

Bottom-Up Imaginaries: The Cultural-Technical Practice of Inventing Regional Advantage through IT R&D

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ABSTRACT

Recent HCI research on social creativity and bottom-up innovation has highlighted how concerted efforts by the government policy and business communities to develop innovation ecosystems are increasingly intertwined with IT research and development. We note that many such efforts focus on cultivating *regional advantage* [20] in the form of innovation hubs that are situated in and leverage distinct sociocultural histories and geographies. Cultivating regional advantage entails achieving broad consensus about what that region's advantage might be, that is, the construction of a regional advantage imaginary beyond the policies, IT supports, and practices to make it happen. Here, we document how an ongoing public debate among makers and manufacturers in Taiwan as a region—distinguished by direct engagement with design, fabrication, prototyping, and manufacturing processes—are proposing pathways toward a regional advantage that both reflects Taiwan's recent sociocultural and economic histories and also its near future aspirations.

Author Keywords

Internet of Things, IoT, makers, making, policy, innovation, regional advantage, Taiwan, Asia.

ACM Classification Keywords

H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION

Economic development today is commonly framed in terms of (a) *innovation*: an intentional and proactive process that involves the creation, adoption, and spread of new and creative ideas, which includes *product innovation* and *process innovation* and can lead to profound changes in a community [8,22]; and (b) *ecologies on the scale of geographic regions* (e.g., large cities or metropolises). For example, Silicon

Valley remains the go-to example of a regional innovation ecology, and increasingly Shenzhen, China is being described in similar terms. They seem to be displacing former economic models based around traditional industrial clusters for manufacturing (e.g., Detroit) and increasingly playing vital roles in technological breakthroughs, social change, cultural evolution, wealth production and distribution, and shift of political powers. As a result, there is a growing demand for effective strategies and practices to further enhance innovation potentials at scale and to better understanding the implications for HCI—a field that has been long considered successful in supporting technological innovation [19].

Following this call, recent HCI and CSCW research has highlighted how concerted efforts in the government policy and business communities to develop innovation ecosystems are intertwined with IT design and development (e.g., [2,3,4,9,11,12,14,15,16,17,18,19,20]). Rather than literally attempting to replicate successful models, such as Silicon Valley, many of these efforts focus on cultivating *regional advantage* [20] in the form of innovation hubs that are situated in and maximize the possibilities of distinct sociocultural histories and geographies in a coordinated way (e.g., Taiwan, Shenzhen, Hong Kong, Singapore, South Korea, India, Bangladesh, Israel, Ireland, Barcelona, Stockholm, and Vienna) [6,8,17,18,19,20].

Leveraging regional advantage entails achieving consensus across diverse stakeholders (e.g., government, business, general public) about what that region's advantage might be—in other words, the construction of a *regional advantage imaginary* along with the development of policies, infrastructures, and other supports to help bring it into being. For example, Silicon Valley's regional advantages include the following: major air and sea ports, elite universities, significant US military/DARPA funds, superlative IT infrastructure, high quality of life, non-disruptive weather (e.g., no snow or hurricanes), a strong startup culture, and global multinationals in the neighborhood. And Shenzhen's regional advantages include supportive government policies (e.g., has been a Special Economic Zone since 1979), abundant and low cost labor (a metropolis of 10 million people), hub for large contract manufacturers, and an informal network of design, engineering, and production [19].

Our research focuses on the ways that IT design is implicated in the development of specific innovative regions: we

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have witnessed that technologists are directly contributing to this process by proposing new *imaginaries* and new pathways towards regional advantage. In sociotechnical studies, the concept of *imaginaries* is often used to describe how visions of scientific and technological advance lead to implicit expectations and beliefs about public purposes, collective futures, and the common good [13]. In this study, we refer to *imaginaries* as how a group of technologists envision a future, an envisioning that reflects a shared understanding of the near past and current trends; in other words, an imaginary is a social construction of near-future possibility, which is used to motivate and also to organize action. To better understand this phenomenon, we consider Taiwan a *region* and document how an ongoing debate among makers and forward-looking manufacturers in Taiwan are seeking to reimagine, and to redesign Taiwan's manufacturing-dependent economy in a new global order. And while they are not immune to the siren call of trying to be "the Silicon Valley of X," they demonstrate how direct engagement with design, fabrication, prototyping, and manufacturing processes provides them with materials to propose glimmers of, or pathways toward, a regional advantage that reflect Taiwan's recent economic history and near future aspirations in a global innovation economy.

We contribute to HCI and CSCW research on social creativity and bottom-up innovation, which identifies technical, organizational, and other infrastructures that support social creativity and innovation at scale. Our exploration of technological innovation in Taiwan adds nuance to existing HCI and CSCW studies of regional innovation. We highlight how bottom-up imaginaries of innovation are both mediated by sociotechnical systems and are likely to result in the development/appropriation of sociotechnical systems at scale to support these imaginaries. We explicate how and why technological innovation is a sociocultural and political practice. We also shed light on the complex tensions among the underlying ideologies and myths in which narratives of IT innovation are often couched.

IT INNOVATION, REGIONAL ADVANTAGE, AND HCI

Innovation is tightly linked with technology: technology supports innovation, and innovation produces (among other things) new technologies. Scholars distinguish innovation from invention: While invention indicates something new (e.g., idea, product, or practice), innovation involves people, their values, and what they will adopt [5]. Therefore, innovation has been defined as an intentional process that involves the creation, adoption, and spread of new and creative ideas, which usually leads to creations of economic significance [8,22]. Innovation also has two aspects: *product innovation* refers to new and improved material artifacts as well as intangible services, and *process innovation* indicates new or improved ways of producing such artifacts and services [8]. In this sense, innovation embraces entrepreneurship, which involves institutional and networked ways to turn practices of innovation into an organization [7].

A traditional innovation model is top-down manufacturer-centric: Innovations are often carried out by large firms, corporations, and enterprises such as technology giants. In this model, users have little role beyond accepting new products or services identified and produced by these corporations [23]. Yet the emerging bottom-up user-centric innovation model (e.g., users of products and services are increasingly able to innovate for themselves) [23] and open innovation model (e.g., systematically encouraging the integration of internal and external sources for innovation opportunities with firm capabilities and resources) [1] are changing this landscape: technology startups and seed accelerators [14] as well as hackerspaces, makerspaces, and hardware incubators all over the world [19] have become new sites of technological innovation.

Such a change has led to what AnnaLee Saxenian [20] describes as *regional advantage*. Saxenian does not explicitly define "region," but she uses Silicon Valley as a paradigmatic example. According to Saxenian, the traditional core-periphery economic/innovation model (i.e., development and innovation built on success in advanced economies such as Silicon Valley, while peripheral economies such as non-Western countries follow) is dissolving. Instead, a more complex and decentralized flow of people, technology, and information provides these peripheral economies with tremendous opportunities to develop independent technological, economical, and political capabilities through leveraging their distinctive regional features. Saxenian particularly focuses on what she calls *Argonauts*, by which she means individuals from outside of the U.S., who come to spend time in Western universities and/or Silicon Valley, but then return to their home countries and found startups. These Argonauts—a reference to the Greek myth of a band of heroes who travel abroad in search of the Golden Fleece—are a primary mechanism to not only to transfer lessons and experiences from Silicon Valley to their home countries but also (and more importantly) to redesign and reboot their regional innovation ecologies.

These phenomena have also drawn growing research attention in the HCI and CSCW community. Building technologies and infrastructure to enhance innovative and creative activities has long been a central research agenda in HCI (e.g., [10,19,24]). Yet the shift of innovation models and the rise of *regional advantage* have extended HCI and CSCW researchers' focus on creativity and innovation at the individual level to innovation at scale, especially with regards to how technological innovation is intertwined with design, policy, and regional and global politics (e.g., [2,3,11,16,18,19]). This body of research has pointed to the importance of studying DIY (Do It Yourself) making as a new form of HCI innovation (e.g., [3,19]) and the role of policies in shaping and determining the trajectory of innovation (e.g., [3,11,16]). Most importantly, they call for a globalized and democratized view of technology, which reframes technological innovation as a sociopolitical problem rather than a technical problem [14,18]. Following this call, we

use MakerPro in Taiwan as our research site to explore how activities and interactions of a network of distributed individuals collectively identify Taiwan's *regional advantage* in IT R&D from bottom-up, and how their actions construct a vision of an innovation ecology in Taiwan's near future. In this study, Taiwan is considered a *region* because the island is relatively small and due to its mountains, and its cities are concentrated in a metropolis along the western side of the island. Further, MakerPro participants also tend to frame their discussions around Taiwan as a geographical unit, rather than (for example) its capital city of Taipei or Hsinchu, a city known for its IT R&D.

METHODOLOGY

Research Site

Founded by Owen Ou in the November of 2014, MakerPro is a P3 (public-private partnership) with a focus on building maker economy (<http://makerpro.cc/>) and cultivating a public sensibility and awareness of the future of technological development and manufacturing in Taiwan. It is located in the heart of Taipei and provides consulting services on crowdfunding and project management related to bottom-up innovation and entrepreneurship. It also regularly organizes roundtable discussions, seminars, factory-touring, and makerthons throughout the country.

Its Facebook presence ([facebook.com/groups/makerpro.cc/](https://www.facebook.com/groups/makerpro.cc/)) is one of the largest and most active among similar groups in Taiwan, with more than 10,000 members. Facebook does not have a feature to reveal groups' demographic information and some MakerPro members do not report their age and gender online. Yet based on our observation of the posts and comments, direct check of members' names and profile pictures, and experiences of interacting with MakerPro members, we found that about 60% of the active group members are male while 40% are female; most of them appear to be between 20 to 50 years of age. Importantly, these members are not "makers" in the hobbyist sense. Instead, the self-identified makers at MakerPro include veteran engineers, factory owners, open source evangelists, IT managers, and entrepreneurs—many of them occupying two or more of these roles. Typical interaction in its Facebook group includes exchanges of best practices and experiences of maker to market, discussions of issues related to Taiwan IT innovations, event planning, notifications, and summaries and reflections of organized activities, product and/or tool introduction and trouble-shooting among others.

Data Collection and Analysis

The primary data we collected in this study were threads (e.g., posts and comments) of MakerPro members' discussions regarding the future of maker economy, Taiwan IT innovations (e.g., IoT), and entrepreneurship posted on the public MakerPro Facebook group. We focus on this data source for three reasons: 1) This Facebook group page has become the most active and popular online group for makers in Taiwan. Most makers and technologists, who are interested in seeking information, connecting with others, or

further engaging in this community, often resort to this online page for mutual help, collaborative learning, social interaction, and in-depth discussions. Content posted and shared in this group not only provides a comprehensive image of the varied collective activities members conducted but also represents the shared interests and common goals of makers and technologists in Taiwan. 2) Both the founder and members of MakerPro have strong willingness to openly share their concerns, reflections, and efforts for technological innovations in Taiwan online. Thus, these threads become valuable documentation of their group actions, some of which may have been ephemeral and transient. 3) This group page has been perceived as a significant feature of innovation communities in Taiwan. A MakerPro member posted, "*I think this Facebook group represents the core values and major trends of making in Taiwan: open, sharing, community, collaboration, conversations, and warmth. I cannot imagine discussing making and makers in Taiwan without looking at what's happening on this group page.*" (Unless otherwise noted, all quotes were originally in Chinese and have been translated here by the authors.) Analyzing data from this Facebook group provides direct access to one of the most vibrant sources of ongoing debate in Taiwan about the interrelations of IT agenda-setting and the pursuit of innovation ecologies.

To collect data, we developed a social media crawler. We then automatically crawled all posts and comments on the MakerPro Facebook group from December 11, 2014 (shortly after when the group was established in November 2014) to April 27, 2017. As a result, 6,324 posts plus their affiliated comments were collected. Two of the authors have been conducting ethnographic fieldwork in Taiwan on cultural and creative industry and IT innovation since 2011 and attended numerous MakerPro events and workshops in person and observed MakerPro members' interactions, discussions, and activities. In addition, they interviewed the founder Owen Ou (twice, once in 2015 and again in 2016), several MakerPro members, as well as government officials who have worked closely with MakerPro. In this study, these observations and interviews were used to contextualize our understanding of the MakerPro debates online and also to ensure that our data analysis and interpretations cohered with ethnographic data as well.

We then used an empirical, in-depth qualitative analysis of the collected Facebook data in the hope of shedding light on the complexity, depth, and subjectivity of MakerPro members' *regional advantage imaginary*. Our coding and analytical procedures were: 1) All authors closely read through the collected data and collectively identified thematic topics and common features in the data for further analysis. The criteria included: filtering out posts of advertisements, general announcements, and product introduction as well as those with no or few comments; and identifying posts that demonstrated MakerPro members' collective discussions (e.g., receiving more than 10 comments) on their domains of inquiry (e.g., making, IoT, Taiwan IT, maker economy,

and entrepreneurship). 2) All authors carefully examined and reviewed the thematic topics and developed sub-themes. 3) All authors collaborated in an iterative coding process to discuss, combine, and refine themes and features to generate a rich description synthesizing how MakerPro members collectively made sense of and reflected on their domains of inquiry (e.g., what Taiwan needed for its future national development and technological innovation).

As a result of initial filtering, 386 posts along with affiliated comments (total Chinese character count = 182,670, which equals to 121,780 English words approximately) were analyzed. The average number of comments that these posts received was 36 (max. = 183). This sample reflected two primary issues that attracted most MakerPro members: 1) the endeavor to generate a collective analysis of the competitive strength and challenges that Taiwan IT is facing, both regionally and globally (N=227, 59%); 2) the identification of ideas, strategies, and actions to promote technological innovation (both software and hardware) in Taiwan (N=40, 10%) and the development of a high level economic model for Taiwan to advance its innovation ecology in a coordinated way (N=119, 31%).

FINDINGS

We present how a distributed collection of government, private, and social media based individuals (i.e., MakerPro members) collectively sought to construct a regionally appropriate and globally distinctive actionable vision of an ecology of technological innovation. We divided our Findings into two parts: the first presenting a critique of the status quo in Taiwan, and the second presenting several proposals for intervention to bring about a better near future. For the critique, MakerPro participants recognized Taiwan's great successes with traditional manufacturing but recognized that this model was in decline. As for the intervention aspect of their discussions, MakerPro participants, like many others, propose an innovation-driven economic strategy instead, and they offered a number of strategies to facilitate the emergence of an ecology of technological innovation in Taiwan. In what follows, we use quotes from MakerPro members' own Facebook posts and comments to explicate the two.

MakerPro's Critique of Taiwan's Status Quo

The founder of MakerPro, an entrepreneur who dedicated to strategizing the process of making to market, cited the opening of *A Tale of Two Cities* by Charles Dickens to express his take on Taiwan's technology industry in his May 23, 2016 post: “*It was the best of times, it was the worst of times [...] This paragraph can also be used to describe what Taiwan's technology industry is facing. We all know that innovation has become a global theme, but what's our role? We have lost our traditional strengths in engineering industries – the golden era of mass production has faded, and success no longer builds on local cheap labor.*”

His post echoed many MakerPro members' concerns: They were witnessing the dramatic change in the world economy

– the dissolving of the traditional core-periphery economic/innovation model, as Saxenian [20] suggests. As one of the peripheral economies, Taiwan had grown into a high income country (2016 population: 23.5 million; 2016 GDP: 532 billion USD; 2016 GDP per capita: 22,585 USD; source: www.focus-economics.com/countries/taiwan) since the 1960s, and is known particularly for its leading micro-electronics and OEM (original equipment manufacturer) manufacturing industries (e.g., making OEM products for core IT innovators, such as Apple). Yet with these prospects diminishing while Taiwan's economy depended on them, business, policy, and IT leaders have all sought to transition to an innovation economy. In other words, instead of working as contractors or suppliers to traditional IT innovators (e.g., Silicon Valley firms), they aspire like many other regions to become independent developers of new technologies and active participators in technological advancement. The MakerPro Facebook group, thus, brought these distributed individuals together and provided them with an open platform to collectively work towards such a future—a necessary step was to carefully analyze Taiwan's competitive strengths and weaknesses in this decentralized global innovation economy.

The emerging local technology communities

Many MakerPro members considered people a key strength to develop a new ecology of technological innovation in Taiwan. For them, “people” did not refer to human labor in factories as in the mass production age. Rather, it meant highly skilled and talented individuals who were familiar with the local context including the subtle social, cultural, and political settings and who were able to form a network of regional technological clusters. For example, in a reply to the question “*What are good examples of maker to market in Taiwan?*”, a member wrote, “*The best way is not do it for fun or do it to solve a problem but DIWO (do it with others). [...] Innovation benefits from sharing with the larger community and finding someone to work with. Isn't this the best thing about Taiwan makers? We understand Taiwan and we understand each other. We share resources, equipment, and knowledge. We may visit the whole world but we come back to make a better home. Together we are stronger.*”

Saxenian's Argonaut theme is unmistakable here (“*we may visit the whole world but we come back to make a better home*”) and returns throughout our data. Another post described the author's successful case of hardware innovation and pointed out: “*The best experience of creating new hardware in Taiwan is: if I encounter problems and even Google cannot tell me the answer, I can always find someone (online or offline) in this community to ask. I also can easily find collaborators to subcontract part of the work. Since the first release of my product, I have received tremendous critiques and suggestions from the community. I think this open network has offered invaluable help to me.*”

For many of them, Taiwan's people and their knowledge, experience, and connections made Taiwan's future promising – everyone contributed to building active local technology communities, pooling together a variety of individual expertise ranging from design/development to marketing. Most importantly, the shared enthusiasm for making Taiwan emerge as an independent technology power drove them to engage in collective innovation. As a result, local technological capabilities were fostered, as this member summarized, again alluding to the Argonaut phenomenon: *“what we are thinking and doing is co-creation. We all have different backgrounds: industry design, UI/UX, engineering, anthropology, sociology, or storytelling. Some spent years overseas and then returned, some never leave the island. We just come together to do what we want to do – this is not new in this land; it has been our belief and group action in the recent 20 to 30 years.”*

The legacy of traditional industries

While many members were proud of Taiwan's history of being a leader in engineering and electronic industries, they considered such a legacy both a strength and a weakness for supporting and advancing Taiwan's IT innovation. The following post expressed such a mixed feeling: *“Would traditional factories disappear? They are the reason why our electronic industry was so successful before. They are also the reason why we have to change. Many ODM [original design manufacturing], OEM, and EMS [Electronics manufacturing service] factories are panicking today—big orders are fewer and fewer and production lines are left unused. But if they are flexible enough to meet creative minds' needs, they have a brand-new opportunity.”*

It highlighted a major challenge that the formerly thriving manufacturing industries in Taiwan are facing in a changing world: In a post-industrialization age, the key to success has shifted from capacity of mass production (e.g., factories) to capabilities of creation and innovation. Other members expressed similar concerns regarding the so-called “OEM mindset.” One wrote, *“The key for our manufacturing industries is to change their mindset: they get too used to the OEM stereotype – produce only after receiving a big order. The way to create value in the US is to innovate, while the way to create value in Taiwan is to lower down the cost.”* Another agreed: *“Our electronics industry was too successful in the past, which had limited many people's thinking. They rest on their laurels and do not want to acknowledge [...] new challenges – IT innovation, software and hardware, and entrepreneurialism.”*

On a more positive note, MakerPro members recognized strengths of Taiwan's traditional manufacturing industry and of the predominance of small and medium-sized enterprises, as this post pointed out: *“The global economy is focusing more on localization and customization. It actually works in our favor. Our manufacturing industry used to only emphasize mass production. Now it may change to mass customization: an innovative IT product can easily be*

manufactured in Taiwan with low cost because of our traditional strength and high flexibilities. I think this is our unique advantage.”

Taiwan's manufacturing is viewed as a double-edged sword. Currently in decline and stultified, this industry is inhibiting Taiwan's transition to an innovation economy. More positively, this same industry offers a highly advantageous foundation on which to pursue at least two aspects of the innovation economy: (1) sufficiently deep and widespread skill to pursue a highly technical IT agenda—with an engineering population as concentrated and skilled as any in the world, and (as many pointed out) much cheaper than most; and (2) the manufacturing infrastructure to serve an economy based on mass customization.

Regional Cooperation/Competition

As the traditional core-periphery economic/innovation model fades, formerly peripheral economies potentially rise: they collaborate and compete as networked economies. For Taiwan, the most significant cooperative/competitive relationship with other formerly peripheral economies is the Taiwan-mainland China relationship. Stepping cautiously around the hotly contested political debate concerning Taiwan's status with regard to mainland China, many members endeavored to raise the public awareness of Taiwan-mainland China in the era of global innovation. They often considered these two economic entities mutually dependent but also competitors:

The advantage of Shenzhen over Taiwan is not only about technology but about a whole ecology. Don't look down upon the collaboration between Shenzhen makers and Silicon Valley startups. Once those startups mature, Shenzhen is the biggest beneficiary. Maybe in the near future, more capital will leave Taiwan and more Taiwanese entrepreneurs will move to Shenzhen. The competition between Shenzhen and Taiwan is already here. The best way to deal with it is to make Taiwan more open and international instead of blocking Shenzhen.

Similarly, in a post that discussed collaborating with OEMs in Shenzhen and in Taiwan, many members compared their experiences and summarized appropriate and effective approaches/attitudes to cope with the growing competition from mainland China. The following four quotes are from different comments written by four different participants:

[If manufacturers see] no quantity or no forecast, they are not going to accept your orders. But this practice literally gives the genuinely good and innovative ideas to those competitors in mainland China. I think if manufactures in Taiwan can change their mindset, plus collaborating with makers and startups, we will have tremendous advantages over China in cutting edge industries such as robotics.

What we need is to encourage tech innovators to create and promote their own brands. [...] That's how Dajiang [a drone manufacturer in Shenzhen] became successful. They started as makers!

I think the best way is to make good use of Taiwan makers' design expertise and then move the large quantity production to mainland China for lower costs. That's what we need: integrating the varied resources and advantages across the strait.

Yes now we have an advantage in terms of quality and innovation. But how long can we maintain such an advantage? I think there is no need to be scared by competition. Shenzhen is becoming a world factory. [...] Again, my point is not to show how cool Shenzhen is. My point is how Taiwan can make good use of resources and services that Shenzhen can provide.

These four quotes position the relationship between Taiwan and Shenzhen in four different ways. The first proposes a competitive relationship, where Taiwan is handing its advantage over to its competitor; the second proposes one of inspiration—Taiwan makers can be inspired by Shenzhen successes; the third sees a cooperative relationship, where Taiwan and Shenzhen perform different roles in the new economy; the fourth views Shenzhen as a resource for Taiwan, and as Shenzhen improves, so does Taiwan benefit downstream.

Government policies for/versus individual innovators

Taiwan's technological innovation is significantly influenced by the national development plan "Creative Taiwan" that launched in May 2009 and the "Cultural and Creative Industries Development Act" that became law in 2010. These policies construct a vision of Taiwanese culture that can serve the local economy while also placing Taiwanese brands on the global market. This creative industries policy seeks, among other goals, to small family craft businesses into international brands, as well as to stimulate IT startups by integrating Taiwanese creative practices—craft, art, and design—into IT R&D and entrepreneurial clusters. However, government policy appears to underestimate the depth of the differences between cultural creativity and technological innovation, and also between bottom-up innovation and top-down policymaking [3]:

[We makers worry about] the excessive special attention from the upper level (e.g., Department of Industry, Department of Education, and Department of Labor). [...] If those officials do not understand the community of makers and cannot provide systematic and sustainable policies, it is more likely for them to hurt the healthy development of maker ecosystem. [...] Of course, makers need resources such as space, tools, study materials, projects, and ideas. Yet the role of government officials is not to provide makers with some resources so as to achieve their own Key Performance Indicators (KPI), but to actively and humbly participate in makers' plans and actions as partners.

This post triggered a lengthy discussion regarding the role of government in Taiwan makers' endeavors to innovate. Within 7 days, it received 225 likes and 142 comments. Its most provocative claim is tacit: the maker community, not

the government, should be setting the agenda; the role of government is to go along with and financially support it. Part of that is the political assertion that the government provides resources based on its own (and, according to these speakers, misguided) performance indicators. Stronger still is the assertion that the proper role of government is one of "humility," seeming to imply subservience.

Others proposed a more equal partnership. *"I don't think it [the government's involvement] is a bad idea. We at least can get sufficient resources and support. A movement that even doesn't have resources to sustain itself will not be able to grow."* Another responded, *"Just depending on makers themselves is not enough. Many people hate the term 'make money' even when they just hear it. This mindset will never lead to sufficient resources and support."* This view acknowledges that many makers are more into technology than business, and so the implication is that makers should pursue innovation and the government should provide financial resources to support that.

Another suggested that part of the problem is that Taiwan's makers are insufficiently differentiated from each other, making it more difficult for the government to understand their potential impact and support them accordingly: *"[I saw we] let each makerspace in Taiwan focus on a specific domain such as environmental protection, agriculture, fabrics, water resources, aerospace, national defense, education, robotics, drones, etc. Today, all the makerspaces are quite similar and have no unique goals. We should propose a Maker x.0 Manifesto. [...] Then the government would hear our voice and know what we really need, which can even lead to new national policies."*

If this speaker is right, it might help explain the misalignment between government KPI and what the makers view as their "real" needs and outcomes. More explicitly tying making to economic domains might enhance the government's ability to perceive their value, which could facilitate better decisionmaking from the government.

In summary, Taiwan is a manufacturing powerhouse, built on its capacity to engineer and manufacture IT components at scale. This economy is now in decline, dragging all of Taiwan's economy down with it. The MakerPro community expresses near-universal support for the implementation of a new innovation economy as the solution, though of course there is disagreement about the details of that implementation. There is surprisingly little debate about the overall vision of the innovation economy—an issue we return to in the Discussion.

From IT R&D Agenda to Sociocultural Agenda

The foregoing section outlines MakerPro's critique of Taiwan's IT/economic development agenda, and we now turn to the ways it is proposing strategies for intervention and constructing IT imaginaries for the island's near future.

"Brain circulation"

Saxenian [20] distinguishes "brain circulation" from "brain

drain.” *Brain drain* refers to the movement of talented, high skill individuals from peripheral regions to core ones. In contrast, *brain circulation* reflects trends toward global mobility and the phenomenon of the “new Argonauts”: it refers to the movement of skilled technical and entrepreneurial talent in and out of what used to be peripheries and hubs. Saxenian suggests that brain circulation has become the key for formerly peripheral regions to grow into independent technological powers.

Many MakerPro members, while not referencing this specific language or Saxenian’s writings, express similar ideas. For example, one poster argued, “*In the past, Taiwan’s industries did not quite understand how to design a product with emotional value—like how Apple can design their products based on consumers’ aesthetic tastes and lifestyles. Instead, the main goal of Taiwanese designers was to solve whatever engineers wanted and to lower the cost. Luckily, this is changing now: a group of designers, artists, engineers, and entrepreneurs who were educated overseas and then returned, together with our local talents, lead the effort to focus on designing the product itself instead of always emphasizing manufacturing and cost.*” Here the influence of the creative industries policy view that art/design are stimuli for innovation is clear.

Another poster emphasizes the local role of developing talent in the first place: “*The Department of Education plans to invest billions to establish makerspaces in high schools. In my opinion, they should first select 20 schools, provide each with 200,000 Taiwan dollars, and let each school create its own makerspace. Based on the outcome, the department can promote this plan in more schools. My rationales are: (1) schools are different so their makerspaces should be different; (2) the key is to create the most efficient makerspaces using minimum amount of money, which requires creativity and time. [...] (3) we need to clarify what the purpose of such makerspaces is.*” The substance of this post is directed at education policy, not the content of making. We have seen this move by makers in Taiwan elsewhere [Anon], and it constitutes direct evidence of our claim that makers are setting sociocultural agendas—and government investments and curricular changes clearly reflect this input—even if not always to the makers’ liking. Put another way, the new Argonauts are not just bringing back IT skills and entrepreneurial initiatives to Taiwan, but also education policy concepts.

Design for manufacturability (DFM)

Another intervention strategy is to develop new industrial models. One proposal is to shift the focus from OEM to Design for Manufacturability (DFM). Instead of producing massive orders inexpensively, DFM emphasizes close collaboration between innovators and manufacturers: “*Makers’ task is to materialize ideas, but if we aim for mass materialization even commercialization, we need to collaborate with local manufacturers. Successful prototypes or small production is still far away from ‘ready for the mar-*

ket.’ Design for Manufacturability indicates the possibility of mass production for customized products, which guarantees safety, stability, and consistency. Therefore, innovators should not treat manufacturers as merely suppliers but collaborators.”

Another post described a small startup IT team’s successful crowdfunding and their extreme pressure to produce 8,000 pieces of products in three months: “*Our crowdfunding was super successful. Suddenly we had a lot of money, but it also forced us to hasten our plans: we got 8,000 orders, which means we had to have three-year’s products in basically three months. It was so hard to find a manufacturer who could do this. Eventually we found one but the process was so tough. My suggestion for all innovators: Design has to take manufacturability into account, otherwise you will get to a dead end when proceeding to mass production.*”

Stated in a general way—that inventors and manufacturers need to cooperate meaningfully—it sounds almost banal; but the significance lies elsewhere. Designers everywhere would benefit by understanding manufacturing processes and capabilities, but designers in Taiwan have access to some of the most sophisticated manufacturing capabilities in the world. If they leverage this fact, and if manufacturers are forward-thinking enough to participate, they have identified a regional advantage.

Maker to Market

DFM is one industrial model proposed by MakerPro participants; another is *Maker to Market*. On September 26, 2015, the founder of the MakerPro group posted a summary of a meeting he had had with other community leaders. The meeting had three foci: how to facilitate the communication between the government and maker groups so as to distribute government-funded resources with the highest impact; how to translate outcomes of making into the language of KPI that the government uses for decision-making; and how to differentiate the *maker to startup* model from the *maker to market* model.

This post triggered a series of comments regarding what the most appropriate business model for making and technological innovation in Taiwan can be. One member commented, “*I think maker to market is more realistic than maker to startup. Innovation means advancement and applying knowledge in practice. It is more than just ‘thinking’ or ‘inference.’ Having a startup is related to but different than innovation. It will be disastrous if we are forced to always talk about startups when discussing innovation!*” Another agreed, “*In my opinion, maker to market is more appropriate for today’s Taiwan. Our goal is not to introduce an unrealistic dream of ‘everyone can be a CEO’ but to nurture our inner desire to make new things.*” Examples of maker to market approaches included: providing workshops and training after work; selling signature products to peer makers and gathering advice of improvement from them; contracting to provide service to pre-startup, and so forth.

These comments assert a distinction between innovation and entrepreneurship, which runs counter the dominant neoliberal ideology underpinning the innovation economy. It underscores a theme we have seen earlier in our results: many makers are more skilled with technological innovation than business innovation, and they do not want to be forced into entrepreneurial roles.

Making, arts, and crafting

MakerPro has also been influenced by the concepts of cultural industries policies. MakerPro posters proposed that Taiwan's traditional artistic and craft traditions—when combined with Taiwan's regional strengths in engineering and manufacturing—offer an opportunity to pursue regional advantage. Along these lines, one poster wrote, *“I used to work in the wood processing industry. Many of those factories are gone now. Many experienced crafters in this industry have left because there was no value and respect left. [...] I chose another path—combining design, arts, and technology. I use computer numerical control (CNC) to process wood so as to meet designers' and artists' strict requirements for modeling and texture. Of course, delicate handwork is still desired—it is the core of Taiwan's culture of crafting. But the use of technology not only adds extra value to the work but is also reviving this traditional industry and its highly skilled crafters.”*

Many members believe that interweaving traditional Taiwan culture and arts into modern technology will help Taiwan to stand out in regional and global markets. A different poster echoes the previous quote: *“It's time to reemphasize the expertise and skills of our craftsman—they, along with those small workshops, constitute Taiwan's identity. They are our treasures. Yes, the manufacturing industry may face some challenges, but the need for delicacy is actually booming. Manufacturing is not just OEM. What we need to do is not just accepting ordering but use craft to support innovation.”*

Both quotes emphasize the significance of “delicacy.” It is an aesthetic term that has strong connotations of precision, refinement, and elegance. Delicacy bridges the world of precision manufacturing, for which Taiwan is famous, and the world of art and craft—opening up a cultural-technical framing of future innovation.

Fostering toleration of risk-taking and failure

Some MakerPro members attributed the tension between government and innovators to risk-adversity in Taiwan's culture. A post on August 11, 2016 used how Taiwan government reacted to the success of Pokemon Go as an example: *“Witnessing the worldwide popularity of Pokemon Go, the Executive Yuan of Taiwan asked the Ministry of Culture to report about science and technology development. Their hope is to incorporate culture with science and technology in order to develop a Taiwan-based tech product that is as successful as Pokemon Go. However, if you have read two articles that were recently published in Business Weekly, you will know why it is almost impossible for Taiwan to*

develop such a product of worldwide popularity.” The poster argued that the most serious issue of Taiwan's technological innovation was to overemphasize external, tangible benefits (e.g., revenue and similar KPI) while ignoring the internal value of a product (e.g., aesthetic qualities of warmth, intimacy, care, and creative surprise).

This post immediately attracted many MakerPro members' attention and triggered a heated discussion. From August 11 to September 26, 2016, this post received 79,000 likes, 3,874 shares, and 183 comments. Many members added criticisms about the revenue-driven approach in Taiwan's tech industry and the government's seemingly superficial policies for technological innovation. One wrote, *“It's so ironic to see the government's claim to promote cultural creativity. This is a typical example of how Taiwan government and investors treat new products and phenomena, which is two 'Nos': No this, and no that.”* Another added: *“what those government policies are doing is to buy out fruits of innovation not to encourage real innovation.”*

MakerPro members made suggestions to create a culture that is friendlier to experimentation and risk-taking. One argument pinpointed how risk aversion is baked into KPI: *“If the government considers innovation crucial for Taiwan's development, they should think more about how to make [...] the system tolerate mistakes and failures—forget about paperwork, political achievements, and KPI.”* Another pointed to the prioritization of loss prevention over societal benefits: *“This may be due to the sociocultural context in Taiwan. However, such an attitude has become inappropriate in an era of global innovation. How can we win in this competition? Keep being OEM for others or gaining control of price and platform? It's time to leave our comfort zone and explore the new frontier.”* Innovation will succeed in Taiwan if it undergoes a sociocultural attitude change—which, if anything, sounds like a regional disadvantage. As another poster elaborates, *“it is not easy to promote entrepreneurship and experimentation in Taiwan, because they do not fit our mainstream values. We also don't have a strong garage culture and DIY culture as those in Western countries such as US to support them. The current maker movement is an opportunity to make changes.”*

MakerPro recommendations to the government

Following these discussions of feasible strategies for inventing IT imaginaries in Taiwan, MakerPro members further engaged in proposing recommendations to the government with the hope to incorporate and take advantage of various resources and stakeholders (e.g., government funding/support, civic participation, and domain experts) to make their imaginaries come true. A post on March 22, 2015 demonstrated such an effort and its outcome. It states, *“From the government's perspective, what is most needed to build a maker ecosystem? Then from a bottom-up perspective, what can we, as makers, can do? I hope we can come out a doable plan that we can share with the government officials and the public.”* This post quickly triggered a

heated discussion regarding different roles of stakeholders and how to make the best of their advantages. Here are three different responses:

In my opinion, it will be important to build an open-source hardware ecosystem in Taiwan. If we can focus on investing in a few good platforms for hardware and software innovation so as to create product/business roadmaps for makers and innovators, we can have a few successful examples of tech innovation that people can follow.

I think the relation among makers, industry, and government will be increasingly close and complementary: more and more tech companies will seek project ideas at Maker Faire or Kickstarter, while makers can be more creative and innovative with support from industry and government.

What we need is cooperation among different stakeholders! Even when we just start designing and prototyping a potential product, we should know OEM's capacity and requirements. We also need to know the government's tech policy, what their priorities are, and how we can make good use of those policies to benefit our products.

Though they differ in their particulars, all propose new alignments among makers, business, and government.

DISCUSSION

We have shown how the pursuit of *regional advantage* in Taiwan entails the cultivation of innovation hubs that reflect the island's distinctive economic and political history as well as its cultural traditions, and further that this work can itself be a bottom-up process. In other words, MakerPro not only offers an IT R&D agenda (e.g., “how making will contribute to IoT”) but it also offers a *national sociotechnical imaginary*: it is national, because macro-level actors (including government, private, and social media based groups) coordinate to produce a vision meant to encompass the entire island. It is sociotechnical, because the vision intermingles socio-ideological matters (e.g., a shared sense of Taiwan's history, values, tastes, and aspirations) with a concrete and pragmatic IT agenda, situated in (and also influencing) business strategy and economic policy.

Four Double-Edged Swords

But it is a deeply conflicted imaginary. We noticed time and again that its greatest obstacles could not be separated from the resources it depends on to overcome the obstacles! One example is Taiwan's *successful history of traditional industries*. Traditional manufacturing drove Taiwan's economy for decades, making it one of Asia's “four tigers” (along with Singapore, Hong Kong, and South Korea). This now fading success has many Taiwanese manufacturers stuck in the past, unable to adjust to a changing world—even rejecting orders from the very kinds of innovation that would carry them forward. Yet this manufacturing capability is also where Taiwan's biggest hope for an innovation ecology is—it underlies the possibility of Taiwan to be a global leader in manufacturing for mass customization.

Similarly, MakerPro participants express ambivalence concerning Taiwan's *proximity to Shenzhen*, the economic success story of rising rival mainland China, offering a multi-level threat to Taiwan. Shenzhen is responsible for a notable percent of the decline in Taiwan's manufacturing orders; its own status as a regional innovation hub offers stiff competition to Taiwan; and its success economically powers a rising China that isolates Taiwan and vows to return the island (nation or province?) to its control, by one means or another. Yet Shenzhen is also considered one of the most resourceful and convenient suppliers for Taiwan's IT development. It is located right across the Strait, a less than two-hour flight away from Taipei. It shares a common language—Mandarin—and cultural history. And major Taiwanese companies, such as Foxconn and many others, have major investments in Shenzhen. The Shenzhen maker movement is world renowned, and mobility of makers and maker practices between Shenzhen and Taipei is high [18].

Finally, Taiwan's *government* is another source of ambivalence. The government is strongly supportive of the innovation agenda and has devoted considerable resources to making and IT innovation in Taiwan. Yet the government also interferes with the innovation ecology in Taiwan, shoehorning all outcomes into its key performance indicators (KPI). These KPI fail to map onto the qualities of bona fide innovation hubs—ones that tolerate and even reward risk-taking. The government appears to want to direct bottom-up innovation from the top-down.

On an even deeper level, the pursuit of Taiwanese regional advantage appears to simultaneously entail the preservation and rejection of *Taiwanese cultural dispositions*: preserving its arts and crafts traditions and tastes, while replacing its attitudes towards risk/safety with those imported from more freewheeling cultures, such as those of the United States. All of these double-edged swords represent both Taiwan's struggles and progresses in redesigning and reimagining its IT agenda in the global innovation economy, making Taiwan's *regional advantage* also its *regional dis-advantage*.

They Could be Heroes

This last point—that the pursuit of Taiwanese regional advantage appears to preserve and to reject Taiwanese culture—stood out to us, encouraging a more critical stance towards Taiwanese makers' efforts to pursue regional advantage. We realize that the theory of economic development that MakerPro participants are proposing is not Taiwanese. The idea of the innovation economy, with its concepts of innovation hubs, creative clusters, FabLabs, regional advantage, and “design thinking” has global currency today, promoted by experts from Stanford and MIT, *Harvard Business Review*, and so on. As noted in [3], these ideas have had enormous, if controversial, impact on policy and decision-making in Taiwan.

This model of economic development also has its *heroes*: the innovators themselves. These innovators are implicated in technological development as societal transformation.

These are the likes of Steve Jobs (with his DIY garage story) and Mark Zuckerberg, who generate wealth, jobs, and political power almost beyond measure. “We just need a Taiwan Facebook” we heard in so many interviews, referring to the invention of a global IP from Taiwan that, beyond its own success, would, in a virtuous cycle, attract inventors and investors from all over the world. MakerPro is creating the fertile ground, and culture and society itself should (to re-use a quote from earlier) “*actively and humbly participate in makers’ plans and actions as partners.*” In short, the makers of MakerPro might be attracted to this vision of innovation because they are its protagonists. Perhaps it is no coincidence that Saxenian refers to many of these same people as “Argonauts,” that is, as metaphorical heroes from Greek mythology. The line between IT R&D agenda and cultural myth is a delicate one.

We do not have an exact number on how many MakerPro participants are “Argonauts” in Saxenian’s sense. Yet our data offer empirical evidence that Taiwan’s IT Argonauts are not only bringing technical know-how and entrepreneurial tactics back to Taiwan. They are bringing back an ideology—one of individualism and labor in service of economic development as the primary goal. The fit of this ideology in a culture with collectivist tendencies, where a commitment to Taiwanese ways of life (as opposed to economic development as an end in itself) is prevalent, seems questionable. Further, their extensive use of English-language IT media (e.g., in the links that they share and discuss) suggests that MakerPro is not insular, but rather is a group with broad global ties, particularly to the US and Silicon Valley. In other words, there is a “virtual Argonaut” effect, where American and/or European IT trends continuously enrich and provoke—but do not determine, or set the agenda for—IT imaginaries in Taiwan. We interpret the ideological conflict and the “virtual Argonaut” effect as potentially explaining the deep ambivalences towards industry, Shenzhen, government, and Taiwanese culture itself summarized in the preceding section. Stated more broadly, one of the challenges of *regional advantage* is that the concept itself is culturally contingent. It is based on an American interpretation of how and why Silicon Valley works. And that interpretation is exported to peripheral economies as economic development policy, business strategy, and an IT R&D agenda bundled into a highly desirable package. Ironically, it suggests that even if the core-periphery model of manufacturing is becoming obsolete, the core-periphery model of American ideological mythmaking remains intact.

CONCLUSIONS

This research contributes HCI research on supporting creativity at scale. If an understanding of organizations and institutions was required to understand creative communities of practice [10], then it seems that understanding regional innovation entails an understanding of creativity as a cultural process. Specifically, cultural issues are tied up in IT innovation agendas in at least two ways. First, creativity itself is situated in cultural traditions such as the arts; and

second, developing regional advantage in the form of an innovation ecology entails leveraging distinctive features of one’s culture.

Focusing primarily on the latter, we have highlighted how bottom-up imaginaries of innovation are both mediated by sociotechnical systems (in this case, Facebook) and are likely to result in the development/appropriation of sociotechnical systems at scale to support these imaginaries (in this case, the hope for the next Facebook—from Taiwan). We have demonstrated the complex threads that tie IT innovation to cultural dispositions (e.g., artistic creativity, attitudes towards risk and failure, etc.), and to social policy (e.g., the pragmatic challenge posed by KPI of innovation). We saw that the pursuit of Taiwan’s regional advantage at times seemed to entail a rejection of Taiwanese culture itself, a deep ideological contradiction that revealed how IT agendas cloak themselves in mythmaking, and that these myths can be demonstrably (counter-) productive. One aspect of supporting creativity and innovation at the regional scale is, therefore, attending to the subtle yet efficacious (for better or worse) roles of ideologies and myths.

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