of the past two decades. The world's most modern cab factory is manned by 283 new, high-tech robots.
Scania



ECONOMIC

FIGHTING OLIGOPOLY WITH DISPERSED CLUSTER SUCCESS

The trends seem to point to a small number of financial and business groups reaping all the rewards in the tech center, but a few cities are forging an alternate path to thrive.

SIGNALS

STEEP-V

Source: *Cicpindiana.com*

Central Indiana Corporate Partnership has developed six talent and industry sector initiatives that focus on a combination of interventions to kickstart clusters of innovation in Indiana, including talent development; technology development; capital provision; district/infrastructure development; and research, information provision and education (Parilla, 2018).

Source: *YouTube: Tesla Model S Problems*

Tesla is in retreat, shuttering most of its stores in a bid to cut costs. Expecting a loss in its first quarter, the company is jarring investors' faith in the firm and its founder. It seems as if the Tesla board is letting Elon Musk wing it. Tesla has also laid off 7 percent of its work force in January, 2019, the second job cut in the last eight months. Profit margins on the new Model 3 are close to zero these days (Boudette, 2019).

Source: *Flex.com*

"I was just talking to an executive at Flex, which is in Michigan, and they're hiring 250 folks in Detroit. The software company basically is a cloud computing company that allows manufacturers to be more productive because they allow manufacturers to be on the cloud [just in time]. That's an example of a technology that's helping create jobs in Michigan. Talent isn't just concentrated here in Silicon Valley."
– *Silicon Valley Congressman Ro Khanna* (Recode, 2017).

Source: *Wikipedia: Rust Belt*

A new set of understandings and policies is needed to push back against today's epidemic of divergence geographic economic success and to knit the country back together. Scholars, journalists, politicians, local leaders, and investors are all beginning to reassess the costs of inaction. No longer does nonchalance about the pulling away of "superstar" cities and the decline of "left-behind places" seem tenable (Galston, Hendrickson, Muro, 2018).

Source:
Washington Examiner

General Motors announced Monday that it planned to idle five factories in North America and cut roughly 14,000 jobs in a bid to trim costs. It was a jarring reflection of the auto industry's adjustment to changing consumer tastes and sluggish sales (Boudette, 2018).

Source:
The Business Journals

North Texas has risen to become one of top U.S. data center markets. North Texas area has made inroads in this sector, it is located in a central time zone, is not coastal, and there is technically no seismic activity. Also, this area is not prone to large-scale flooding or weather extremes. Many applications needed for business, commerce, industry, and social media all compute from these platforms, much like when a large corporation relocates a major headquarters or manufacturing operation to the region, other companies that supply to, and benefit from, the presence of the large installation are lured here as well (Kirkpatric, 2018).

Source: *FEE.org*

The artificial intelligence computer scientists working on the self-driving car have an average salary at Google of $345,000. It is very difficult holding onto specialists with expertise in a market the big five tech companies are interested in controlling. Today, the number of new tech businesses is at a 30-year low. Oligopolization has set in, and it's fair to assume that some of those new businesses that the big five's anti-competitive behavior is keeping locked out of the market would have been born in metros less expensive than San Francisco, Boston, or Seattle. Instead, as there are fewer and fewer tech IPOs and more and more acquisitions by the big five, it seems as though many start-ups angle to be acquired by those super-rich companies located in those super-rich metros (Ecker, 2018).

Source: *GeekWire*

Since 2010, Seattle's growth has outpaced that of any other of the nation's 50 largest cities, even sprawling Sun Belt powerhouses like Austin, Texas. Seattle is a major technology cluster, which creates high-paying jobs for knowledge workers. The inflows of money to the tech industry spill over into a huge variety of local services — everything from food to law to health care and real estate — and generates plenty of work even for those who aren't engineering whizzes. That positive dynamic drives demand for residency in Seattle (Smith, 2018).

RISKS

As housing costs rise, routine workers — especially those in routine-in-local jobs — are shunted off to less expensive metros which, by definition, have smaller concentrations of higher-paying creative-in-traded jobs. This creates a vicious cycle in which the advantaged become more advantaged over time, while the disadvantaged sink further into poverty (Florida, 2016).

General Motors announced Monday that it planned to idle five factories in North America and cut roughly 14,000 jobs in a bid to trim costs. It was a jarring reflection of the auto industry's adjustment to changing consumer tastes and sluggish sales (Boudette, 2018).

Austin, Texas, which now has a successful tech cluster, is like Silicon Valley seeing a challenge in facing an increased cost of living — fast rising food prices, utility costs, basic services, costs of housing and rental. Addressing these concerns is a major priority for future growth and prosperity of this urban innovation hub (Berbegal-Mirabent, Engel, Pique, 2018).

Using tax incentives to try to poach companies from elsewhere tends to weaken communities' tax bases, while any growth benefits are zero sum, at least in economy-wide terms (Irwin, 2018).

MATURITY

Emerging
The world seems to be growing to the idea that Silicon Valley as the all-important tech cluster without equal will come to an end in a number of years. Other cities both in the U.S. and the world will show that different cultures and different forms of building innovation will prove resilient and will demonstrate competitive success.

IMPLICATIONS

Regions can improve their economic performance by improving its existing assets, rather than attempting a transformation by chasing industries situated elsewhere (Dizikes, 2014).

"Policymakers can use analytics to understand what their sources of relative advantage are," Stern says. "And while they, of course, want to avoid picking winners and we want to let a lot of experimentation flourish, we can prioritize those activities that leverage the things about our regions that are unique, distinctive, and meaningful. That leads to a

smarter type of economic development than simply chasing the next big thing"(Dizikes, 2014).

Taking a longer view of cluster development makes it easier to see beyond clusters as self-contained and localized to their more nuanced role as interactive spaces that foster communication and collaboration between foreign and local organizations and individuals and enable the integration of developing countries into the global economy (Hannah, 2017).

Universities need to be leveraged better — to make them healthy, and upgrade the ones that need upgrading, and make them more research focused (Irwin, 2018).

An overhauled immigration policy to help attract more people with advanced skills, especially to struggling regions, and changes to labor laws such as banning the "non-compete" clauses that make it hard for people to switch jobs (Irwin, 2018).

The lack of quick and plentiful funding for digital startups in cities like Chicago may serve as a helpful constraint that can guide disruptive innovators and cut through the noise. These alternative visions are shaped by demand, not investors. The tech industry is calling for a culture of substance, and the timing might be right for the value-driven culture of Chicago and other cities to step up to the plate. The stress of running a company without customers — the Silicon Valley way — is seen as a distraction that gets in the way of real value when profit is seen as a guide to innovation (Akkawi, 2017).

What is the economic future for a Hartford or Akron or Tulsa or the countless smaller towns and rural areas that didn't get so much as a serious look from companies like Amazon? They will still need heavy investment in digital skills, even in areas without a large existing high-tech sector. New channels will need to be in place to ensure that businesses in struggling areas have access to capital, including small-business lending from banks and venture capital for start-ups (Irwin, 2018).

The recent spate of auto plant closures poses a tough challenge for policy-makers who could be faced with a radical reshaping of the labour market, a business-as-usual scenario, or anything in between. Yet, the Oshawa plant closing reminds us that these conversations shouldn't default to a "wait-and-see" approach, which won't help workers who are in need of better supports right now. Instead, there's a growing international consensus that governments must focus on overhauling skills training for adult workers who might face multiple job transitions (Johal, 2018).

ENVIRONMENTAL

CREATIVITY, CAPITAL, TOXIC WASTELAND

It's now clear that environmental degradation, along with other excesses, is now part of the story of Silicon Valley.

SIGNALS

STEEP-V

Source: *U.S.News.com*

Although air pollution from traffic congestion and sprawl is the most visible environmental problem caused by Silicon Valley, there are others, including groundwater plumes of solvents that have moved under working-class housing areas near industrial zones. These plumes of solvents migrate to working-class neighborhoods and communities of color to be far more exposed to pollution than whiter and wealthier areas (Ottenberg, 2018).

Source: *Daily Sabah*

Saudi Arabia's alleged involvement in the disappearance and possible murder of a dissident Washington Post columnist is putting Silicon Valley in a difficult position, with potentially billions in business deals at stake. Rep. Ro Khanna (D-Calif.), whose district includes Silicon Valley, specifically called out the tech sector for taking money from Saudi Arabia given its record of human rights abuses (Neidig, 2018).

Source: *Truthout*

In addition to an incoming tidal wave of middle- and working-class residents fleeing sky-high housing costs in Silicon Valley, the Central Valley absorbs emissions from mammoth traffic jams to the west. The resulting sprawl pays its real estate investors, delivering profits through property investment and capital accumulation, rather than fulfilling the American suburban dream. Property capital aims to stretch suburbia as far as possible, with the highest profits come from land value appreciation, not from building houses (Ottenberg, 2018).

Source: *SumOfUs*

Silicon Valley is now one of the leading generators of inequality. The housing crisis is becoming an embarrassment, with hundreds of thousands of people being priced out of the city and having to move either far out into the Central Valley, where they are 100 miles away from the center, or they give up and go to Las Vegas or Reno or Oregon, or wherever the possibilities seem better for ordinary working folks (Florida, 2018).

MATURITY

Growing

The environmental and human costs inherent in Silicon Valley are beginning to be acutely felt, and will increase until there is either a major change in infrastructure or ultimate and long-term deflation in the tech industry and the Bay Area.

IMPLICATIONS

Given how much warming is already locked in, green tech can only accomplish so much. Tech titans may find it hard to accept abandoning estates to wildfires or office parks in low-lying areas to floods, but climate change will not spare them. They do, however, have the political and economic clout to blunt its effects. If they wanted, they could promote smarter building, smarter development and a more thoughtful use of resources. So far, however, the will for this has been lacking, leaving capitalism's prized tech empire belching out air pollution and exposed to fire and flood (Ottenberg, 2018).

Towns that want to become successful clusters will want to take heed of the unexpected environmental problems that resulted from Silicon Valley's explosive growth and plan for transportation and housing accordingly.

Silicon Valley through the smog
Medium Corporation

POLITICAL

SCRAMBLING FOR THE LOCAL TEAM: POLITICIANS GAMBLE ON THE TICKET FORWARD

In the face of federal uncertainty, luring the biggest tech companies to a home town is risky political business, and it can ultimately sell a town short.

SIGNALS

STEEP-V

Source: *Baltimore Sun*

In 2017, Howard County in Maryland was among the many jurisdictions criticized for offering undisclosed — but presumably generous — tax incentives for Amazon to relocate to their city (Benz, Storring, 2018).

Source: *Norface*

With the federal government mired in gridlock and hyper-partisanship, local leaders are stepping up to advance solutions to their unique economic, social, and environmental challenges. As a result, the public maintains high trust in local government while its faith in federal institutions has eroded dramatically (Vey, 2018).

Source: *Washington Examiner*

Trump administration's immigration policy has threatened the livelihoods of tech workers and researchers in the US. The restrictions introduced make harder to recruit and retain top talent from abroad, being particularly troublesome for the U.S. tech-hub — circa 71 percent of tech employees in Silicon Valley are foreign-born and 43 percent of Fortune 500 companies in 2017 were founded by immigrants and their children. Almost half of Fortune 500 companies were founded by American immigrants or their children (Berbegal-Mirabent, Pique, 2018).

Source: *Chicago Tribune*

Cities from Memphis to New York to a small community in Georgia that offered to rename itself after Amazon are offering billions in subsidies and whole departments of city employees dedicated just to servicing Amazon's needs in the hope of becoming home to Amazon's "HQ2." Larry Hogan, the Republican governor of Maryland, offered Amazon $5 billion in incentives and called HQ2 "the single greatest economic development opportunity in a generation" (Ecker, 2018).

RISKS

More public transport and funding in Silicon Valley is needed and it's being blocked by the Republicans in California in the administration.
— Silicon Valley Congressman Ro Khanna (Recode, 2017)

The "spiky, unequal" cycle in which the advantaged (higher-paying creative-in-traded professionals) become more advantaged over time, while the disadvantaged (routine workers) sink further into poverty provides a substantial challenge to local and national policymakers (Florida, 2008).

A sense of unfairness can become a major issue for other businesses and some taxpayers upon learning that city officials have promised over-the-top financial rewards that other businesses would never get in luring a huge company like Amazon to set up there (Florida, 2018).

IMPLICATIONS

Governments should subsidize more independent multi-disciplinary research evaluating ethical, social, legal, environmental and technological implications of future automation, while developing ideas for solving issues that might arise (Weber, 2018).

Smart policy, using tools both from America's own experience and from models in other countries, can help alleviate the pain and spread some of that prosperity — but only if voters demand that elected leaders choose to do so (Ecker, 2018).

Source:
Brookings Institute

VALUES

LEAVING THE VALUES OF SILICON VALLEY BEHIND

From disaffected former residents of Silicon Valley to longtime citizens of far-away locales in-the-know emerges innovation hubs that offer more than quick riches and excess

SIGNALS

STEEP-V

Source: *CNBC*

Recently, Peter Thiel, the President Trump-supporting billionaire investor and Facebook board member, became Silicon Valley's highest-profile defector when he reportedly told people close to him that he was moving to Los Angeles full-time, and relocating his personal investment funds there (Founders Fund and Mithril Capital, two other firms started by Mr. Thiel, will remain in the Bay Area). Mr. Thiel reportedly considered San Francisco's progressive culture "toxic," and sought out a city with more intellectual diversity (Roose, 2018).

Source: *Austin-American Statesman*

Apple's recent announcement that it's building a new $1 billion campus in Austin, Tex. adds momentum to the trend among tech startups and investors to look beyond Silicon Valley to incubate and grow the next generation of innovative companies. Moreover, in what amounts to doubling down on its satellite strategy, Apple also said it will establish new sites in Seattle, San Diego, and Culver City, Calif., as well as expand in cities across the U.S., including Pittsburgh, New York, and Boulder, Colo. over the next three years — welcome economic boosts for those areas (Shipley, 2019).

Source: *The Oklahoman*

"We don't believe in raising a lot of cash early on and then throwing all that money at the problem of not having a business model until somehow everything starts to work." says Tailwind Founder and CEO Danny Maloney, who moved out to Oklahoma City to launch the business. He had to fight back against investor doubts about their location before getting funding. He did just that. "They said we had to prove it to them we could be successful from here" (Reback, 2018)

Source: *Al Jazeera America*

"How could you have this gross inequality, how could you have so many working people earning minimum wage? A quarter of them are earning minimum wage; a third of them can't earn a living wage. And then the homeless situation is just beyond immoral. Perhaps the most disgusting homeless situation anywhere in this pretty heartless country."
— Author Richard Walker of San Fransisco in conversation with Richard Florida (Florida, 2018).

RISKS

But tomorrow, will the Gateway cluster development still be able to retain and cultivate this center of employment and innovation in a landscape where its firms and workers demand a more dynamic, urban environment? (Benz, Storring, 2018).

To what extent do concerns about localized gentrification distract from the potential of inclusive citywide economic growth? This question is especially hard to answer when an innovation district is young, and the upsides uncertain (Benz, Storring, 2018).

MATURITY

Emerging
As the influence of Silicon Valley begins to wane and frustration of those who live there makes them look to other locales for a future that is more livable, the positive traits of many other cities are becoming more apparent.

IMPLICATIONS

The coming years will likely prove that culture is a consideration that lies deeper than excitement generated around the quick establishment of a tech cluster or the explosive growth of a particular startup (Akkawi, 2017).

This evolution of remote workers (as opposed to gathering daily in a geographic cluster) will create both opportunities and challenges for communities throughout the U.S. — to provide both the education and quality-of-life options that top tech companies will require as well the infrastructure to make productive remote working possible (Shipley, 2019).

CRITICAL TRENDS AND UNCERTAINTIES

THE EVER-CHANGING GEOGRAPHY OF CLUSTERS

Over the last 20 years, the downtown centers of choice cities have accounted for a great percentage of more in-demand tech hires, compared with the influence of these centers two decades ago. Cities like Columbus, Ohio, have seen impressive growth via tech cluster activity over the past two years. Growth in Silicon Valley, on the other hand, seems to have gone in a different direction. For the first time since 2011, net domestic migration to the Bay Area was negative, meaning that more Silicon Valley residents left the region for other parts of the country than arrived from other regions (Reback, 2017). The impulse for millennials to work in vibrant urban areas — with their inner-city atmosphere, walkable areas and amenities — will continue at the expense of the prevalent (and aging) corporate suburban complexes. For organizations contemplating moving their leaders or skilled employees to a downtown 'innovation' office, there are ba few important factors to consider. Uprooting an existing workforce or changing legacy customer locations and other elements of an existing cluster could mean that relocation will be disruptive, possibly offsetting the advantages of a move to the more exciting environment. Additionally, ideas generated within the urban talent hub may fail to spread to the rest of the organization. Additionally, talent may flow into an organization in a new creative urban hub, but it can just as easily flow out of the organization and into neighboring competitors or other businesses. The poor alternative, however, is to be disrupted by the decampment of employees looking for the more dynamic working environment of downtown (Kerr, 2018).

A newer generation of workers will be enthusiastic about centers of business that engage in what is known as "placemaking", that offer greater community engagement, better health and other forward-thinking considerations for an improved quality of life (Vey, 2018). However a significant number of people returning to the old urban centers could make excess urban density a problem once again. Placemaking can also be restricted by policies, practices, and investment structures that are failing to keep pace with the changing needs of firms, institutions, and workers, hampering the scope and scale of their impact (Vey, 2018). For example, local and regional planning organizations may advocate for transportation, economic development, and land use policies and investments to support existing economic districts. Ostensibly created to trigger growth, government or philanthropic programs or private firms, anchor institutions, or other organizations looking for a development site may be reactive rather than strategic. With competition for resources and revenues among and within jurisdictions added to the equation, the result can be scattered, transactional, and uncoordinated development projects that do not add up in form or function in ways that help achieve larger economic goals.

Inclusive economic growth in another important uncertainty. In Silicon Valley, the feeling of "scraping by on six figures" has become common for tech workers who feel poor in the tech bubble (Reback, 2017) with the increased cost of living that equates to fast rising food prices, utility costs, basic services, costs of housing and rental. Addressing these concerns is a major priority for future growth and prosperity of the urban innovation hub (Engel, et. al, 2018). The urban clustering of talent can instead result in a zero-sum situation of regional winners and losers. The wage gap between creative and routine workers — and between creative and routine metros — has increased considerably over time (Florida, 2016). The "blue-collar" tech worker that supports the forward-moving leaps of the tech trailblazer could be a promising future for many in cities like Columbus, Ohio, where a comfortable middle-class life is a possibility, or in Seattle's plan for increasingly dense and numerous dwellings. Everyone appreciates centers of work where there are industry-academic partnerships that satisfy the curiosity of the brightest creative workers and offer a way up for those who want to get out of the routine.

How does a city or region build an innovation hub where more than few can afford to live? Can Seattle provide the answer in their opting for density in their technology cluster planning? If so, cities will have to demonstrate a sustained commitment to building housing at a rate that is greater than their scope would ordinarily allow. Technology workers will make their homes there, but so will those not employed in tech (or so-called 'blue collar tech'), who will likely be able to afford less than their high-tech counterparts and will benefit from rent that can be held down at reasonable levels (Smith, 2018). As a city that is growing at a rate that exceeds 50 of the country's largest cities (including Sunbelt successes like Austin), Seattle's ability to generate considerable opportunities even for those who aren't engineering or tech standouts can be a lesson for other cities (Smith, 2018). This will be important as the largest companies move more of their operations to downtown areas. Innovation districts tend to reflect the knowledge-based industries that comprise them, and thus often lack diversity in terms of workforce, business ownership, and decision-making — which leads to patterns of low affordability (Benz, Storring, 2018). Developments like Columbia Gateway in Maryland seem to be leading the way in their dense, mixed-use, transit-connected area where startups, anchor institutions, and research-intensive corporations cluster together and connect through community-oriented places and programs (Benz, 2018).

Source:
Brookings Institute

ROBOTS AND AI ARE ON THE VERGE OF BRINGING ABOUT THE NEWEST SHIFT IN INDUSTRIAL CLUSTERS

Though the U.S. is still the leader in robotics innovation, robotics and AI will likely find a significant niche in multiple countries, while indications point to China in taking the lead in all things electronic. The healthcare, consumer, and manufacturing industries in particular will be big potential users of robots and AI, which will bring robotics partnerships, mergers and acquisitions (Demaitre, 2017). For all the jobs that robotics purportedly eliminate, it should be noted that regions in the U.S. where much of the manufacture of these robots occur are in Rust Belt metros, lead by Detroit, Chicago and Boston, with a few smaller metros in Ohio, Iowa and Colorado having high concentrations of robotics for their size. Places that serve as robotic integrators (designing and implementing robotic systems) are also old Rust Belt manufacturing hubs (Lorinc, 2018). Could this lead to a scenario where those skilled in designing the future live in cities, while the manufacture of the machinery that will build this future can continue in the Rust Belt? If this is possible, it may lessen the continuing upheaval resulting from the severe 'spikiness' of the mega city as center of innovation, surrounded by the constrained, routine workforce that Richard Florida indicates is the possible future of lopsided regional progress.

Moore's Law holds that robotics follow a trajectory of becoming concurrently ever-complex and cheaper, making them increasingly attractive to all levels of manufacturing businesses. When combined with mobile computing and big data analytics, robotics and AI will transform not only strategies central to business operations, but also worker and customer experiences — and ultimately business models. The manufacturing process has always been subject to large-scale change, having been influenced so completely by productivity-enhancing innovations of the past. It is estimated that AI will make a quarter of all factory tasks automated by 2030. An automotive think tank at the University of Waterloo sees the age of "light out" factories in the future, with no workers at all. An autonomous truck would simply back up to the loading bay, and robots load or unload the vehicle (Lorinc, 2018). The switch to "Industry X.0" — a vast machine of connected technologies — is already being practiced by many companies attempting to keep up with the changing digital landscape. Getting it right is challenging — but the strong business case of data analytics, AI, and wireless connectivity makes it compelling to progressive businesses (*Business Wire,* 2018).

Researchers suggest global spending on these technologies will be more than $200 billion (US) in the next five years (Lorinc, 2018). Mastering AI can enable industrial-equipment manufacturers to boost their market capitalization by as much as 25 percent (*Business Wire* 2018). Suppliers can also harness data analytics, and those that can identify components at risk of failure will be favoured by automakers in particular. Multiple industries can benefit from adoption or expansion of automation, but only if they understand their own processes and needs and can work well with partners (RBR Insider, 2018). Though the areas of the U.S. Rust Belt where robotics are being manufactured is notable, the tech centers where applications are envisioned exist only in a narrow group of cities. At the same time, other parts of the world are stepping up, partly as a result of the exclusionary

and anti-innovation policies of the Trump administration, which may have lasting effects, especially on start-ups that heavily rely on international talent. Though the U.S. remains the world's leading center for venture capital, trends from the past few years show the U.S. share of total venture capital investment has declined from roughly 70 percent in 2012 to slightly more than 40 percent in 2017. Meanwhile, the Asia-Pacific region has seen tremendous growth in venture capital funding, increasing its share from about 14 percent to nearly 40 percent. The rise of the rest of the world is the biggest challenge to America's dominance in the coming decades (Florida, 2018).

To what extent will the future favour the human mind? The complex tasks for the future will likely require multiple skills from different domains — skills of communication, logical reasoning, analytical skills, dexterity and visual stimuli among others. For these reasons, many have the view that automation will progress slower and will not be as disruptive as currently predicated. There could indeed be a cultural shift away from the dramatic forward momentum of technology, with potential resource scarcity, pollution, conflicts or other external influences necessitating a leveling of tech's trajectory. Conversely, a widespread use of planned automation would accept that many tasks are better off automated, while at the same time valuing many human-only experiences (like many kinds of human-centered services). An example of a dramatic scenario would bring rapid automation and a questioning of values — like those of capitalism and innovation. In a world of full automation, Viktor Weber, writing for the World Economic Forum, has the opinion that "corporate monopolies that will have created these automated systems or amassed the most data, would eventually aggregate power and money, while breaking the logical implication from productivity gains to higher wages, because there would not be enough human jobs. In consequence the driver of growth, consumption, would be inhibited. Social inequity in the extreme or a universal basic income could be a way of life." Governments should subsidize more independent multi-disciplinary research evaluating ethical, social, legal, environmental and technological implications of future automation, while developing ideas for solving issues that might arise (Weber, 2018).

Source:
Car Magazine;
Brookings Institute

PUSHING AGAINST OLIGOPOLY AND DISPERSED CLUSTER SUCCESS

Many small towns have had enough of being left behind while superstar cities take the future into their hands. An outbreak of new thinking seems to be raising the possibility of a response. The need for new policies is at the forefront of this thinking in pushing back against the extreme geographic divergence of economic success in the U.S. Scholars, journalists, politicians, local leaders, and investors are considering the cost of decades of inaction, and realize that "left-behind places" are no longer tenable (Galston, Hendrickson, Muro, 2018). The decision of tech companies to open headquarters in centers like New York and Washington demonstrates that struggling cities cannot expect a single big gift from technology leaders that will ease their hardship (Irwin, 2018). New strategies need to be taken up so that the country's employment gains can spread to new places other than New York, Boston, the Bay Area, Seattle, and Washington, D.C., along with fast-growing Sunbelt areas like Dallas, Atlanta, and Orlando (Vey, 2018). At the same time, recent developments suggest that large tech companies may not have free rein to preside over a workforce of city people willing to go along with inequitable policies, no matter the firm's hold on the public's hearts and wallets.

The big coastal cities that are drawing in much of the tech investment have limits to their viability. In February, 2019, Amazon indicated that it would pull out of an agreement to build a large corporate campus in New York when it encountered political resistance to Jeff Bezos' lack of recognition towards unions and the expansive tax breaks that were promised by New York's governor and mayor which drew the ire of many in the state as a proclivity towards more socialist policies becomes popular (Goodman, D, 2019). Though it may reflect a political failure on the part of officials who wanted opportunity for their region, it also "reflects the hubris of one of the world's most valuable companies, which sought billions of dollars in tax incentives it didn't need, and then got cold feet when local organizers and officials objected to that largess." It also shows that making customers happy alone may not be enough to succeed when a firm is up against political resistance or criticism over corporate shortcomings (Roose, 2019).

Cities may in the future be more likely to disregard the concessions to large oligopolies in what is now seen as a race to the bottom in an effort to be one of the few who are chosen as headquarters or major satellite. Instead, it is argued that a region can improve its economic performance by improving its existing assets, rather than attempting a transformation by chasing industries situated elsewhere. Analytics can be used to understand what their sources of relative advantage are, while giving prioritized allowances for experimentation for those activities that leverage that which is unique, distinctive, and meaningful. This leads to a smarter type of economic development than simply chasing the next big thing (Dizikes, 2014). Taking a longer world-view of cluster development makes it easier to see beyond clusters as self-contained and localized to their more nuanced role as interactive spaces that foster communication and collaboration between foreign and local organizations and individuals and enable the integration of developing countries into the global economy (Hannah, 2017).

Part of the crisis of capital that Silicon Valley is facing is socially-derived. Developer-turned celebrities have centered around increasingly superficial social novelties — and have possibly lost what once made the Bay Area a center of important innovation — while other cities are filling the gap to produce more pragmatically important innovations. Will older cities take back the mantle of being the nation's innovation hubs by catering to capitalists who require a more traditional quick cash-flow return on investment? Silicon Valley, in contrast, has been content to wait years to amass an uncertain customer base for an innovation before realizing profitability (Akkawi, 2017). Today, the number of new tech businesses is at a 30-year low; there are fewer and fewer tech IPOs and more and more acquisitions by the big five (Ecker, 2018). If oligopolization has set in, is there enough opportunity for smaller startups that have a chance of competing against the big five tech companies to be able to get a foothold without being bought up right away, or be crushed? We are entering a "third wave" of venture capital funding in tech companies, according to the Startup Ecosystem report. The first wave of tech startups were the original gateways to the internet, like AOL and Netscape; the second wave consisted of social media companies like Facebook and Twitter. The third wave, according to the report, will be defined by sophisticated "deep tech" firms, specializing in fields such as artificial intelligence and blockchain (Florida, 2018).

Like tech, finance also tends to cluster. As the banking industry has become more concentrated, more and more of its wealth has been located in select areas. The five largest institutions now have nearly 50 percent of all banking assets. And while there are financial services operations scattered throughout the country, they are often badly-paid back-office operations. As bankers cluster around New York, Midwestern and rural America have fewer small, regional banks geographically proximate and culturally sympathetic to the small businesses that need investment and lines of credit (Ecker, 2018). Areas that are not obviously candidates will still need a heavy investment in digital skills, even in areas without a large existing high-tech sector. New channels will need to be in place to ensure that businesses in struggling areas have access to capital, including small-business lending from banks and venture capital for start-ups. There also needs to be more federal support for people who want to move to greater economic opportunity in the face of a decline in Americans' mobility in the successful pursuit of better jobs (Irwin, 2018).

Source:
Roosevelt Institute;
Brookings Institute

CREATIVITY, CAPITAL, TOXIC WASTELAND

In Silicon Valley, there has been an emigration to Central Valley of scores of middle- and working-class residents fleeing sky-high housing costs in the metro area (Ottenberg, 2018). There are also hundreds of thousands of people having to give up and move to Las Vegas, Reno or Oregon, or wherever the possibilities seem better for ordinary working people (Florida, 2018). This mirrors the emigration from older industrial cities with poor public transit to the Sun Belt cities with better roadways (but poorer wages). The sprawl pays its real estate investors, delivering profits through property investment and capital accumulation, not from building houses (Ottenberg, 2018). The Central Valley also receives emissions from massive traffic jams to the west. Although air pollution from traffic congestion and sprawl is the most visible environmental problem caused by Silicon Valley, there are others — including solvents that have moved under working-class housing areas near industrial zones. And solvents do not migrate to affluent Palo Alto or Menlo Park. Predictably, proximity to environmentally hazardous industry causes working-class neighborhoods and communities of color to be far more exposed to pollution than whiter and wealthier areas. The area also has another looming water problem in the rising sea level, with the Union of Concerned Scientists predicting chronic inundation all around San Francisco Bay by the end of the century (Ottenberg, 2018). Towns that want to become successful clusters will want to take heed of the unexpected environmental problems that resulted from Silicon Valley's explosive growth and plan for transportation and housing accordingly.

SCRAMBLING FOR THE LOCAL TEAM: POLITICIANS GAMBLE ON THE TICKET FORWARD

A major critical uncertainty is the future of politics and industrial clusters. One question is what trajectory people's confidence or distrust in government will take in the years to come. In 2017–19, with the federal government mired in gridlock and hyper-partisanship, local leaders are stepping up in advancing solutions to their unique economic, social, and environmental challenges. As a result, the public maintains high trust in local government while its faith in federal institutions has eroded dramatically (Vey, 2018). Bay Area author Richard Walker comments that: "We have a long and pretty honorable tradition of progressive politics in the Bay Area. And the question is, where's that going? Even though we're still the bluest of the blue, that doesn't necessarily mean that our radical edge, our progressive edge, is doing well. A lot of that has been blunted" (Florida, 2018).

Governments should subsidize more independent multi-disciplinary research evaluating ethical, social, legal, environmental and technological implications of future automation, while developing ideas for solving issues that might arise (Weber, 2018). Congressman Ro Khanna from Silicon Valley toured a depressed far-away state, and felt positive about the ways regions that have experienced hard times could create growth. He related that there are apprenticeship programs in these regions that pay; he also said that the job of the Valley should be to support these programs, to look at investing in some of these programs,

and not to say, "Okay, we're here to tell you what to do," or, "We're here to teach you." It should be about partnership, empathy and an understanding and concern about the country's future and everyone participating (Recode, 2017). Smart policy, using tools both from America's own experience and from models in other countries, can help alleviate the pain and spread some of that prosperity — but only if voters demand that elected leaders choose to do so (Ecker, 2018). Given that service work is such a fast-growing sector of the economy, programs should be instituted to make sure that these service jobs are designed in a way that they can provide real financial value to firms and be entitled to compensation proportionate to that value.

LEAVING THE VALUES OF SILICON VALLEY BEHIND

Other cities' recent emergence as innovation or tech hubs may be an example of a more prudent business culture that has more to it than brilliant technologists or opulent living — but of hard work and getting things of value done with discipline and dedication (Akkawi, 2017). Tailwind Founder and CEO Danny Maloney moved out to Oklahoma City to launch his own business, with the opinion, "We don't believe in raising a lot of cash early on and then throwing all that money at the problem of not having a business model until somehow everything starts to work." He had to fight back against investor doubts about their location before getting funding. "They said we had to prove it to them we could be successful from here" (Reback, 2018). A backlash against Silicon Valley values is now well underway, with the Bay Area increasingly coming to stand in the public's mind for exploitation, excess and elitist detachment (The Conversation, 2018). In the interview given by a Bay Area congressman, he made clear the problems of Silicon Valley in its new San Francisco center:

> "How could you have this gross inequality, how could you have so many working people earning minimum wage? A quarter of them are earning minimum wage; a third of them can't earn a living wage. And then the homeless situation is just beyond immoral. Perhaps the most disgusting homeless situation anywhere in this pretty heartless country. We are one of the leading generators of inequality, which is hidden because we look at our high median income — the highest in the world of any big city — and say, "Wow, that's great. Capitalism lifts all boats" (Recode, 2017).

It is a far cry from Patterson's Dayton, where the city's chief firm was committed to its citizens so wholeheartedly. There will probably always be positive lessons to draw from Silicon Valley — reasons why the Bay Area will likely be a center that ambitious people with ideas will still flock to for a while to come: the risk-taking and speed with which people move, and the passion people have for developing ideas. A risk-taking attitude is key to the Valley's investment strength, and current lead over most U.S. cities. "Getting comfortable with risk is something they do in San Francisco better than anywhere," according to David Hall (David Hall, partner, Rise of the Rest Seed Fund). "The investor class in cities we invest in are relatively risk-averse." What cities across the United States need is more late-stage capital from more millionaires and billionaires "ready to double down on

their hometown" (Rosenbaum, 2018). Venture capitalists, who recognize a bargain when they see one, have already begun scouring the Midwest. Two investors recently amassed a $150 million in the "Rise of the Rest" fund. Backed by tech luminaries including Jeff Bezos of Amazon and Eric Schmidt, the former executive chairman of Alphabet, the fund will invest in start-ups throughout the Midwest (Roose, 2018).

Source:
Linkedin: The Swedish-American Chamber of Commerce in San Fransisco and Silicon Valley

SCENARIOS FOR THE FUTURE

From the scanning of signals, trends, risks and implications derived from the present, we can envision futures that can take on radically different forms.

SECTIONALITY, EQUITABILITY AND THE FANTASTICAL

TECH GEMS IN A NATIONAL WASTELAND

Three decades into the 21st century, The middle and wage-earning classes have emptied out of principle cities just as many residents were forced to leave San Francisco in the 2010s because of an explosion in the cost of living, leaving only wealthy "mansions on a hill" for tech superstars, with vast numbers of service and lower-skilled tech workers inhabiting far-flung outskirts – including communities that failed at revitalization efforts. This zero-sum world is a frustration for millenials, who grew up believing that vibrant urban areas are the spaces that provide the best quality of life, but now largely cannot afford to live in them. The present generation of workers have the feeling of being on the outside, looking in. This cost-of-living crisis has replicated itself in the centres of most major cities, including those that are not even on the list of the 20 largest in America – such as Boston, Denver, Washington, Nashville, Portland, Sacramento, Omaha, Minneapolis and Cleveland. These cities have joined a few expensive and congested "mega regions" of economic activity, surrounded (and fundamentally separated) by hundreds of miles of lower level service and manufacturing regions that lack diversity – while being economically and socially disconnected. Many companies that are not apart of these urban innovation hubs suffered from non-existent playbooks on how to enter the new technology revolution, failing to pay attention to the digital until it was too late; they would not survive the Kondratieff Winter that ended in the mid-2020s. Those cities that survived the tension and trauma of the passing from K-Winter into the K-Spring largely swelled into mega regions of tech, enjoying the K-Spring of transformed value systems, social practices. organizational cultures, and new business models ushering in productivity not seen since the 1950s - '70s.

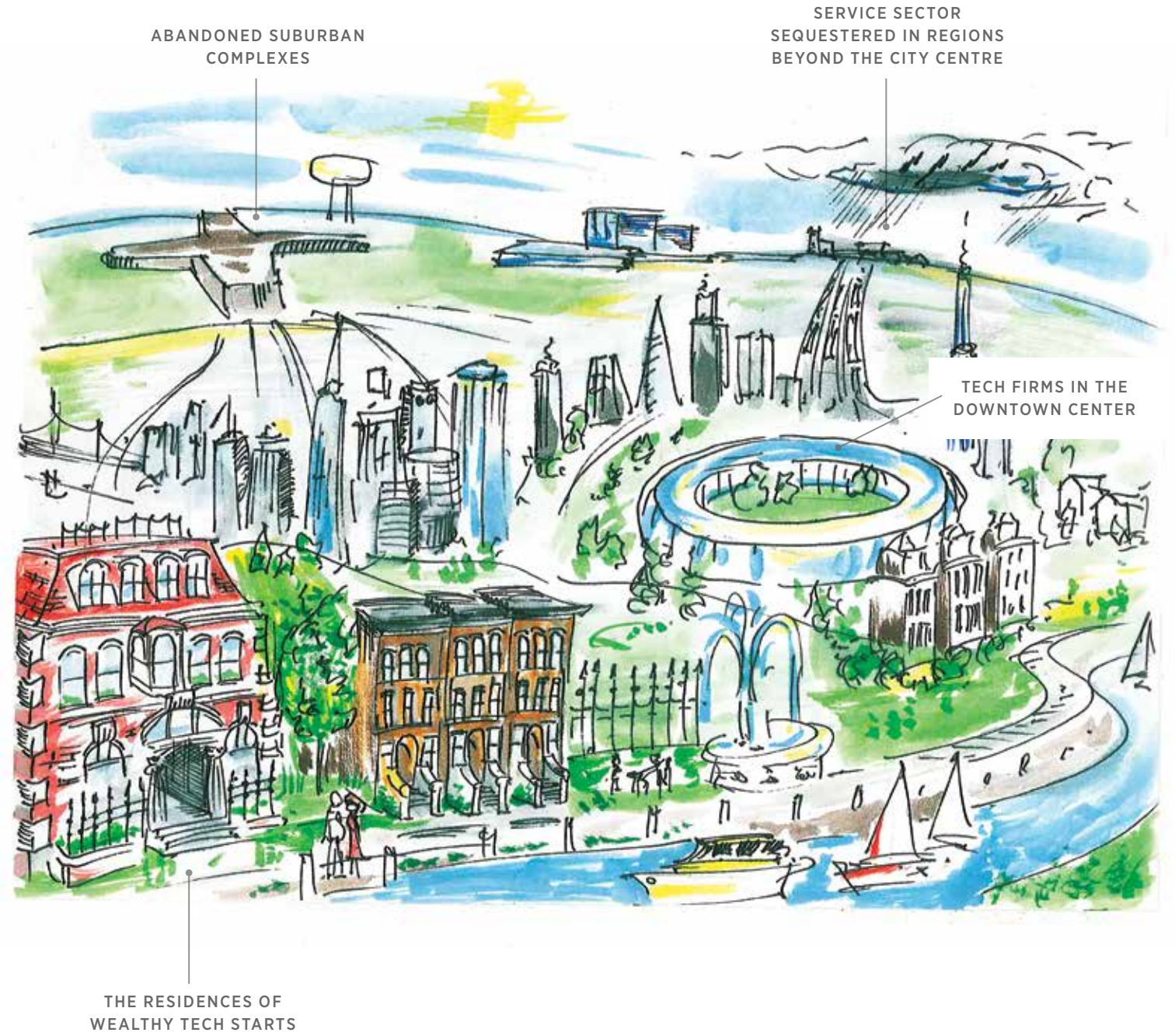
The former corporate campuses of large organizations have closed down since moving to the downtown metros, or have dwindled in importance to become service centres or warehouses. The brightest staff had made it clear in the later 2010s that they wanted to be around people that are leading innovation, and companies had no choice but to move their leadership into downtown innovation labs, where talent is constantly flowing in (but also out) of companies. The digitalization of businesses demanded by Industry 4.0 in needed a whole new set of tech leaders to oversee the myriad processes required to make the great leap to new business and manufacturing processes, while redefining the nature of work. These digital leaders, who impart their knowledge into reimagining products, services and processes, are seen as more expansive in their skill level in comparison to the IT and IO leaders of the recent past – and the best of them live in the high-priced downtown areas. These smart tech workers began to be paid more and more, now living in proximity to each other and assisting their community in getting hired for better salaries elsewhere or starting spin-offs together. Other suburban offices held on for longer than they should have because of strategic but inflexible policies and investment structures intended to make existing outlying areas attractive for investment. The traditional long product development and sales cycles no longer worked for them, as the Schumpeter technology cycles should have made clear that the upward wave of new technology would run its course and then slope downward

much faster than in previous cycles. Businesses that kept their employees away from this environment inevitably suffered a brain drain.

Manufacturing has moved almost entirely to India, China and Mexico, leaving the tech-forward American cities to make innovation their main export, while compelling what talent is left throughout the nation to the biggest tech centres. Two terms of anti-innovation policies, poor investment and other exclusionary political actions during the late 2010s and early 2020s hurt the long-term wealth of the nation as a whole, which had difficulty meeting the challenges posed by other competing nations which took up the slack of forward-thinking investments.The less tech-forward cities have nothing but services to offer, and the population that works in these regions can only try for jobs that have some semblance of creativity in spite of the region-wide low pay. One bright spot in the nation is the manufacture of high-tech robots throughout the Rust Belt for the now-dominant AI world of the Sixth Kondratieff Wave. Organizations that prepared for the future based on reading historical K-Waves and their future implications understood that a great K-Spring of investment in previously-developed but under-funded robotics and AI would one day take hold, and prudently invested in its manufacture. The "blue collar" nature of employment for less-skilled tech workers of cities like Columbus, Ohio, remained middle class for a limited period of time, but in time experienced a race-to-the-bottom in wages. These formerly down-to earth centres of technology-supporting industry were a temporary bright spot for a struggling middle class to get a foothold in the tech industry. But as industry eventually made its way overseas, only the historical downtown areas were left to thrive, populated with well-paid tech investors and inventors. In the past, massive tech companies had been criticized for wielding outsized influence in regions, but the status-quo now sees the largest of these companies headquartered in only the largest tech-heavy cities, with nothing resembling a headquarters in any mid-sized town, in spite of promises of ever-more generous tax breaks. The talent just isn't there to make those centres viable anymore.

Though the Kondratieff Spring of the mid 2020s witnessed rapid automation, with a new amassing of data and wealth, a scarcity of resources and painful after effects resulting from armed conflicts were experienced during the Kondratieff Summer of the 2030s-40s, which saw a shift away from technological innovation for much of the population. Civic engagement is rarely encountered in the urban tech centres that survive – the population does not stay around long enough to foster it. The flow of talent in and out of centres of innovation never ends, largely because of neighborhoods constantly being transformed from livable spaces for up-and-coming tech workers to unaffordable, gentrified neighborhoods that increasingly take over much of a city's blondaries. Many of the tech workers, in fact, will join the service workers on the outskirts of town where the only livable housing is. Sufficiently dense public transit, however, does not follow them with their heir displacement, and the problems of 21st century San Francisco are repeated time and again in multiple tech centres. The luster of being a member of a high-level cluster of creative and ambitious design, finance and media professionals is becoming less attractive as time marches on.

ILLUSTRATION 1. A WEALTHY TECH CITY SURROUNDED BY DECLINE



AN EVENLY-DISPERSED WORLD OF TECH: THE GLOBAL ROBOTICS INDUSTRY

Though the U.S. had been the leader of robotics for some time, the rest of the world caught up, and now there are centers of invention and manufacture for robotics in numerous centers throughout the world. This development, however, did not spell doom for the U.S. industry, as the sheer variety of robots and their materials required for different manufacturing purposes throughout the world has necessitated several hundred plants and tech laboratories throughout the U.S., employing middle-class assemblers and the high-flying tech whizzes that design them. Robotics is now a highly-flexible industry of hardware and software, where robots and factories are frequently customized for multiple jobs during their lifespan, allowing for new entrants to thrive. Meanwhile, the ever-growing need for data centers in the stable climate and geography of the Midwest and south west has created a number of construction opportunities for data centers. In time, there will be acquisition and mergers in the manufacturing of robots, but the industry created by the need for these high-tech and complex machines of industry will have provided 30 years of expansive manufacturing and engineering opportunities much like those Dayton and Detroit enjoyed in the first half of the 20th century.

Chattanooga, Dayton, Maryland and Columbus experienced their boom in entrepreneurship the late 2010s and early 2020s, and two decades on, have continued to thrive based on the well-informed practice of customer-centered commercialization models applied to pockets of knowledge and talent that was previously latent but underdeveloped in these cities. This talent was supported by access to workshops where these tried-and-tested business and innovation models could be practiced and made to work for entrepreneurs and partners. To these business models, the GEMS framework provided guidance on the overall health of the clusters of which these cities were a part of, with cluster-wide results of success factors reviewed every quarter by leader firms, who make sure that important factor conditions are addressed by the various cluster agents, including important cultural and social considerations. Universities and colleges were augmented by important technological centers on campus, where the all-important principles of digital transformation are taught to future local tech leaders who will help guide the city's firms through the Fourth Industrial Revolution. In addition to centers of learning, electric and telecommunications utilities have prudently been incorporated by the cities themselves to avoid the loss of control of important infrastructure to far-away conglomerates that once held so much control over the affordability of utilities for the population of these clusters.

Columbus stands out as a centre for innovation where robotics are taught and built. Centered around a well-funded university, Columbus turned their institution into a centre for robotics innovation, where the processes of digitalization are pioneered by scores of graduates, many of which reside in the region, building up robotics firms and fostering spin-offs from success. Having been built, the new generation of robots require little manual attention once in operation in their respective end-use plants. It is the age of the "lights out" factory, where robots are commissioned into use, and are predominantly left to run for long manufacturing runs, sometimes lasting an entire business quarter. With manufacturing and delivery largely left to robots, a majority of middle-class workers have

thankfully been re-employed in the numerous value-creating functions that modern businesses must engage in to remain relevant: manning website chat bots, strategic thinking at all different levels for multiple business models and corporate efforts, an increased employment of personalized virtual selling, and other forms of quality personal attention now in demand. An embracing of the more intangible aspects of business have been a feature of this sophisticated world of business, where the manufacturing of objects and levers of finance are no longer the sole considerations of measuring the health of an organization and economy. To get to these new higher-value service jobs, a greater network of transit has been built in more cities, bringing back a world of dense mixed-use areas much like the downtown world of streetcars, storefronts, affordable retail and lake fronts that long ago were the thriving picture of American towns.

The older concept of manufacturing has long been discounted, with the dated policies of the 2010s and 20s abandoned for a widespread embracing of a more sophisticated view of what building things and serving customers entails for all levels of American talent and labour. The knowledge that clusters operating with these strategies put into place can boost their market capitalization by as much as 25 percent has been a motivator in moving to what has become the Industry 4.0 paradigm of industry. The use of data analytics as part of this evolution has been adopted at a moderate speed over a generation by industry leaders and suppliers alike, easing the disruption. A new 'blue collar' tech has been supported – a happy return to a strong middle class that lives alongside the wealthier tech leaders in well-planned urban centers typified by Columbus. Cities like this support a 'mid-tech' workforce that compose more than one half of all tech employment in regions that have embraced the Sixth Wave of new energy, AI, big data and other products and enablers of the new digital industries. This is true even in Chicago, where greater access to helpful business models have lessened the blight of poverty-stricken areas and have moved more citizens into the creative culture. Massive companies like Amazon have retreated somewhat from the consciousness of innovation leaders as a force to emulate or attract to cities, while the desire for companies to become mammoth conglomerates has waned after being compelled to pay their fair share of taxes demanded by the current generation.

ILLUSTRATION 2. FUTURE DAYTON CLUSTER SUCCESS

USING STRATEGIES TO IMPROVE CLUSTER ADAPTABILITY, HISTORICAL CYCLES OF INNOVATION TO UNDERSTAND THE PAST AND THE FUTURE, AND THREE HORIZONS TO INVENT PROJECTS AND STRATEGIES TO BRING EACH OTHER INTO THAT FUTURE

IN THE 2030s, DAYTON IS A PART OF MANY FORMERLY DEPRESSED REGIONS THAT HAVE EXPERIENCED A RE-EMERGENCE BASED ON AN EVENLY-DISPERSED INDUSTRY OF ROBOTICS AND THE USE OF BETTER BUSINESS MODELS

A WORLD SHAPED BY AN UNKNOWN NEW ECONOMY

The world's economies are fundamentally different in the Kondratieff Spring of the 2030s. But before that happens, the K-Winter of tepid investment and growth had to run its course. Resembling time periods of the past (namely the 1930s), America continued to experience a "Great Devaluation" in financial markets that started in the mid-2000s, experienced a crash, and then lived in the long shadow of slow and disappointing economic growth, with chronic underemployment of labour and capital. Like in all K-Winters, a lack of enthusiastic investment, fears of deflation, troubling inequality and the failure of banks to spur healthy consumption were hallmarks of the cycle ending in the mid-2020s. Indeed, there was an every-nation-for-itself mindset reminiscent of the '30s, when peace-keeping alliances gave way to authoritarian havoc that portending a terrifying future. The change from the long K-Winter to the K-Spring saw the creative destruction of public institutions – some dysfunctional, others necessary and life-giving – and an ultimate shifting of power and wealth from the old to the young.

A debt crisis grew as businesses continued to hoard cash as the K-Winter lengthened into the 2020s, delaying investments. And as China's exports declined, it bought fewer U.S. Treasuries, influencing interest rates to fall, impacting the U.S. economy in unprecedented ways. The K-Spring was to be a new golden age, but by definition needed to be heralded by traumatic adverse events to galvanize public action, as the Fourth Turning generational theory suggests. Indeed, war happens in every Fourth Turning. This cycle coincides with the Kondratieff Winter which began in 2008, and lasts until the end of the 2020s. The tremendous fortunes wasted on warfare in faraway places made the situation much worse than it could have been. Much of the 2020s was demoralizing, with rising prices, stagnant wages and a dearth of international competitiveness manifested in the U.S. Ignoring the need for basic research in things like AI greatly decreased the capacity to lead the next wave of innovations that would have given the U.S. the leading edge in things like military technology, while students from other countries have become the leading-edge mathematicians and engineers, beneficiaries of a far-advanced level of education in the top categories. By 2030, the U.S. had lost its status as the world's dominant reserve currency – a milestone in its ultimate loss of influence. This occurred while being continuously and threateningly challenged by China, Russia and others for control over oceans, space and cyberspace. These factors brought about a complete rewriting of what can be considered the American social contract.

The world of the Sixth Kondratieff Spring could hardly have been planned for. The barely-conceived of technological discoveries of the 2030s have revolutionized the already altered mega-political reality of an expanded information technology. Most tried-and-tested business models centered on innovation bringing about capital have been totally wiped out, with outer-space travel defining the age. A group of scientists from a China mega region displaced Tesla to conquer matter itself, transforming the lives of everybody. Energy from shale deposits – removed from the earth in newly-efficient ways that have stretched the earth's deposits ever-longer – have created a stronger dollar that for the next decade will restore investor confidence, at least until the 2050s. Concentrated solar-powered energy, including solar photovoltaics is still popular among some quarters, complete-

ly running countries like Germany, though the cost has not quite dropped in the way the previous generation expected it would.

China, as expected, became the production powerhouse for the world, "thanks to low wages, cheap loan capital, entrepreneurial power centers, and the creation of capital goods, which have far outpaced the rest of the capital world." Like the American industrial clusters of old, Chinese assemblers numbering in the hundreds of thousands of workers succeed with cluster architectures of excellent balance among firm and system agents, while working with nimble and inexpensive delivery systems that guarantee on-time delivery that has come close to Amazon's decades-old dominance of moving things. 3-D printing of bionics and organics took their turn at disruption for many industries, varied from orthodontics to fast food. Combined with nano technology, plastics and many fabrics have rivaled metals for sheer strength, making all kinds of products lighter and stronger for quick delivery via suppliers and retailers, heightening profitability. These nanoparticles may become the properties of everything, while biomaterials and bio-processes will eliminate the excessive use of non-renewable materials, processes, and destructive cycles of industry. Modern renewable energy can become a substitute for fossil fuel in the generation of power, heating and cooling, transportation fuel and off-the-grid energy services (Casti, Wilenius, 2013). These innovations are but one of a parade of other innovations that have seen profitable use in the K-Spring, including advanced robotics, autonomous vehicles, energy storage, advanced oil and gas exploration and recovery and renewable energy. Then again, new technology and prices could fail rapidly just as a Kondratieff Spring is underway, the outcome of a dramatic X-Event.

Thanks to The Dog Bone Portfolio: A Personal Odyssey into the First Kondratieff Winter, *by Margret Kopala and John Budden for insights on what this particular scenario may hold for the future.*

ILLUSTRATION 3. LEAVING A KONDRATIEFF WINTER, HEADING INTO THE SPRING

IN THE KONDRATIEFF WINTER, THE FEDERAL RESERVE WILL NO LONGER HAVE AMMUNITION TO WITHSTAND THE NEXT SHARP RECESSION, HAVING FORCE-FED BILLIONS INTO BANKS DURING THE 2008–10 RECESSION

EXCESSIVE DEBT CAN ONLY BE ADDRESSED THROUGH GROWTH, INFLATION OR DEFAULT. THE LACK OF GROWTH IN THE K-WINTER MAKES DEFAULT THE MOST LIKELY SCENARIO, CLEARING THE WAY FOR FUTURE GROWTH

THE RISE OF CHINA, REPRESENTED IN THEIR DOMINANCE OF SPACE TRAVEL AND EXPLORATION

THE END OF A KONDRATIEFF WINTER FEATURES THE BREAKDOWN OF THE SYSTEMS THAT SUSTAINED THE THE LONG WAVE OVER DECADES, WHERE FINANCIAL, BUSINESS AND SOCIAL MODELS PROVE NO LONGER USEFUL

INNOVATIONS THAT BEGAN APPEARING IN THE K-WINTER NOW TAKE HOLD IN THE K-SPRING: A NEW ENERGY MATRIX WITH SOLAR, WIND, BIOMASS AND SHALE FRACKING, USE OF BIONICS AND DRONE DELIVERY

The Oregon District, Dayton, Ohio. *Reddit*

DISCUSSION

This section will attempt to give insight to the future development of clusters (especially the upcoming Kondratieff Sixth Wave) based on the cumulative lessons in this study — stages of clusters, strategy frameworks and forecasting. Avenues for future research are suggested, along with acknowledgments of the limitations of this study.

The life cycle of industrial clusters follow two varieties of paths, each providing its own insights: the first are three stages specifically associated with cluster development; and second, where the emergence, maturity and decline of clusters fall on multiple historical waves of innovation/technology and finance. The three stages can be used by cluster leaders to understand which stage they are approaching in their life cycle. As a tech cluster, for example, New York City can be seen as living in its first stage as an emerging tech cluster, where agglomeration benefits are starting to materialize – albeit at a more measured pace since Amazon's decision to not set up headquarters there in February, 2019. From the vantage point of this first stage, New York can look towards the second stage of the cluster life cycle, where the consolidation of firms, growth of infrastructure and standardized processes will herald the cluster's maturity, while greater costs of doing business and other looming negative agglomeration externalities may point to an uncertain future with the third and final stage of cluster development in sight. The case studies of Dayton, Detroit and Hartford ultimately demonstrate all three stages, and their narratives offer up factors that can be read as signposts of warning for a developing cluster. There are lessons in strategies, attitudes, culture and reaction to change in the analysis of these case studies that leaders of a cluster can identify as forthcoming issues that can be addressed before they happen. A moral attributed to many thoughtful people throughout history is that "only fools learns from their own mistakes. The wise learn from the mistakes of others."

The historical cycles of innovation, on the other hand, show circumstances and developments that may seem out of a cluster's control, but can be planned for and capitalized on. The upcoming Kondratieff Spring, according to Margret Kopala and John Budden, will breathe revolutionary life into:

> space travel, quantum teleportation, shale energy, cheap solar and photovoltaics, nanotechnology, artificial intelligence, 3D printing, Higgs Boson, Khan Academy, big data, internet of things, carbon capture and storage, life extension processes and products (Budden, Kopala, 2015).

Along with these scientific developments (much of it a part of Industry 4.0), Budden and Kopala predict war – no less than World War III – instigated over South Pacific, Eastern Europe or Arctic resources. This will occur over the usual span of the K-Spring where similar conflicts within past waves are plotted. A K-Summer recession in 2036 is identified, followed by several years of expanding credit lasting until 2047 when the new economy bubble crashes, ushering a K-Winter depression lasting until perhaps 2065 (Budden, Kopala, 2015). K Waves should then be seen as a combination of trends and critical turning points before rolling into the new trend, following a cyclical history of observable temporal changes. Markku Wilenius and John Casti identify the most shocking turning points as X-Events that are even more dramatic turning points, as identified in their exploration of the Sixth Wave; these can take the form of hurricanes, asteroids and other shocking events. Indeed, anything can happen given the coming together of context and a random trigger. Complex situations require complex thinking and structures; without this, a complexity gap can develop. How an established system might collapse can be

determined by the size of this complexity gap from the triggering event (Casti, Wilenius, 2013). Once a collapse or disruption occurs, can there be a rebirth?

Institutions, clusters and firms can only do so much to prepare for seemingly random events that can end a trend. And though Kondratieff Wave theory suggests a cycle length of 40-60 years, might an X-Event shorten this considerably? Like Schumpeter waves, could K-Waves become progressively shorter as developments and events occur at faster intervals? Should Budden and Kopala's long-wave future of more than 40 years be treated as an actuality? Certainly not on its own. It needs to be reinforced with other signals, trends and foresight work from other authors and methods to create a reasonable multi-decade look into the future to prepare for. One of these methods is Three Horizons, which offers a convivial approach to plotting and solving for the future. But Budden and Kopala are basing their assessment of what is to come on the empirical plotting of similar trends and events on multiple historical waves going back over 200 years. It shows that the above technologies are currently being developed, but are underfunded or otherwise not yet diffused throughout society to their fullest advantage. This current K-Winter will give way to the wholesale movement of investors into these sectors in the K-Spring. This is why waves of innovation like those of Kondratieff are valuable for foresight work when paired with strategic frameworks for success. One study strengthens the other. Looking to the Sixth Wave will offer predictions based on observing trends and extrapolating on them based on its upward trajectory.

The Sixth Wave may be a future of scarcity, abundance, fragility or an astounding era of evolution. Given the technological and scientific innovations fermenting as we enter the 2020s, a revolutionary paradigm shift is expected to be the only insurance against the massive changes brought about by order-of-magnitude shifts in the environment and world population. Europe, for example, is on trend to experience an astounding drop in population before the century is through (Germany will see a population of 80 million decline to just 40 million by 2100). North America and Latin America will see a moderate stalling of population, with the U.S. likely to be able to take care of its old during this century, care of a robust-enough infrastructure (at least in comparison to places like the Middle East). Literacy, it is suggested, may be the cause of this population drop, and large nations might get a lot smaller over time. A global food crisis might be another reason for a disruption in populations, ushering in protectionist policies and the breakdown for stasis of international agreements (Casti, Wilenius, 2013). Technological and social infrastructure will need to be willed into reality so that people can lead more meaningful lives. There will be more networking opportunities in the new digitized space that has been created, whether it remains a free-for-all public arena or a platform for private sharing.

Society itself may become more local and private, given the severe distrust in institutions that has become a hallmark of the past decade, rising sharply in its trend year after year, driven by an unrelenting pursuit of special interests. Or will a Fourth Turning, in its cyclical fashion, bring us together as the new generation ages into their future Hero clothes? Whatever the resulting upward trajectory, we know from cyclical history that at a certain

point the revolutionary and profitable new technology networks will offer diminishing returns, with the familiar stagnation of credit demand and the dropping of interest rates ending at the nadir of the K-Winter cycle. The key drivers of the coming Sixth Wave vary among authors of long wave studies. It can – and certainly has – been argued that perhaps Kondratieff and Schumpeter Waves are too deterministically loaded to be of great use in an increasingly complex and unpredictable world. And whatever the coming decade brings in cyclical familiarity or random disruption, there will be massive learning challenges for societies. The present systems will simply not take us to where we need to go (Casti, Wilenius, 2013).

The GEMS framework indicates what firms and clusters need to be good at for their cluster to succeed, and can function as a sort of checklist of 'ducks in a row' for maintaining that fitness. GEMS bears some resemblance in practice to the Balanced Scorecard framework for organizational strategic thinking, in that it encourages a balanced consideration of multiple factors for successful big picture planning of activities in service of an agreed-upon purpose. This study includes a table of GEMS factors populated and cross-referenced with examples of how each case study realized success with each factor, illustrating the varied efforts a firm or cluster can execute on to help achieve long-term survival. The study of cluster theory beyond the three stages of cluster development and recognition of the importance of complex systems thinking can strengthen the grip leader firms have on cluster success and adaptability. Put together, it would be demanding to adopt all of these frameworks and theories synchronously – but the more strategic, historical, foresight and theoretical arms that can be brought to bear on a subject as elaborate as industrial clusters, the better the chances component firms will have for surviving as a cluster.

FUTURE RESEARCH

Embracing complexity in systems thinking is touched upon in the theory section of this paper. While the GEMS framework has been introduced as a strategic device for addressing some of the complexity of industrial clusters, there is key additional literature in the field that offers guidance on applying new structures, functions and processes that have the ability to be responsive in a fluctuating business landscape. This is a highly-relevant skill in a world increasingly affected by chaos and complexity. Systems thinking is composed feedback loops and delays, pathways, redundancies, external shocks, diversity and other elements that are part a language to be mastered in solving the problems of the world by restructuring one's environment for agility in recognizing changed circumstances, and then adapt to the change. The properties that make up this structure to assist in assimilating shocks (while probably not remaining the same afterwards) will forever be reconstituted and tested for success. Though some of the literature has suggested systems approaches for the lifecycle of industrial clusters, more work can be done in combining the basic systems rigging to create ideal systems that can work alongside other strategic and historical/foresight exercises.

The writing of Alfred Marshall, Michael Porter and Richard Florida have been often cited as key to understanding the benefits and risks of firm agglomeration into clusters. The writing of Jane Jacobs is only briefly touched on in this paper, and is recognized as being very important for studying urabanization, and probably by extension, industrial clusters. She was the first to write about the idea that cities are the key forces of wealth, rather than nations. With select cities transforming into mega regions of tech wealth, how do Jacobs' writings on the livability of the dense urban centre suggest we preserve the benefits she outlined that are important for future urban planning? Can top-down cluster development in bringing numerous ingredients together derived from frameworks like the GEMS model bring success to clusters, or is it really just hard-working entrepreneurs combined with geographical factors that bring an emergence about? These experiments throughout the world are being attempted now, with different combinations of firms, institutions, populations, infrastructure and beliefs. Each of these places can be treated like a case study with factors that can be entered into a table to monitor their respective successes or failure, which can add greatly to future study of clusters. Further study of Dayton's new innovation labs would offer up much insight for follow up, as they have been very active in publishing their vision, frameworks and activities relating to their activities as an emerging centre of downtown innovation.

Industrial clusters abroad are an area of study that would contribute to North American attitudes and habits in the management of regions of innovation. The Italian textile industry in particular has been cited as exhibiting successful organizational practices, with economic downturns and downsizing over the years failing to seriously diminish its strength by new competitors. There seems to have been fairly good academic studies relating to this industry, with frameworks that attempt to demonstrate its success as something that can be repeatable for other industrial clusters. On the financial side, further research into money markets, the Federal Reserve system, deflation and inflation, national debt, the stock market and other aspects of monetary policy are obviously important as to what will occur in society over the next decade and more. Not going to depth on these subjects was certainly a limitation of this paper, and might have made an economic cycle such as Elliot waves more prominent in the writing, possibly brought up to the same level as Kondratieff Waves in attention paid in the section on long waves. A detailed examination of exactly how a particular cluster might use the strategic frameworks, historical waves, foresight method and case study comparison all together has not been laid out here, as I think a suggested formulaic approach might draw an unnecessary boundary for readers as to how all these varied instruments might work in concert.

CONCLUSION

As stated in the discussion of long wave theory, Kondratieff waves of historical innovation may not have always been embraced by most economists, but carefully following the development of innovation, its investment and diffusion over the decades cannot help but offer insights to those who want to see their industry and others spread itself over waves of emergence, maturity and decline. To me, the pattern of innovations being developed during a cycle of collapsed capital and low growth — then see consummation in a new Spring with all the disruptions and ferment that the rise of automobiles in the 1900s–20s and Silicon Valley saw with transistors in the 1950s–60s is compelling. At the very least, it should spur regions to prepare for the next cycle based on signals, trends and people who are going out on a limb to imagine new scenarios for a future just around the corner. Spending time with K-Waves looking backwards in time and forwards into the future seems to offer a more substantial grounding for foresight work, in allowing us to look at the big picture instead of only peering around the corner. In trying to plan for a world of innovation that has undoubtedly demonstrated patterns of rise and decline, knowing where we have come from matters.

To this somewhat controversial study of historic waves foretelling the future (Kondratieff, after all, was executed in Stalinist Russia for his unpopular insights that predicted long-term American prosperity), we can append the general stages of cluster life cycles discussed to allow firms and regions the general good things they should be seeing in the emergence of their own cluster, followed by milestones that signify a maturation, and finally the signals of agglomeration externalities that may spell doom for the region and its firms. These stages and waves have been demonstrated in five case studies that hopefully show similarities between the life cycles of industries that once stood as models of American proficiency and prosperity, and those that are in their emerging or mature form. When taking them in as a whole, one can make sense of these patterns to more completely plan for being adaptive in the face of industry-changing possibilities or threats, including those that would seem to be out of one's control. Knowing what a successful architecture of clusters might look like also helps, and the GEMS model can influence clusters to have sufficient variety in its arsenal throughout the stages of its life cycle to allow for an extended life in a very complex world of competition and globalization.

Finally, having achieved a greater understanding of cluster theory, its workings, a larger history and possible future, the people who populate clusters can come together around a foresight framework like the Three Horizons to try to plan for a future with a more refined consciousness. Ultimately, needs arising from the observed limitations of existing ways will prompt a new awareness of how we can make society smarter and more human through the use of now-developing technologies in concert with humanity, to the point of extending the power of our own minds. In thinking about the long past, workaday present and uncertain future, we can use this greater contextual awareness to create a more informed future as we head towards a new wave just beyond the horizon.

Hudson Motor Car
Company factory, 1917
Wayne State University
Digital Archives

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