The

INNOVATION FRAMEWORK FORWARD

Resilient and resourceful, our past and future are tied to innovators

Prepared for

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Abstract

The Innovation Framework Forward: resilient and resourceful, our past and future are tied to innovators

Developed by Yuka Nagashima of Paideia Enterprises for Enterprise Honolulu, with funding from the U.S. Department of Commerce, Economic Development Administration and the City and County of Honolulu, this report serves as a framework of a master plan for an innovation-based economy in the State of Hawaii. This report builds upon the most recent reports on innovation in Hawaii by entities such as the Hawaii Business Roundtable and the High Technology Development Corporation to provide justification for Hawaii to embrace the innovation economy, and offers a framework for both metrics and policies with sample innovation indices and initiatives. It also summarizes some of Hawaii's key innovation assets through storytelling, how they fit into our innovation ecosystem map, and how they are being used as evidence of our merging innovation economy. It offers suggestions on some action items the community can consider as steps towards this transformation to encourage innovation-drive growth.

This publication was prepared by Paideia Enterprises, Enterprise Honolulu, and the City and County of Honolulu. The statements, conclusions, and recommendations are those of the authors, and do not reflect the views of the Economic Development Administration.

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FOREWORD

Over the past several decades, there has been a dramatic shift in states in their economic development approaches with more emphasis on diversifying the economic base and growing one's own companies rather than exclusively recruiting companies. Having observed Hawaii's actions for some time, it is clear to me that there is a growing movement to broaden the state's economy through innovation. Hawaii will be better able to withstand the inevitable economic shocks and be the beneficiary of the growth innovative companies create.

The success of Silicon Valley, Research Triangle Park, and Route 128 paired with the rapid decline of manufacturing in the 1970s and 1980s inspired states across the country to explore new methods to encourage the growth of innovation and technology companies. The states were motivated to diversify their economy. State action in technology-based economic development can be traced back to the early 1960s, but it really took root in the early 1980s with the creation of Pennsylvania's Ben Franklin Technology Partnership and Ohio's Thomas Edison Program.

The importance of these jobs cannot be understated. A study conducted by the Center for Economic Development at Cleveland State University found that between 2004 and 2008, employment in Ohio's high-tech industries increased by more than 19,000 jobs while employment in all other sectors in Ohio declined by more than 7,000 jobs.

The results of the investments have been impressive. From just 2007 to 2011, the Ben Franklin Technology Partners' client firms created more than 7,400 jobs, and the commonwealth's investment of $137.7 million in state tax dollars during that time generated $358 million in additional state tax receipts.

But these were not overnight success stories. They were the result of a long-term commitment by state government, universities, the private sector, foundations, and local government, and they were investments being made reflective of regional strengths. In Ohio, the Edison Program and the Third Frontier have operated under five different gubernatorial administrations, and Ohio voters approved ballot initiatives twice to fund the Third Frontier. In Pennsylvania, the Ben Franklin program was created under Republican Governor Dick Thornburgh's administration, but has been embraced by two Republican and two Democratic succeeding governors.

In recent years, there has been an explosion in activity by both the public and private sectors. There's been dramatic growth in accelerators, angel investing tax credits, proof-of-concept funds, and venture development organizations.

These are exciting developments, but we know from experience that success is dependent on several factors:

- States and regions should be trying to grow their technology and innovation economies based on what makes sense for their areas—their assets, strengths and culture—not by blindly copying Silicon Valley, Research Triangle, Route 128, or another state's approach.
- The public sector can play a catalytic and facilitator role, but success will ultimately be achieved only if the private sector supports the activities—and supports them not out of a sense of good corporate citizenship but as a result of the approach being good for their bottom line.
- The effort is sustained and coordinated. Silicon Valley, Research Triangle, and all of the other successful technology examples resulted from decades of investment. Sadly, across the country, there are examples of efforts that failed because they were one politician's vanity project that had no basis in reality.
- The results of the work are measured and adjustments are made to activities and operations. Technology and innovation change rapidly, and our efforts to encourage economic growth through science, technology and innovation must adapt to the changing economic conditions and the results (or lack thereof) of our efforts.

Based on Hawaii's past investments and assets, it is well positioned to move forward. And in some respects—its positioning both geographically and culturally with Asia, its better than national average in educational attainment—it is better positioned than other states. However, to take advantage of this opportunity, Hawaii's private and public sectors must come together to make a sustained commitment to investing in its technology and innovation assets.

Dan Berglund
President and CEO
State Science & Technology Institute (SSTI)

PREFACE

"The real source of wealth and capital in this new era is not material things. It is the human mind, the human spirit, the human imagination and our faith in the future."

— *Steve Forbes,*
President and CEO, Forbes Inc.

Aloha kakou.

In 2008, the Center for Regional Economic Competitiveness released a report on technology and innovation in Hawaii. That report recommended that a statewide innovation plan be developed to bring together the stakeholders and current efforts, and to address remaining gaps. This report provides such a framework for the plan, building on the most recent Hawaii's Innovation Asset report by Hawaii Business Roundtable and the State of Hawaii's Cybersecurity report, and other national and international best practices in innovation.

We consulted a wide spectrum of stakeholders and experts to gain a holistic view of the status quo and the future they envisioned for Hawaii, from Hawaii entrepreneurs and established business owners, to policy leaders and economic development experts around the globe. Despite their different perspectives, three common points emerged:

1. Innovation can be the basis of a much needed economic transformation;
2. Hawaii is poised to embrace the innovation economy now; and therefore,
3. Hawaii must take advantage of innovation to move forward.

In fact, the interviews further revealed that despite the existing gaps within the ecosystem, innovation is already taking place in different segments of our community, fueled by passionate individuals who became the change they wanted to see in Hawaii.

It may surprise some to learn that Hawaii has a history of world-class innovation. The fundamental strengths that have inspired these innovations remain today; therefore, our challenge is to capitalize on this foundation so that we may capture the economic benefits of innovation. This report celebrates what we have and seeks to inspire our vision for the future.

We urge all of you to take part in this shared vision of an economy based on innovation by taking the steps recommended in this report to further Hawaii's economic transformation. When we connect the dots, our economy can be more than the sum of its parts.

We appreciate the City and County of Honolulu and the Economic Development Administration of the U.S. Department of Commerce for recognizing the need to move forward on innovation at the local level by providing the funding for this report. We would also like to thank the entrepreneurs, policy and business leaders, and economic development practitioners both in and outside of our community who have contributed to this report.

Pono Shim
CEO, Enterprise Honolulu

photo credit: PBN

Yuka Nagashima
Paideia Enterprises

"For centuries people assumed that economic growth resulted from the interplay between capital and labor. Today, we know that these elements are outweighed by a single critical factor: innovation."

— *Bill Gates,*
Co-Chair, Bill & Melinda Gates Foundation

EXECUTIVE SUMMARY

Hawaii's economic growth in the last 20 years still lags behind the national average, despite the recent recovery of the tourism industry. If we are to provide the quality of life we have come to expect or to leave a better Hawaii to the next generation, we must change how we approach economic development in our community. In the traditional model, a government agency or business group may use data to identify a new industry and will then develop infrastructure and incentives to encourage the growth of this industry (sometimes known as "picking the winner"). We propose Hawaii consider a new model called '**innovation-driven growth**'. Under this new model the focus is on "innovators" in the entrepreneurial segments of existing industries already committed to doing business in Hawaii. Firms that are innovators in the entrepreneurial segment are characterized by having a **high growth potential with faster growth** per year than the underlying economy, having **exportable goods or services**, and being **scalable**—meaning output efficiency increases with the size of the companies' operations. While some roles remain the same, in general, an innovation-driven growth strategy requires a more versatile and nuanced role by the government, informed by the community and market feedback. For example, government must still provide and encourage the provision of certain physical infrastructure, such as broadband, but top-down business attraction by the government will not work.

This approach works even if the majority of the community is not considered innovators. We only need a small percentage of firms in the entrepreneurial segments to be innovators, because they act as major drivers of the economy with a high multiplier effect (where a creation of one job in a particular field results in multiple jobs created in the rest of the economy), raising the wages of the rest of the community (Moretti, 2013).

This report provides justification for the vision and offers some frameworks for both metrics and policies with sample innovation indices and initiatives. It first presents Hawaii's economic history, which shows that we have undergone several major economic transformations successfully. The report then presents the three components required for any economic transformation: infrastructure, talent, and capital for the agricultural economy of our past, the current tourism industry, and the emerging innovation economy. Lastly, it identifies some of Hawaii's assets through success stories to show that we are poised for this transformation. By finding these bright spots and learning how they have achieved success in our particular environment, we can scale our innovative operations, accelerate our growth, and replicate the impact statewide. This report strongly advocates for Hawaii to enrich its innovation ecosystem in order to support the entire continuum of the innovation process and the components that support that process: research, commercialization, information technology infrastructure, training, marketing, and job creation. By **increasing the "network density"** (the number of participants and the connections among them) in our innovation ecosystem, we increase the opportunities for collaboration and the cross-pollination of ideas that result in impactful innovation. Recommendations to innovate our paradise are organized under the categories of: **infrastructure**, **talent**, and **capital**.

THE VISION:

Hawaii, a world-class innovation economy

We will make Hawaii a world-class innovation economy, which preserves and values the unique culture of our community today and in the future, by nurturing the high-growth and entrepreneurial segments of all of Hawaii's industries.

While Hawaii has many of the elements needed for this innovation transformation, this report has identified one significant gap: a lack of a go-to innovation entity, which commands the respect of both the public and the private sectors. Most of the states prioritizing innovation adopt an umbrella structure that functions as the main recipient of innovation funding, thereby helping existing innovation-related agencies come together to meet their goals. Another step this report recommends is the creation of an innovation council, whose membership would consist mainly of respected business leaders, but also with active participation from the state legislature and statewide innovation entities. This council would then craft the policy that is then implemented by public and private entities. Other states that have been successful in jumpstarting their innovation economies have all realized that innovation is a process, and it cuts across many fields requiring different talents, and that no single entity can execute this transformation alone. Equally important is the longevity of the umbrella structure and the council, as economic transformation of any type takes 15–25 years. It is essential that the commitment to this vision outlasts political and fiscal cycles.

Establishing a shared vision to make Hawaii a world-class innovation economy, with holistic policies backed by public-private partnerships and investments can accelerate the high-growth and entrepreneurial segments of Hawaii's industries. This approach can help Hawaii avoid some of the economic development challenges we have faced in the past.

KEY RECOMMENDATIONS

- **Identify** a go-to entity devoted to innovation that is respected by both the private and public sectors
- **Provide** dedicated funding streams or mechanisms for innovation initiatives
- **Align** and support initiatives that contribute to the infrastructure, the talent development, and the capital needs of the innovation ecosystem
    - Require all new government buildings to support gigabit broadband connections
    - Leverage government's need for services as an opportunity to support local startups as a key customer
    - Open excess government-owned buildings or land for proof of concept centers/ demonstration space
- **Support** the HI Growth Initiative, which focuses on scalable and exportable ventures
- **Shift** university research commercialization from an exclusive license model to the transferring projects model
- **Use** community colleges as innovation campuses to accelerate university research commercialization
- **Agree** on the metrics for innovation performance and the methodology
    - include "date of first use/purchase" in assessing the effectiveness of tech transfer
- **Designate** a state entity to consistently report on the agreed-upon metrics

INTRODUCTION

Whether you are a business owner, policy maker, educator, or a parent, we all want Hawaii to prosper. Hawaii, unfortunately, has not kept up with the economic growth of the United States: while the U.S. on average experienced 2.5% growth in its economy over the last 20 years, Hawaii's growth rate during the same period is lagging significantly at 1.2% (DBEDT, 2014). Despite the fact that the existing engines of our economy, such as tourism, agriculture, military, and government are performing, we need a new approach to be able to close the growth gap. How can we amplify our strengths to continue to sustain the quality of life we have come to expect? It is unrealistic to expect these sectors of our economy to expand given the limitations of hotel rooms and airline seats, or future earmarks and employment by the public sector. Climate change will further challenge Hawaii and our tourism industry, with more coastal erosion, fewer trade winds, more drought and flooding (Associated Press, 2014). A new model for economic development is needed, if we want a different result.

Even before the economic maladies of the 1990s, Hawaii strived to address this challenge with a variety of initiatives with mixed success. What may have worked then, may not work any more given today's environment. Similarly, there are opportunities available now, which did not exist then, such as the proliferation of broadband, social media, big data, mobile technologies, and the Internet of Things that we can and should take advantage of.

Luckily, we can draw on the experiences of previous generations in Hawaii, because we have encountered and lived through several economic transformations. On the following page is a brief economic history of Hawaii:

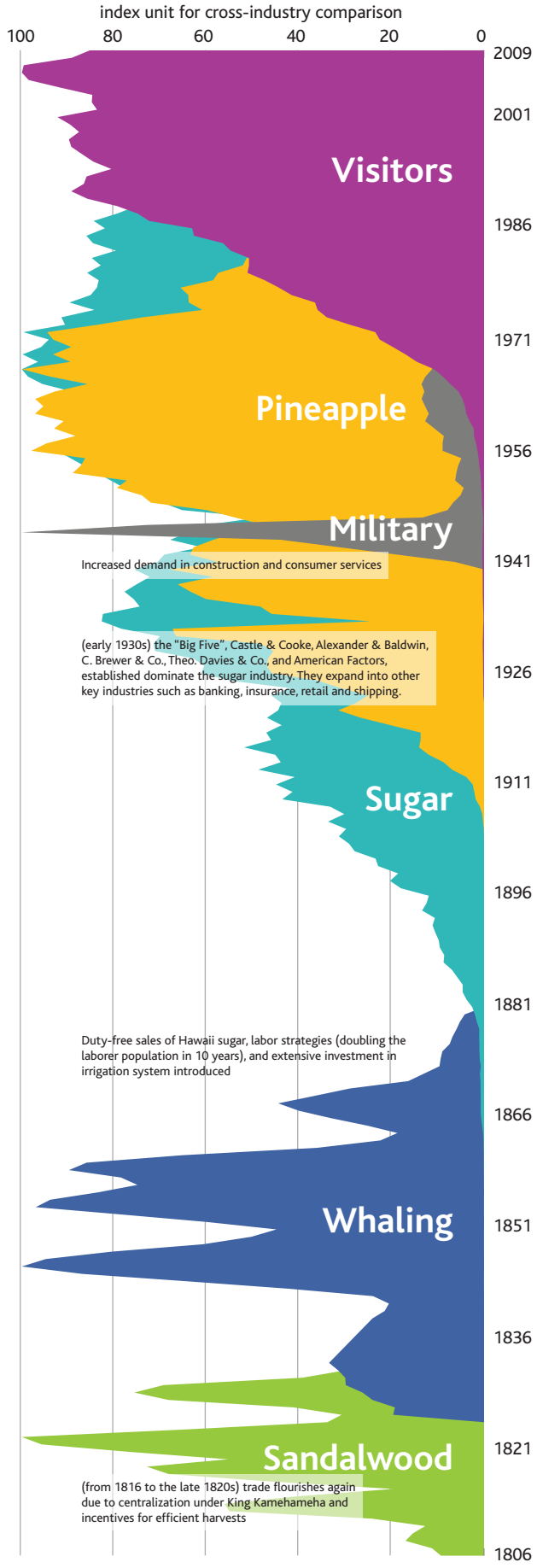


Figure 1: A Very Brief History of Economy in Hawaii (La Croix, 2001)

Based on charts from UHERO 2011

INTRODUCTION

2009

RECENT HISTORY

- 1980s: the phrase "diversification of the economy" starts to permeate the media (LA Times, 1986)

2001

- 1981: VeriFone incorporates in Hawaii
- 1983: Hawaii State Legislature establishes the High Technology Development Corp. (HTDC)

1986

- 1990s: US recession, the Gulf War, slowdown in Japanese economy
- 1990: VeriFone goes public; Hawaii Strategic Development Corp. is established by the legislature
- 1997: Hewlett-Packard acquires VeriFone
- 1999: IPO of Digital Island ($60M), 3 years after its incorporation (MIC graduate) (HTDC, 2014)
- 2000: Tech Omnibus Bill introduced and enacted (Act 297)
- 2001: Act 221 enacted

1971

» 1970s–1990s: stagnation of defense spending and agriculture industry; most growth observed in visitor arrivals

» (late 1950s) military presence increased due to the Korean War; tourism expands due to increase in commercial air service

1956

» (1945) end of WWII depresses Hawaii's economy; sharp reduction in population

1941

» (1941) Martial law declared after Japanese attack on Pearl Harbor

» (mid 1930s) U.S. Military responds to Japanese occupation of Manchuria

» (1930s) Great Depression: about a quarter of the labor force is unemployed

1926

1911

1896

» (1898) annexation of Hawaii to the United States

» (1890) U.S. government enacts McKinley Tariff, undermining the reciprocity treaty

1881

» (1876s) reciprocity trade treaty signed

1866

» (1859) U.S. Civil War, and discovery of petroleum oil in Pennsylvania

1851

» (1846) record year, over 700 ships arrive (Info Grafik, 2014)

1836

1821

» (1820) over 150 whaling ships stopping in Hawai'i annually

» War of 1812 [sandalwood trade interrupted]

» (1810) Unification of Hawaii: Kingdom of Hawaii is established under King Kamehameha I

1806

» (1778) Captain Cook reaches Hawaii

LESSONS LEARNED

Figure 1 tells many stories: 1) Hawaii's economy has been driven by one or two dominant industries based on exporting natural products until the rise of tourism; 2) each industry experienced a similar growth pattern characterized by a sharp peak then a drastic decline; 3) the dominant industries have all been based on exports, meaning external funds were brought into Hawaii in exchange for products or services; 4) external events can wildly and unexpectedly shape the market, as seen in the interruption of the sandalwood trade during the War of 1812, the diminishing demand for whale oil when another source of oil was discovered on the mainland U.S., and the effects of the September 11 attacks on tourism; and 5) governance, even in the early days, did affect commerce as seen in the sandalwood trade levels when King Kamehameha united the Hawaiian Islands and offered incentives for effective harvesting. Beyond the graph, the most controversial policy for innovation was the passing of Act 221, the tech investment and research and development tax credits. Regardless of the controversy, two pieces of wisdom gained from it were 1) a single initiative that tackled just one component of an economy (capital) was not sufficient to establish a new tech-based economy; and 2) it had an unintended effect of dividing not only the nascent tech community (between investors and startups), but placed them at odds with the rest of the industries within Hawaii, as resources poured into this sector meant less support for the rest of the community.

What have we learned from these transformations and the more recent diversification strategies to establish the tech industry in the islands? Here are five of the lessons learned:

1. There is No Silver Bullet

While it might be tempting to search for that one initiative that would dramatically improve the status quo, there is no single clever program that can transform an economy. Embracing a new industry or new type of economy requires infrastructure investment by the government, a strong workforce optimized for that economy, risk capital to jump start it, and partnerships that require coordination towards a shared vision. For the sugar industry to leverage the Reciprocity Trade Treaty of 1876, the government also had to invest in irrigation infrastructure and help address their labor supply issue. The tourism industry not only requires physical infrastructure of an airport, but also a revenue stream that finances beautification efforts and business associations united under the mission to welcome our visitors. Therefore, a tax credit scheme alone to attract new businesses won't work if we lack the appropriate labor force and infrastructure to support those businesses.

➤ *We need a coordinated set of initiatives.*

2. Transforming an Economy is Not a Short-term Proposition

Because there is no silver bullet, and because of the nature of investing and nurturing the economy, the process extends beyond election cycles and the tenure of a government administration. Therefore, it is paramount that the larger community shares the overall vision, and chooses policy and community leaders that reflect and can further that vision.

➤ *There needs to be a long-term vision shared by the community that extends beyond political cycles.*

3. The Market Alone Cannot Make It Happen

With any economic transformation, there will be gaps not met by the private sector (at least at the beginning). Government's role is to bridge these gaps. In most cases, the gaps are in infrastructure, although gaps can also include financing or growing or attracting talent. The key is identifying the specific infrastructure needed for what we are trying to accomplish. Just as the sugar industry required irrigation systems, the digital era requires robust broadband connections. It is equally important to recognize what should not be the focus for the government. Government has not been successful at "picking winners", and no new economic development approach will change that. The winners will emerge from the market, given a healthy ecosystem.

➤ *There is a specific role for government: to invest in infrastructure, to ensure there is sufficient talent available and to bridge the gap in capital formation.*

4. Avoid a Zero-sum Game

Major shifts in the economy result in a bigger "pie" when they bring in external funds (i.e., exports); therefore, we should not be approaching economic activities as if there is a fixed total amount we would all have to share. In the past, trying to grow the tech sector specifically has drawn criticism because the investments going towards the tech sector were seen as resources being taken away from other industries. Our approach and implementation must structure a different game than the zero-sum game, to foster collaborations rather than in-fighting. For the national economy, the growth of exports reduced the trade deficit by over 13 percent just between 2011 and 2013. The impact of growth in exports for Hawaii will be significant.

Until now, it was common to approach economic development by supporting an identified industry. Most recently, the word diversification was used to represent Hawaii's economic development efforts, to establish a third leg of the proverbial stool besides tourism and government (including the military). Seeding to establish a technology industry was viewed to be a potential third leg. This focus unfortunately resulted in industries being pitted against each other.

➤ *Concentrate on export opportunities where we can grow the pie by bringing in external revenue vs. competing for customers within the local market.*

5. Do not spread the peanut butter too thin (or water down the poi too much)

While the "we don't have much, but everyone got some" approach may sound fair, it does not necessarily improve the situation. When resources are spread too thin, where each economic development initiative may be given some funding but not enough to actually accomplish their goals, it often leads to the organization or the theory behind the initiative being discredited. To add to this ineffective use of funds, it also creates the need for other initiatives or entities to attempt to achieve the original goal. The other entities would likely receive insufficient funding as well, perpetuating the cycle of creation of new programs and new entities, and increasing overhead. We need to direct our attention to economic spillover effects and focus on a coherent set of initiatives that aim to maximize the overall gain to our economy, by considering multiplier effects. For example, an increase in bachelor's degree holders is associated with an increase in the income or employment growth rate (Gottlieb & Fogarty, 2003), and it also increases the wages of high school drop-outs (Moretti, 2004). Subsequent research shows more specific and more significant multiplier effects with certain innovation jobs, i.e., when you increase the number of innovation jobs, you also increase the number of non-innovation jobs (Moretti, 2012).

➤ *Focus on a small number of initiatives that bridges the gap in our innovation ecosystem, and fund them well enough that the initiatives contributes to the success of the ecosystem as a whole.*

The good news is that we are not the only state facing this challenge. In fact, many of the states have already faced and overcome this challenge. The main economic drivers of Pennsylvania and Ohio have come and gone, and saw their basic infrastructure and public services degrade. Faced with this dire scenario, the business communities from the traditional sectors (and not necessarily the newer tech entrepreneurs) took the initiative to transform of their economies to focus on innovation jobs.

In addition, the timing is right for Hawaii, as key factors that encourage change are converging: 1) advances in digital communication have reduced many of the geographic disadvantages Hawaii used to face; 2) the buy-in and the level of engagement in innovation displayed by the traditional business community as represented by the Hawaii Business Roundtable (HBR) in their most recent report, Hawaii's Innovation Assets, and 3) the successes of small-scale trials within our own community. This transformation, however, demands private-public partnerships with a shared vision and understanding, to start charting out the map for our future together.

THE SOLUTION IN BRIEF

Old economy vs. innovation economy

Old economy: a mom-and-pop coffee kiosk downtown. Succeeds, and now has a café. Expands menu. Adds another location.

Innovation Economy: a mom-and-pop coffee kiosk downtown, with a few cafés. Aims to source premium Kona Coffee and export to Japan. Adds a kiosk in Ala Moana Center to test their market with Japanese tourists. Strikes a franchise deal in Japan. Their foreign sales will exceed domestic by the end of 2015.

We will make Hawaii a world-class innovation economy, which preserves and values the unique culture of our community today and in the future, by nurturing the high-growth and entrepreneurial segments of all of Hawaii's industries.

This holistic, innovation-based economic development approach is based on both the most recent research and best practices around the world, as well as the wisdom of our past generations. Some of these approaches have been implemented on a small scale in Hawaii, and have shown promise.

We can do more, and we must do more to scale and accelerate the progress we are making towards a sustainable economy based on innovation, so that we may pass on a rich ecosystem to the next generation.

"Each community is different, but there are a few basic building blocks needed for entrepreneurial ecosystems to thrive: commitment from community leaders; partnerships with large companies, local governments, and universities to create network density; and access to capital and talent. Hawaii is headed in the right direction, establishing an accelerator community and promoting high growth startups, but there is still more work to be done."

— *Steve Case,*
Chair, Startup America Partnership

INTRODUCTION

What is an innovation economy?

If innovation is "the intersection of invention and insight, leading to the creation of social and economic value" (Council on Competitiveness, 2004), then the innovation economy is one that relies on the monetization of these values.

Innovation defined

Innovation is the intersection of invention and insight, leading to the creation of social and economic value. (Innovate America, National Innovation Initiative Report, Council on Competitiveness, 2004)

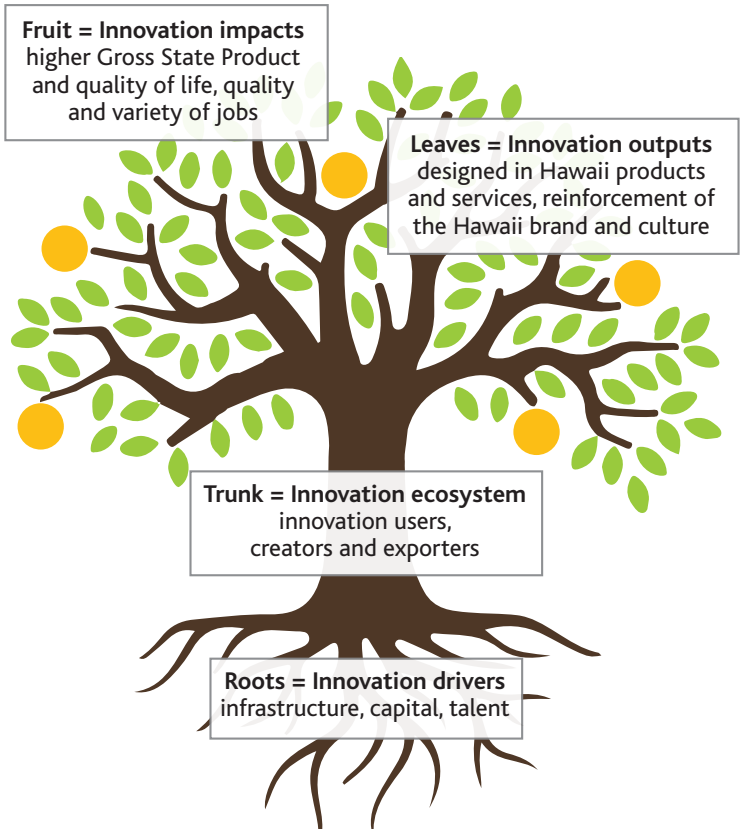
The most significant difference between what this report proposes and the past attempts to diversify our economy by fostering a new industry in Hawaii, is that this approach strives to capitalize on innovations from all industries. By making the innovation economy our vision, we are no longer looking for a specific industry to favor, but rather a profile of companies in every industry sector with the following characteristics: high-growth and entrepreneurial, aimed at global markets. Therefore, the innovation economy is not limited to the tech industry, but also includes companies in healthcare, agriculture, and government, as well as in our main industry, tourism. In fact, some companies in the tech industry do not fit the innovation profile, such as computer repairs.

The innovation economy has 3 types of players: innovation creators, innovation exporters, and innovation users, where some roles may overlap. An IT staffer working for a bank may dabble in mobile game development on weekends. She is an innovation creator. Many larger established companies innovate internally to keep themselves competitive, which is often referred to as intrapreneurship. They are also part of the innovation creators. If they also make the innovations available to a larger market beyond themselves, and find an audience beyond Hawaii, they are innovation exporters as well. In discussing startups, roles of established companies are often downplayed or ignored, but in fact, many of the world's most famous startups needed more than a garage: their origins usually involved a job at an established company in their chosen domain (Audia & Rider, 2005). While star entrepreneurs are painted as lone figures whose internal creativity was all that was needed to achieve their success, Steve Jobs had worked at Atari before he founded Apple, and Steve Wozniak worked at Hewlett-Packard, where they had linkages to networks and infrastructure in addition to the latest technologies.

Given the ubiquitous nature of technology today, every institution, including all levels of government, is part of this economy as innovation users. Established companies and government departments can be the innovators' first customers, providing needed cash flow and credibility to reach the next level for the startups. It used to be that technology workshops were limited to technology-based industry audience. However, the increased number of technology solution workshops hosted by industry associations outside of the core tech segments reflect the demand for such education and the priority placed by business owners on innovating to improve their bottom line and to expand to (or create) new markets, regardless of their industry. While technology is not the only source of or tool for innovation, this type of trend shows that we are all innovation users, and therefore, stakeholders of the innovation economy.

Because every segment of our current economy has the potential to benefit, policy makers can take a more holistic view by focusing on exports derived from innovations as the economic goal. Industries can, in turn, collaborate towards that goal without the threat of feeling attacked for being or not being in a particular industry.

Figure 2: Nurturing the Innovation Economy



Contrasting business paradigms (Collaborative Economics, 2008)

OLD GLOBALISM focuses on the search for regions with low-cost labor and resources to serve as export platforms to produce high-volume commodity products.

NEW GLOBALISM focuses on the search for regions to host high-value, specialized, and innovation-related activities to access specialized R&D, commercialization capacity, innovation infrastructure, and highly-skilled talent.

Strategy:

STEP ONE: Acknowledge the key components.

The key to this vision revolves around a simple strategy: to enrich the innovation ecosystem. There are 3 components to enrich this ecosystem, which span the continuum of research, commercialization, information technology infrastructure, training, and job creation: 1) investing in infrastructure, 2) securing capital, and 3) nurturing talent.

STEP TWO: Mind the linkages.

We must invest in all of the above components and ensure there are links between the components: e.g., nurturing talent in telecommunication won't work if we lack a robust broadband infrastructure.

STEP THREE: Foster collaborations.

One cannot legislate collaboration. Instead, we must increase the network density within the innovation ecosystem. Because innovation thrives on collaboration and inclusiveness, the higher the density of the network, the more likely fortuitous partnerships and collaborations are to take place.

Because the innovation segment is hard to define and is continuously evolving, the implementation of the strategy requires measurement of our progress. The community must agree on the key metrics to first create a baseline, as well as reasonable short-term and long-term goals for these metrics that are tied to the level and type of investments made, and then consistently track them.

This report does not prescribe specific programs to be deployed by specific entities, because each industry with its own assets and challenges know best how to implement what initiatives. Instead, it identifies gaps in the innovation economy within the 3 components necessary for any economy building: infrastructure, talent, and capital. Where there are useful examples of initiatives to consider, the report presents them as a reference for consideration in order to provide a concrete idea for what we can do differently immediately. In order to systematically realize the innovation potential that exists in different industries and to align the efforts of many supporting organizations, this report recommends the establishment of a state-level organization, as an umbrella under which innovation initiatives can be coordinated and funded.

Traditional model	Innovation model
Business attraction	Investing in infrastructure and talent locally
Assisting all small businesses	Focused on high growth entrepreneurship output
Exclusive	Inclusive
Competing priorities and industries (zero-sum game)	Coherent priorities and collaborations among industries (growing the pie)
Small locally traded	Scaled globally targeted (exports)

THE SCOPE OF THIS REPORT

This report builds upon the most recent reports on innovation in Hawaii by entities such as the Hawaii Business Roundtable (HBR) and the High Technology Development Corporation (HTDC) to provide justification for the vision for Hawaii to embrace the innovation economy, and offers some frameworks for both the metrics and policies with sample innovation indices and initiatives. It also summarizes some of Hawaii's key innovation assets through storytelling, how they fit into our innovation ecosystem map, and how they are being used as evidence of our emerging innovation economy. We offer suggestions on some action items the community can consider as steps towards this transformation to encourage innovation-driven growth.

PERSPECTIVES BEYOND HAWAII

Since the turn of the millennium, economic development entities and policy research groups around the globe, both private and public, have been publishing literature, holding conferences, and engaging with the public and elected officials on the merits of an economy based on knowledge rather than natural resources. At the national level, "the need to innovate ourselves" out of this economic slump, culminated in a 2006 convocation in preparation for the 2007 publication by the National Academy of Sciences, National Academy of Engineering, and Institute of Medicine, entitled "Rising Above the Gathering Storm" (Committee on Prospering in the Global Economy of the 21st Century, et. al., 2007). Subsequent studies published by various federal agencies, national associations, and regional economic development groups all documented similar needs for more innovation and a different way to approach economic prosperity. Therefore, for the purpose of this report, we will focus on how the outlook for a new economy has changed since then.

While Hawaii only played a minor role at these early nationwide discussions, this concept of leveraging innovation rather than natural resources to boost our economy was not new to Hawaii. Government agencies tasked with economic development and community groups within Hawaii recognized the early successes of other states that have already implemented their action plans. Hawaii's initial approach did not follow a holistic view, perhaps because there wasn't a single entity that was perceived both by the public and the private sectors as championing the cause, nor was priority given to transforming the economy. Because there are many aspects to establishing the pipeline of innovation, most discussions were segmented within a topic, such as how to increase science, technology, engineering, and mathematics (STEM) education programs, or pros and cons of tax credits to assist the technology sector.

How is Our Approach Different Now?

There are many names for this concept of establishing an economy based more on talent rather than natural resources: from simply the "new economy" or "knowledge-based economy" to the more specific "tech-based economy" and "broadband" or "digital economy", and probably the most often used term locally, "diversification". Through the diversification initiatives, Hawaii sought to attract tech businesses from the US mainland to locate here with tax incentives, following the development strategies used to attract manufacturing industries. Globalization has led to a change in scale of economic development, and one's success is no longer primarily achieved through traditional recruitment of industries (Center for Regional Development, et al., 2009): traditional economic development tools and analysis alone are not sufficient in the new era, but more significant is the collaboration of the leaders of the public and private sectors.

This report proposes a different approach from our old diversification strategy, which encouraged the development of a new industry sector to be added into the existing mix of industries, with emphasis on business attraction from outside the state. We propose that we invest in the existing segments, but encourage the growth of businesses within the segments with specific profiles. The approach is not to focus on the technology industry, which was the original focus of the diversification strategy. When technology is all around us, it no longer makes sense to impose such a limit and to create a zero-sum situation unnecessarily, where resources poured into developing the technology industry are seen as diverting support from other existing industries. What originally attracted the State to the technology industry has to do with the specific nature of that industry which today, can also be seen or fostered in existing industries.

Growing the innovation economy makes sense for Hawaii because the recommended approach here is not one that focuses on grooming one industry to take the lead but rather to focus on developing certain traits within each industry: 1) entrepreneurial and 2) high growth. By entrepreneurial, we mean businesses that identify new markets or deliver new products or services, often in a new way. By high growth, we mean having the potential for rapid expansion. These qualities will result in exportable and scalable business services and products. To that end, we need to enrich our ecosystem to increase the potential for positive "Black Swan" innovation events to take place. A term and theory coined by Nassim Nicholas Taleb, it refers to the disproportionate role of rare, hard-to-predict events that exceed the expectations in a domain (Taleb, 2007). Because they are hard to predict, we need not and should not concern ourselves with a concrete outcome, as we as a society could not have directed Apple to create the iPhone, or even San Diego to predict that they will have a sports equipment design industry. We build a narrative after the events have taken place, a logical sequence of cause and effect. A closer examination, however, shows that it is often one or two entrepreneurs who happened to be in the right place at the right time with the right conditions. What we can predict is that these Black Swan events for innovation seem to take place when a community builds an ecosystem that is geared for entrepreneurial activities, and that encourages the realization of high growth potential.

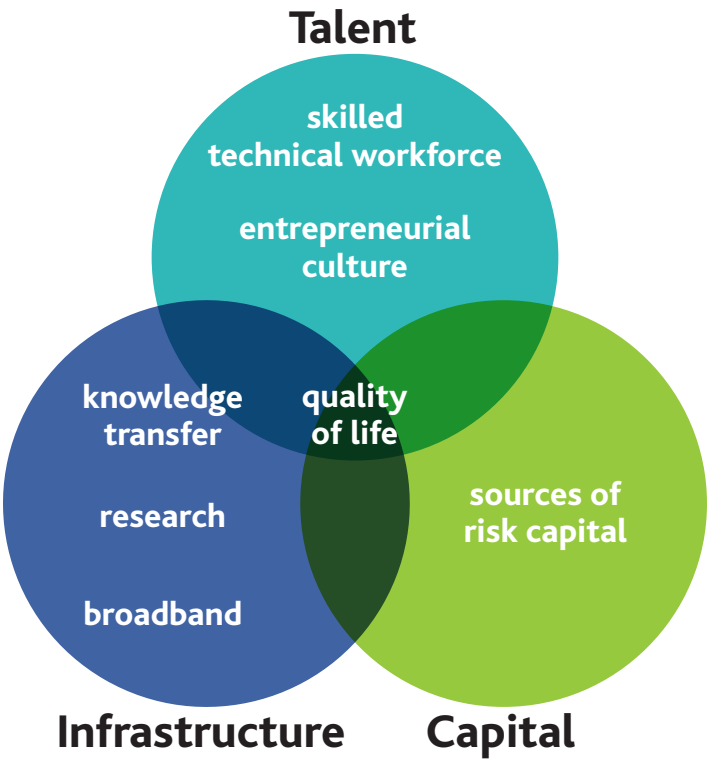
Another term that often appears when examining new economy studies is a "cluster". Loosely defined, a cluster is a group of industries that trade with each other, forming

an economic network. For example, Hawaii has a robust tourism cluster that includes the airlines, restaurants, tour and activities businesses, hotels, and so on. Ultimately, a community's lead industry serves as a dominant cluster. Cluster studies are useful when a cluster already exists, to ensure that policies can be directed to grow and not harm that cluster (Muro & Kats, 2010). Because some of the other states have already implemented their innovation strategies and are seeing clusters emerge, the more recent studies explore various methodologies for analyzing clusters and forming policies around them. However, cluster studies are premature when we are beginning the transformation to a new economy, because they have no predictive powers: clusters can be analyzed after the fact, but one cannot predict if and how a certain cluster will emerge. More importantly, because there are so many factors outside of any government's control, one cannot "will" a particular cluster into existence. The concept of a cluster is often misunderstood, perhaps because the term also has a non-economic definition to mean "a group". A mere group of innovation companies do not constitute a cluster unless they are trading with other industry segments at significant levels. Discussions of clusters should take place later, after an actual innovation cluster has emerged, and therefore, cluster analysis is not explored in this report.

Reports that argue for the innovation economy in Hawaii already exist, from internal documents of various Hawaii government administrations to official reports prepared by both community and government entities. "A Framework for Developing a Statewide Innovation Plan" presented by the High Technology Development Corporation (HTDC), the State's leading agency for tech-based economic development, summarizes the main recommendations from reports published in Hawaii as of 2008 (Scruggs & Associates, 2009). For readers interested in reference materials at the national and international levels, comprehensive reports are available from a variety of entities, many of which were re-examined for the preparation of this report. The State Science and Technology Institute (SSTI) provides a basic overview for policy makers and business community leaders and economic development practitioners. Their list of elements required for a tech-based economy (SSTI, 2006) is still applicable today for an innovation-based economy:

- Intellectual infrastructure, i.e. universities and public or private research laboratories that generate new knowledge and discoveries
- Physical infrastructure that includes high quality telecommunications systems and affordable high speed Internet connections
- Sources of risk capital
- Highly skilled technical workforce
- Entrepreneurial culture
- Mechanisms for transferring knowledge from one individual to another or from one company to another
- Quality of life

Figure 3: Innovation economy requires infrastructure, capital and talent

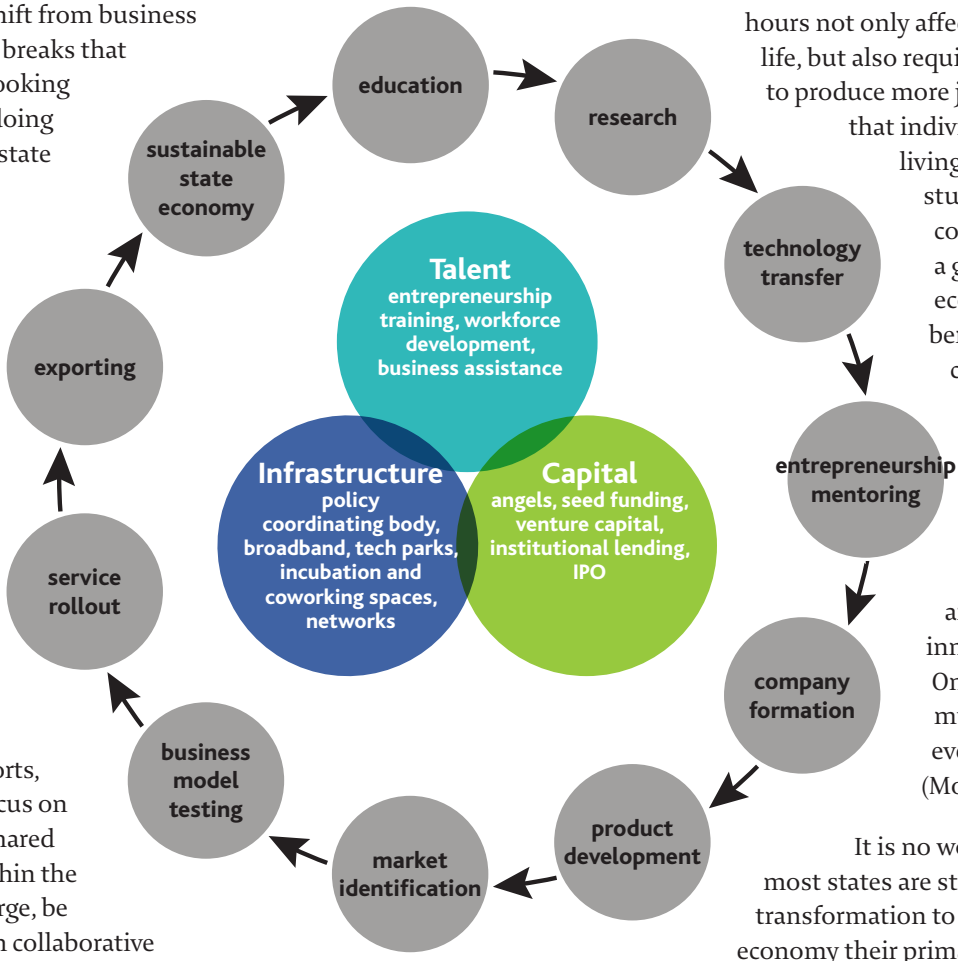


SSTI's most recent project with the Economic Development Administration (EDA) of the U.S. Department of Commerce, the Regional Innovation Acceleration Network (RIAN), has developed guidelines for regional investment on its website, which outlines the theoretical structure and justification of the innovation economy, as well as metrics that matter to track its growth. The Council of Competitiveness, made up of CEOs, university presidents, and labor leaders working to ensure U.S. prosperity, continue to publish reports on innovation, as does the National Governors Association (NGA), the bipartisan organization of the nation's governors, and numerous national consulting firms and think tanks. At the international level, the Global Entrepreneurship Monitor (GEM) Project is the largest ongoing study of entrepreneurial dynamics in the world, measuring entrepreneurial activities around the world, identifying the factors that lead to entrepreneurship, and suggesting policies at the national level. While specific

recommendations differ from region to region, all the reports point to the need for an economy to "innovate itself" out of any economic slump.

Over the past decade in the U.S., states have been on a new course for economic development. According to the NGA, the states are finally shifting gears from policies and practices optimized for the industrial era to strategies geared for a knowledge era. What the NGA observed was a shift from business attraction through tax breaks that appeal to companies looking for the lowest cost of doing business, to investing state dollars into attracting talent and building up the innovation infrastructure, making states poised to attract companies developing new products and services.

Figure 4: Innovation process and linkages



Both the results of the NGA research and the HTDC report, which frames the recommendations from other Hawaii reports, point to the need to focus on action items under a shared vision. Champions within the community must emerge, be identified, and be given collaborative settings to coordinate actions that would lead us to a better future. Again, these realizations are not new. Many states are establishing and following a new policy framework to drive innovation. They want to ensure their investments into the innovation initiatives have proper linkages and address the entire pipeline of the innovation process from research all the way to commercialization and exporting of the product. NGA researcher Erin Sparks noted that not only are the states creating their own research and development (R&D) funds, they are also investing in their innovation ecosystems as a whole, rather than remaining a mere investor in R&D, i.e. minding the entire innovation process and components, rather than just the early stage funding.

Many reports in the past were satisfied with the goal of creating "career path" jobs in the technology sector because they paid significantly more than the average wage, and had more opportunities for advancement. Many traditional service sector jobs, e.g., ones in tourism, are often not considered career path jobs and wages do not lead to continual income growth, where if one needed to obtain more income, they would have to increase the number of hours worked. This increase in work hours not only affects their quality of life, but also requires the community to produce more job openings for that individual to earn a living wage. Most recent studies have made the connection between a growing innovation economy and the benefits to the overall community: that innovation jobs create more higher-wage jobs, which in turn increases the number and wages of non-innovation jobs. One study claims a multiplier of 5 jobs to every innovation job (Moretti, 2012).

It is no wonder that most states are still making the transformation to the innovation economy their primary goal despite the huge amount of effort and coordination required. Another reason for their focus on innovation is that there does not seem to be many alternatives for states without natural resources to export. The U.S. nationally does not have the labor, the regulatory environment, nor the level of natural resources to compete in the traditional economic development game globally, and those factors are even less favorable for Hawaii. The transformation to an innovation economy makes sense because it provides tools for us to more effectively leverage on the strengths of our existing industries such as tourism, and it will also allow us to maintain the natural beauty of the land that attracts our visitors. In an innovation economy, the existing industries are not merely

included, innovation leverages their existing strengths in the Hawaii brand to reach new markets and develop new products. Last but not least, Hawaii is ahead of other locales in attracting talent, the key ingredient to the innovation economy, because our name is synonymous with a high quality of life, which is a key deciding factor for innovation workers.

"In establishing an innovation economy, entrepreneurship is paramount. Therefore, gauging the number of entrepreneurs in a community is a viable way to assess the size of the innovation economy, even if they aren't tech entrepreneurs, because they have identified a market and a method traditional businesses have not."

— Rebecca Harding, CEO, Delta Economics

Another industry that is close to our cultural heritage is agriculture. This industry also helps us protect our lands from overdevelopment. However, our farmers are unable to continue farming in a traditional manner because their revenues from local sales will not be sufficient to cover the rising cost of agriculture (e.g., labor, electricity, food safety regulations, and land acquisition/lease). The government coffers cannot afford more subsidies to maintain this business model. However, we can invest to support the agricultural industry by providing business assistance and lowering the barriers to value-added farming that leads to food manufacturing, where farmers can find customers outside of Hawaii. The innovation approach not only includes, but relies on entrepreneurial and high growth opportunities in our existing industries, regardless of whether the industry, like agriculture, is technology based or not.

Here are the three most significant points that we can learn from the past studies, either directly advocated in their reports or guidance that become evident in interviewing their authors and actual entities involved in the implementation of innovation plans:

1. Identify leaders and leadership structures: Without key champions and a leadership structure accepted by both the private and public sector, no strategy, however sound, will succeed;
2. Avoid one-off initiatives: It is tempting to simply fund the STEM education initiative, but without the job creation pipeline, there will be no jobs for these STEM-educated students. Each stage and the linkages of the innovation process must be supported and reflected in the plan. Transformation of the economy takes more than a single initiative but a collection of initiatives. It requires a holistic, long-term view.
3. Invest in desirable characteristics only: policy makers must exercise discipline to concentrate on investments optimized for and encourage high growth and entrepreneurial characteristics, rather than trying to assist a whole industry or a class of business. We do not have enough resources to provide direct assistance to all small businesses, for example, but instead we can provide export assistance to small business owners looking to expand their market. The small business owners who choose not to participate as innovators are not left behind in the innovation economy: the non-innovation segments of the economy will benefit from the successes of innovative businesses because of the increase in higher wage jobs which translate to more discretionary funds being spent at all businesses. If we, however, squander our resources on blanket polices that "water down the poi too much" so everyone gets some, then we have only appeared to have helped everyone when we impacted no one.

"My personal goal as an entrepreneur and founder is to help 1000 people, teammates, and partners buy a home and make a living."

— Eric Nakagawa, Creator, I Can Has Cheezburger?

HAWAII'S COMPETITIVE ASSETS

Hawaii needs to stimulate its economic engines. Local, regional, national and international reports have presented innovation as the solution. But is Hawaii poised for innovation? The answer is a resounding "Yes!"

Hawaii's many unique attributes can be leveraged for a strong innovation economy. Factors that usually hold Hawaii back, such as the higher cost of blue-collar labor and geographical remoteness, become less relevant in this new economy. The main ingredient required for the innovation economy is a highly educated entrepreneurial labor force with the skill set appropriate for the industry segment within which they are trying to innovate. Because our natural resources are no longer the key ingredients, there will be less tension between land development or the harvesting of raw materials and our commitment to the environment. The global innovation economy is mostly blind to shipping cost, as products and services are usually distributed digitally, or the shipping cost is insignificant compared to the retail price of the value-added items produced. Therefore, **if we focus our resources on assisting entrepreneurial segments of our existing industries** to embrace the global innovation economy, **our investments to nurture our industries will be more effective** than if we provided general assistance to segments of our industries that do not take advantage of the global economy.

"...enduring competitive advantages in a global economy lie increasingly in local things—knowledge, relationships, motivation—that distant rivals cannot match."

— Michael Porter (Porter, 1998)

The 2014 State New Economy Index, created by the Information Technology & Innovation Foundation (ITIF), which ranked Hawaii 10th nationally in the category of "Migration of U.S. Knowledge Workers", attributes Hawaii's quality of life as a key in attracting and keeping talented entrepreneurial workers (ITIF, 2014). This observation is especially significant when founding an innovation economy because talent is its main raw material. Hawaii's entrepreneurial activity is on an upward trend: the ITIF index ranks Hawaii 26th (up from 41st in the nation 10 years ago) and 8th in the Kauffman Foundation's Index of Entrepreneurial Activity (Fairlie, 2014). Hawaii, therefore, has some of the most important ingredients for the transformation to the innovation economy: entrepreneurship and the ability to attract talent from elsewhere.

Another asset we take for granted, which will be more significant as the world continues to shrink, is our ethnic diversity and racial harmony. Hawaii ranks the highest in mixed-race population in the nation (18% in 2009) and 6th highest in foreign-born population (U.S. Census Bureau, 2013). While our community has acknowledged the benefits of having an ethnically diverse community for medical research, a large immigrant population also affects the level of entrepreneurship in the community: the Kauffman Foundation has documented that immigrants were nearly twice as likely to start businesses compared to the native-born (Fairlie, 2014). The process of innovation values different and new perspectives, and therefore, more innovation-based companies are reviewing their hiring policies and corporate culture to develop a more diverse workforce.

With racial harmony, we enjoy peace. There are other beautiful beaches in the world, but few are in regions where tourists feel safe, and where their ethnic origin or faith will not cause problems. This feature is obviously relevant to our tourism industry; moreover, it is one of the factors millennials look for. The millennials, or the demographic with birth years from the early 1980s to the early 2000s, are said to "drive both the housing market and the fast-growing innovation economy" (Fulton, 2012), deciding where they would want to live and establish a career before they are 35. Because millenials put a high value on quality of life and their career choices are mostly geo-independent, many newer indices measure the "coolness" factor of areas, ranging from walkability and number of microbreweries in the area, to access to the arts, and cultural diversity (Next Generation Consulting, 2011).

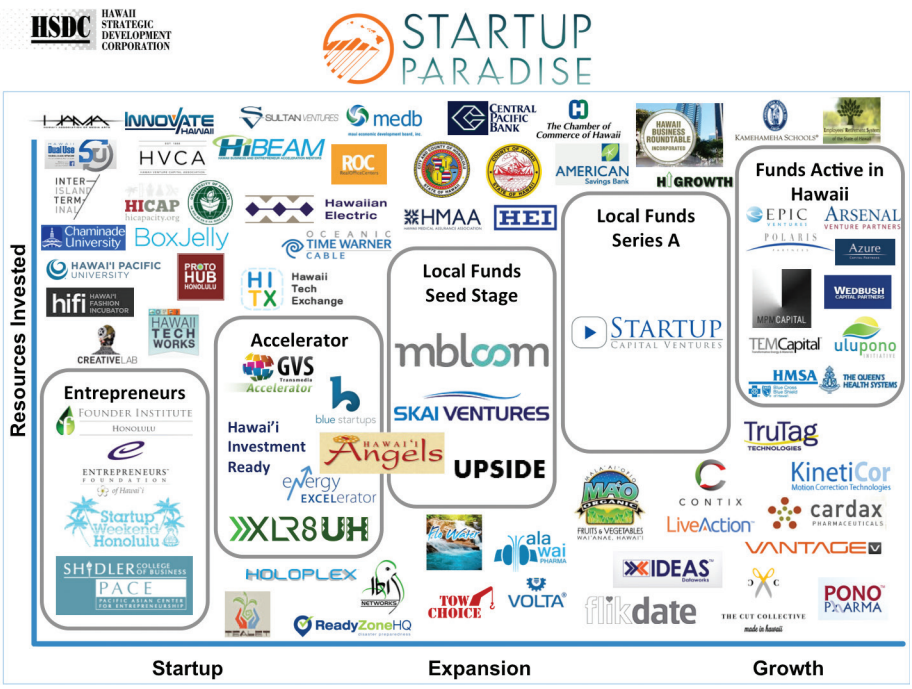
"Racial harmony...I've travelled the world and there's no other place that has it like Hawaii. We take it for granted, but it is our biggest asset."

— Henk Rogers,
Founder, Blue Planet Software and The Tetris Company

Despite the controversies surrounding Act 221, the legislation that created research and development and investment tax credits did contribute to the innovation ecosystem for Hawaii. Pockets of expertise and networks developed during the Act 221 era were united under the banner of the HI Growth Initiative, to redirect the priority on entrepreneurship and innovation rather than a tax mechanism. The more formal capital formation

programs under the HI Growth Initiative merged with grassroots activities such as Startup Weekend to develop talent. Shared facilities and coworking spaces like BoxJelly contributed to the innovation infrastructure to provide a home for many teams of entrepreneurs and a venue for focused interest groups such as WetWare Wednesday and Organization for Understanding Dynamic Languages for the software developers and HI Capacity and Maui Makers for the do-it-yourself technologists. Individuals and firms identifying themselves as entrepreneurs came together as a group at the State Capitol on Entrepreneurs' Day 2013 in support of the HI Growth Initiative. Their energy in coming together was evident in the video captured by the media crew of Roosevelt High School (Rough Rider Productions, 2013).

Figure 5a: HSDC Startup Paradise map from a financial perspective — *Credit: HSDC*



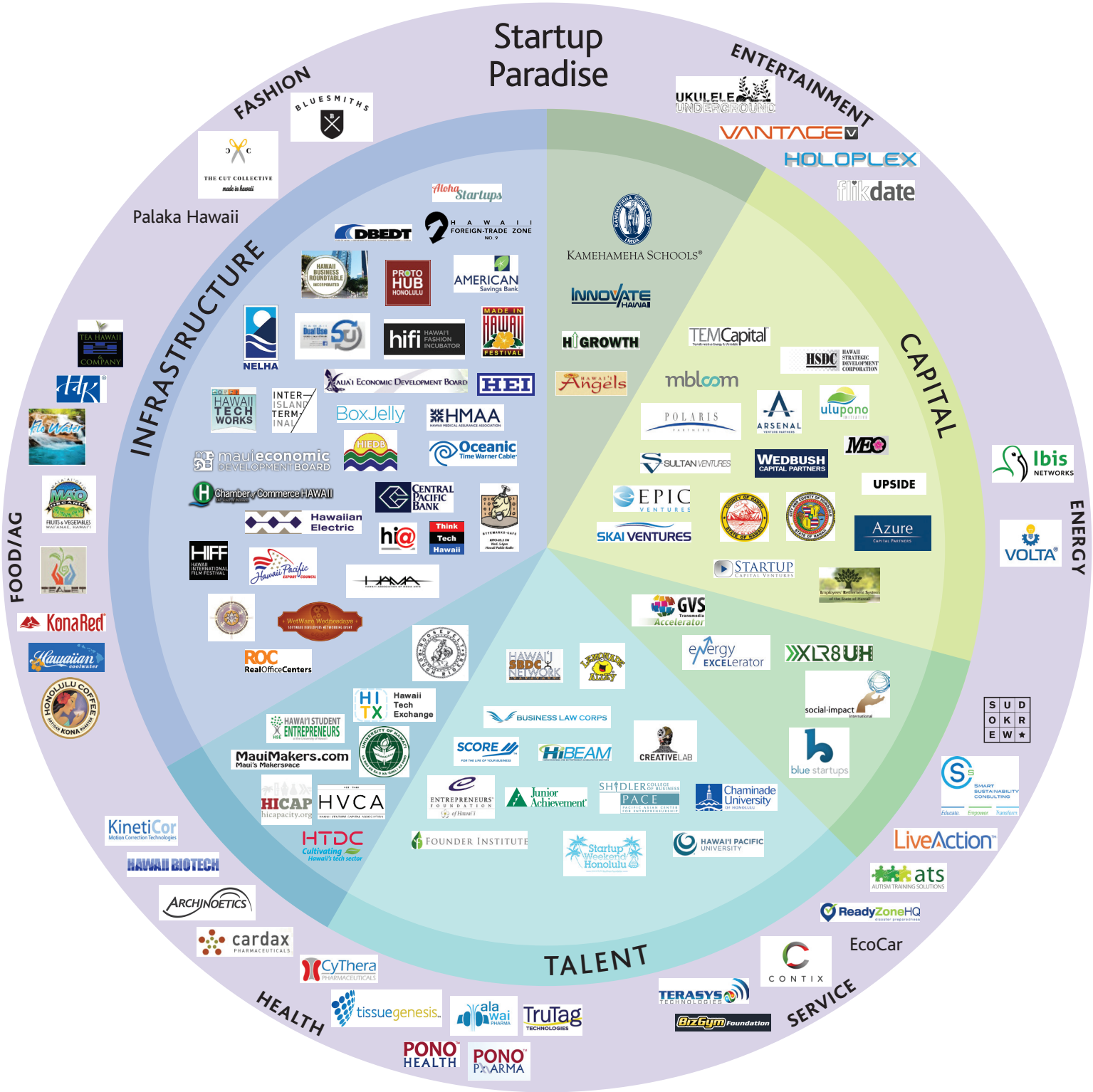
The community of entrepreneurs has since come together to identify their community as Startup Paradise. The ecosystem is both diverse and dynamic, including both the leaders (entrepreneurs) and the feeders (everyone else supporting the entrepreneurs, including educational institutions, service providers, accelerators, and government). With our innovation community expanding, the quality of the interactions within the ecosystem is also improving, where participants are gaining more benefit by being part of the community. Perhaps it is because the ecosystem is no longer just attracting the entrepreneurs, but is also gaining the attention of established entities in dominant industries who are seeing the need for an economic transformation through innovation. They bring connections and expertise not necessarily found in a typical startup community, making the ecosystem richer.

The interest shown by established Hawaii entities such the Hawaii Business Roundtable, whose members' businesses account for more than $25 billion in gross revenue each year (HBR, 2014), not only adds legitimacy to Hawaii's pursuit of an innovation economy, but it also provides a platform to introduce the concepts of the new economy to industries traditionally not associated with innovation. The active participation of Queen's Health Systems and Kamehameha Schools Bishop Estate reflects Hawaii's need to invest in innovation regardless of the industries the entities represent.

Our work, however, is not done. The ecosystem map is hardly complete. As rich as this ecosystem may be, there are more opportunities available for existing industries to participate. We are starting to see innovation companies leverage Hawaii's tourism brand, the domain knowledge, and connections that exist within Hawaii's established tourism companies. The innovation economy in Atlanta, Georgia got a head start when their top establishments, such as the Coca-Cola Bottling Company, CNN, and the Center for Disease Control, contracted the local startups to provide them with innovative services and products. The startups, armed with an impressive list of clients and domain experience shared by these establishments, are able to compete better in the larger market. We have a similar opportunity in Hawaii with established companies in tourism as well as military-related institutions, and other giants in the transportation industry who can benefit by becoming early customers to the innovators.

HAWAII'S COMPETITIVE ASSETS

Figure 5b: A Visualization of Startup Paradise: The Hawaii Innovation Ecosystem[1]



[1] The companies and entities listed are only a sampling of the ecosystem.

In addition to capturing logos to visualize Hawaii's innovation assets as an ecosystem, another way to catalog our assets is through our stories. In the following section we concentrate on innovations in non-technology fields to illustrate what an innovation-driven growth looks like in different industries.

Where are the "Healthy Kids"?

When an international organization, Save the Children, opened their office in Vietnam to fight malnutrition, Jerry Sternin did not import any best practices. Instead, he sought out children in the region who came from poor families, yet did not suffer from malnutrition. He then explored their environment and studied why they were healthier. For example, some families fed their children smaller but more frequent meals, which allowed for better digestion. These practices could then be adopted by families with malnourished children (Heath & Heath, 2010). Indeed, the co-authors of Switch: How to Change Things When Change Is Hard and Made to Stick: Why Some Ideas Survive and Others Die, advocate the use of "finding the bright spot" within the community and then copying that success. Rather than looking for a pre-packaged solution from elsewhere, this report features some "healthy kids" within our community who are innovating their way to success, to show it can be done and it is being done in Hawaii. Community organizations, governments, and policy leaders can learn from their journeys so that we can help scale, accelerate, and replicate their successes.

Because the innovation economy is labor intensive, its main ingredient is talent. How we educate our entrepreneurs and our next generation and how we involve our business and civic leaders in this process can make or break innovation strategies. For the region to be ripe for innovation, there needs to be talent first. Everything else, such as tax incentives, can only help if there is a sufficient talent pool of a certain quality, and a robust pipeline that feeds that pool.

The accelerator model has been touted as an innovative way to educate our entrepreneurial talent. An accelerator is an educational program where selected startup businesses receive some seed funding and mentoring for a fixed-term in exchange for a small amount of equity. The educational program typically culminates in a public pitch day, called a "Demo Day" to which industry supporters and venture capitalists are invited to possibly extend follow-on funding. Accelerators have been effective not only in educating entrepreneurial talent, but also in providing a network of entrepreneurs and their supporters. Its "fail cheap, fail fast" method of rapidly sketching out a business idea and generating a suitable business model, is less expensive and provides a quicker way to obtain practical business experience than obtaining a Master of Business Administration degree. Many seed accelerators and boot camps, such as TechStars, are started by established entrepreneurs to stimulate innovation, and are thereby able to enlist the mentorship and networks of other entrepreneurs and graduating fundable companies.

Thanks to the support of the State Legislature, a $2 million Launch Akamai Venture Accelerator (LAVA) program administered under the Hawaii Strategic Development Corporation (HSDC) provided matching funds to help the private sector to launch accelerators locally with quality that would compete with the accelerators on the Mainland (HSDC, 2014).

The GVS Transmedia Accelerator, one of the accelerators funded by LAVA, focuses on another innovation export aligned with Hawaii's rich story telling traditions: the production of creative content.

Global Virtual Studio is a multimedia studio based in Kailua-Kona, founded by veteran filmmaker David Cunningham, who as a young filmmaker had to leave Hawaii to pursue his passion. GVS saw the need to hone local artists' graphical art and storytelling skills. The GVS Transmedia Accelerator was born through an introduction brokered by the Creative Industries Division of the Department of Business, Economic Development and Tourism (DBEDT), bringing together Global Virtual Studio with the State of Hawaii, HSDC, and the County of Hawaii. The first cohort entered the accelerator in June 2014.

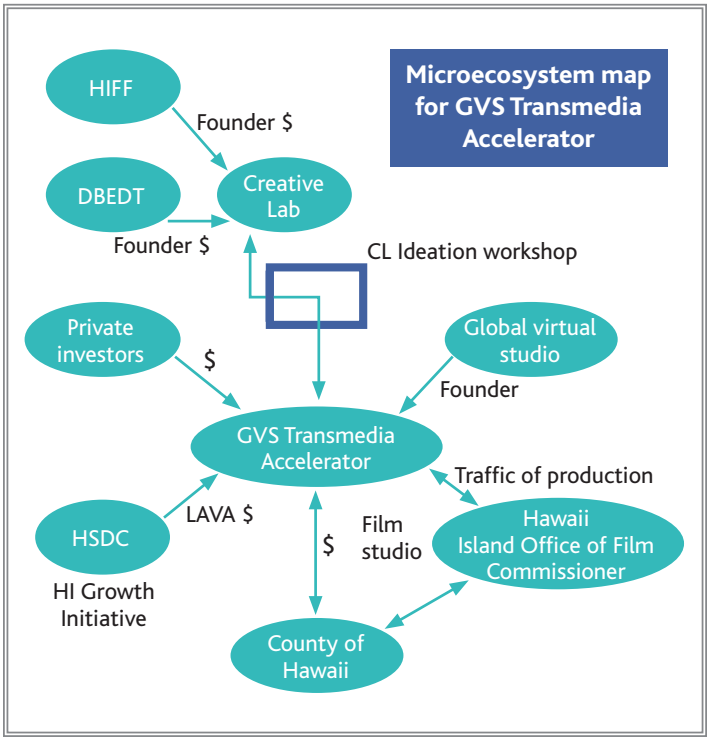
The collaborative approach they took in founding this accelerator attracted the early support of the Mayor of Hawaii County, followed by the Hawaii County Council, which is investing $700K over the next 3 years for facility and operation costs, so that the initial cohorts can grow with less financial and logistical burden. The deal was structured with a larger vision in mind to invest in and to contribute to the infrastructure required to found a vibrant creative media industry on the Island of Hawaii. The County government, through this partnership, established a point of presence for their Film Commission Office, providing workspace for visiting film industry professionals when they visit the islands for location work.

Through the Creative Industries Division of DBEDT, GVS found a collaborative partnership with their Creative Lab Program, which develops content creation skills and acts as a feeder to the Accelerator. Launched in partnership with the Hawaii International Film Festival (HIFF), the Hawaii Film Office, and the City and County of Honolulu Film Office, Creative Lab Immersive programs provide a comprehensive

and entrepreneurial approach to screenwriting, broadband/new media, music, interactive media, design/fashion, acting, directing, and producing. In addition to being a feeder for GVS, Creative Lab connects its finalists in each program to industry leaders to advance opportunities for representation, investment, and global distribution of their creative content.

As this report is being published, we learned that Hawaii Visitors & Convention Bureau (HVCB), identifying the value of promoting Hawaii stories for the tourism industry, supported the first Demo Day at GVS as a sponsor. This type of inter-industry support, sponsoring, mentoring and collaboration seen in the GVS micro ecosystem realizes the potential of Hawaii's existing industries through innovation.

Figure 6: GVS micro ecosystem



Creating Innovation Infrastructure

When a Hawaii designer, Allison Izu Song, started her own brand in 2007, all the manufacturing had to be done in China. Due to poor quality control and project management challenges, she used her New York contacts to move the manufacturing there. Similar problems persisted, even when she brought the job closer, to Los Angeles. It forced her to bring the manufacturing of her line to Hawaii 3 years ago, but she did not have much success getting local companies to sew for her, because they already had a steady stream of jobs sewing aloha shirts. She discovered that other Hawaii designers had the same problem. In order to export apparel, you must have enough supply. To have enough supply, you need a reliable sewing factory to produce your design to your specifications on time and on budget. Smaller batch orders are not prioritized by larger factories, and this is reflected in the quality of the final product. While others may have given up at that point, or remained content just selling what they could manage to produce locally, she took matters into her own hands by creating the very infrastructure she needed to get to the next phase: Allison teamed up with her stylist friend, Summer Shiigi, and setup a mini-manufacturing center at the Manoa Innovation Center called the Cut Collective.

They are eager to grow, because they do want to accept all the jobs they receive from local designers. Being in the fashion business, they were able to identify expensive design equipment that could be shared, such as a "Gerber", a computer assisted design (CAD) machine for dress patterns. Being able to rapidly produce small runs of your designs allows you to test your product and the markets you are after, with low overhead. With this infrastructure in place, successful designs created by crafters can dream bigger than Saturday markets.

THE CUT COLLECTIVE
made in hawaii

In addition to the infrastructure needs, they also found the fashion design community to be scattered, and mentorship hard to come by. They are working with HTDC and HSDC to see if these needs can be met by founding a fashion accelerator. In the meantime, they are practicing the methods of a lean startup with their ability to run smaller batches of their designs and quickly get to market. Because the batches are small, they can incorporate the market response back into the design for another iteration. This "agile development" of fashion, combined with their domain knowledge, makes it easier to find connections to retailers, creating buyers events, and taking designers to the U.S. mainland and beyond. Just as in software development methods, they are "eating their own dog food" as they try out these steps on their own respective brands. It is not enough to have a great design: you have to establish sufficient demand to be able to scale up to large-scale manufacturing, to start a "designed in Hawaii" high growth industry. The capital and the know-how required for this non-linear scaling up process is a crucial period where companies can benefit from being in a healthy innovation ecosystem. The Cut Collective is not only scratching their own business itch

through this mini-manufacturing facility, but they are also building an infrastructure that helps realize other designers' dreams because according to Allison, "Hawaii's brand can be leveraged beyond aloha shirts and bikinis. Hawaii has the talent to compete with LA and NYC designers."

From Farm to Cup, Innovating an Established Industry

As the previous examples have shown, entrepreneurship and innovation can be found outside of the technology industry. The following story will show that it is also possible to do so within an already established industry. Success for Hawaii exports lies in marrying a commitment to high quality with not only domain-specific knowledge, but also business smarts. They saw a potential to transform a commodity coffee industry into a high value-add luxury item. When Honolulu Coffee Company started in 1991, it was a kiosk in Downtown Honolulu. The new owners acquired the company in 2008 with the goal of bringing its coffee to the world. Why buy a café chain to sell a bag of coffee? Because the café experience allowed them to showcase the quality of the coffee from the harvest and roasting, to brewing and serving.

Leveraging their experiences from their past coffee ventures in St. Louis and investment banking, they grew smartly, focusing on Japan as their first target market. Japanese culture values quality over quantity, and they knew that Japanese consumers are also willing to pay for that quality. They set up a kiosk in Ala Moana Center to showcase their coffee to Japanese tourists, as a low risk method to test the Japanese market, while also developing a following from the locals and tourists from other regions. As their coffee had to also look the part, they crafted their packaging to appeal to the high-end market. Their smart marketing and commitment to quality attracted the interest of Fujio Food System, a major restaurant management group from Japan, and allowed them to strike a franchise deal. As of this writing, there are 19 Honolulu Coffee Company cafés in Japan (with 15 to 20 additional stores opening in 2015), 3 in Guam, and more on the way. Their latest strategy involves founding the "Coffee Experience" where the Hard Rock Cafe used to be in Honolulu. Through this interactive museum-type venue, they will be able to actively educate their customers, building on the Kona Coffee brand the State has established. The Experience Center will have guided and self-guided tours, a fully working showcase bakery, a fully operational café, a coffee sensory laboratory, and a full production roasting facility.

Out of 3 million pounds of coffee grown in Kona, only a fraction meets Honolulu Coffee Company's quality standards. Their strategy to secure quality meant growing the beans themselves, allowing them to introduce new farming and processing practices that will contribute to their brand. There is more to their brand than the complete integration from farm to cup. They place great emphasis on hiring the right people with the right skill sets, which allows the company culture to be open, and therefore, nimble. In 2015, they plan to enter the Chinese market in Shanghai. By the end of 2015, they expect foreign revenues to exceed that of local sales. This is what entrepreneurial and high growth look like when we can innovate to break out of a commodity market.

From beans to leaves

Here is a contrast to the previous example, where an early stage venture is trying to establish a new industry focused on exports. The idea of growing tea in Hawaii came from a publication by Dr. Francis Zee et al. through the cooperative extension service of the College of Tropical Agriculture and Human Resources of University of Hawaii at Mānoa (UHM), which documented the suitability of Volcano region's altitude and acidic soil with less toxins for growing tea plants using clonal cultivars. The resulting tea leaves were of excellent quality (Zee, Sato, Keith, Follett, & T., 2003). When Eva Lee, a long time tea ceremony practitioner took note of the findings, something clicked. Combining these findings with the simplified tea processing method Dr. Zee developed, Lee, proceeded slowly and methodically, starting a tea farm in

2002 with her partner, and their tea business, Tea Hawaii, in 2006, mitigating risk scientifically and leveraging grants. The grants from the Hawaii County and the U.S. Department of Agriculture not only allowed them to research best practices in tea farming for their landscape and processing methods, but also led them to co-author a paper documenting an economic

analysis of tea farming and marketing methods that could help the rest of the tea farmers in Hawaii (den Braber, 2010). The paper also included recommended labeling of tea made from Hawaii-grown Camellia sinensis (vs. commodity teas blended in Hawaii or herbal teas) to establish a high-end brand, as well as strategies to incorporate value-added tea-products, like confectionaries, from secondary grade teas to offset the higher production cost of tea in Hawaii.

Tea Hawaii learned firsthand the challenges of export, such as shipping regulations that differ from country to country and from carrier to carrier. Tea Hawaii's commitment to quality has paid off, attracting customers worldwide without advertisements and building on the media coverage of health and tea, and tea as practice. Agritourism and ceramics sales augment their revenue from tea, as well as offering a total experience. In addition to formulating a panel to standardize tea labeling for origin declaration, the County grant will help Tea Hawaii organize an international tea competition to be held in Hawaii to showcase high-end teas.

While the scale and the speed of these innovative activities might be different than that of the Honolulu Coffee Company, these steps are essential when establishing a new industry segment. These steps differentiate themselves by setting their target farther: to brand Hawaii's tea as a high-end exportable experience and being the vanguard for the community. They are doing at a micro scale for the emerging tea community, exactly what is necessary to build an entrepreneurial community: 1) it must be led by entrepreneurs, 2) entrepreneurs must take a long-term view, 3) there must be philosophy of inclusiveness, and 4) there must be meaningful activities that engage the entire entrepreneurial community (Feld, 2012).

It Takes a Village

As if farming itself was not financially challenging enough for smaller farms, they face another obstacle in Hawaii. Because landowners do not offer long-term leases, the farmers cannot make improvements on the property to make their operations more efficient. Larger buyers like Costco require specific kinds of infrastructure, such as enclosures for sorting areas from the farms they do business with. Therefore, the smaller farms unable to improve their infrastructure are unable to gain access to larger markets. The Whitmore Project solves this problem by having the State purchase commercial agricultural lands and then providing a long-term land lease to farmers, who can then use the lease to get a loan from the bank to finance their improvements.

While the solution is innovative in itself, the Project has an even wider vision, and it is still ongoing. It strives to not only address a vertical problem (challenges within farming), but it also takes a holistic, horizontal look at the entire community in Wahiawa. By turning these leasable agricultural lands into an "ag-industrial park", the Project can accommodate shared distribution, processing centers, and community centers where workforce education can take place. Affordable workforce housing should be close by, in order to complete the "Live, work and play" formula familiar in tech park (Association of University Research Parks, 2008) and city planning. The 500 acres of farmland owned by the Office of Hawaiian Affairs adds synergy to the 1200 acres of farmland managed by the Agribusiness Development Corporation (ADC), an attached agency of the State's Department of Agriculture. By grouping the farming activities together, other projects now make sense: e.g., a waste water treatment plant which can then recycle the treated water for ag land use.

Why and how does it work? The benefits of the Project do not warrant its huge cost if we were merely trying to maintain the number and the type of farming jobs. The Project has a full set of partners (ADC, 2014) and a champion within each of the segments who share the vision of agriculture for Hawaii that meets the challenges of the global economy. The Whitmore Project has leveraged each partner's unique strengths and offerings, from State agencies such as Hawaii Housing and Finance Development Corporation for workforce housing to departments at the County level, such as Department of Environmental Services and Department of Planning and Permitting for the wastewater project and structure permits. The Project has involved the education sector such as UHM's College of Tropical Agriculture and Human Resources and the State of Hawaii Department of Education for research and development of innovations within farming and workforce readiness. With this network of partnership, the Project has been successful in gaining the support of the State legislature, where monies have been allocated for different stages of this Project.

With the now grown children of first and second generation farmers, educated in business administration and other disciplines, returning to the islands, they are keen to apply their knowledge to farming: the art, science, and economics of how different crops should be selected, and how to create secondary businesses and products. We can now look at farming beyond import substitution and local food security, to exporting manufactured food products, which have higher value and shield the farmers from sharp fluctuations in the market pricing of their produce.

Innovation from Research to Health

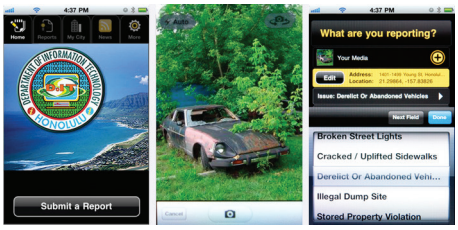
Turning university research into a successful business is challenging not just for the University of Hawaii (UH), but also for most universities around the world. There are many challenges due to the current financial environment and the structure of contracts for UH professors (see the Innovating Paradise section for some suggestions on how to improve the commercialization landscape). Here is one example that shows it can be done despite these challenges when infrastructure, capital, and talent can come together.

Dr. Thomas Ernst has worked on a project over the past 6 years, funded by the National Institute on Drug Abuse to the tune of $3.5 million, which may revolutionize the use of magnetic resonance imaging (MRI). This medical imaging technique currently requires patients to hold still in a narrow chamber, often for 45 minutes, where any movement translates to blurry images. Having to repeat the already expensive procedure adds to rising healthcare costs. Dr. Ernst's new prospective motion correction technology uses a small marker, which is placed on the patient's forehead and tracked by a camera, to produce scans that correct for any patient motion (UH System, 2013). This innovation, which more easily accommodates small children, patients with Parkinson's disease, and others who might have problems controlling their movements, is being commercialized by a local startup, KinetiCor, Inc. They have already installed their prototypes at a number of leading national and international MRI research centers. The funders in this venture include UH Upside Venture Fund, Hawaii Medical Service Association (HMSA), and Queen's Development Corporation, with a close partnership with the Queen's Medical Center. The road to commercialization for medical devices is long, because the inventions must receive clearance from the Food and Drug Administration. We are hopeful, however, when top-notch university research that results in solving problems meets top-notch business teams, the potential for success increases, because innovation is a process, and it does not take place alone. May more UH research projects follow KinetiCor's path under the UH's concerted efforts for innovation called the Hawaii Innovation Initiative.

University of Hawai'i Innovation Initiative

Innovation in Government

The words innovation and government do not often belong in the same sentence, but the government sector is one of the key bodies contributing to the innovation ecosystem, especially in the early stages of the economic transformation. Beyond the obvious contributions of government to innovation in infrastructure such as airports and broadband, it can also be a customer to new technologies being pioneered in the region. For example, in Estonia the government's Tiger Leap project in 1995 led to: telecommunications reform, e-banking, and e-government, (among others), leading the Estonian government to become customers of their IT companies to create e-health, e-learning, and an official state email address for every citizen (ICF, 2010).



One way the City and County of Honolulu (C&C) and the State of Hawaii governments have embraced innovation is through the open data initiative, where data collected by the government are made available to the public in a usable format. The initiative was championed in the city by Gordon Bruce, the chief information officer, and his deputy, Forest Frizzell. C&C had already completed several internal IT upgrades, and came up with creative projects, such as the Honolulu 311 app, which empowers citizens to report potholes, broken streetlights, illegal dumping, and more.

In late 2011, C&C was selected for the 2012 Code for America Fellowship where nationally-selected civic-minded developers, designers, and product managers form startup teams and assist a local government for a year-long collaboration to build apps and tackle the problems the community faces. C&C partnered with Burt Lum who knew how to get community input effectively through formats like unconference, a participant-driven meeting where the community votes on the topics to explore. The selected topics are programmed in real time as open discussion sessions. As a founder of Unconferenz, Hawaii's annual gathering using the unconference format, Lum was enlisted to convene CityCampHNL, where approximately 150 people discussed topics such as transportation, health, energy, and the environment. Beyond discussion, CityCampHNL included rapid prototyping sessions where ideas for a biking app, and open data formats for park and trail information were developed on the spot. Through the Civic Hackathon, participants created applications based on open data available from C&C. Up to this point, no C&C funds were expended for these events, leveraging venues like the Greenhouse Innovation Hub and private sponsorship for prize money and expenses. However, after seeing the promise of an app prototype that displayed bus locations, the C&C CIO provided some project time to complete the app. The "DaBus" app debuted on the iTunes App Store complete with a media fanfare via an event called Geeks on DaBus. The app was born out of one of the first publicly available open datasets from

C&C, generating demand for more government data to be publicly available so that programmers can use the data to create new applications and services. Despite the change in the County administration, this app continues to be maintained.

Initially, there was only limited government data available, but this did not stop them. C&C worked with Code for America to launch Honolulu Answers, where citizens posed frequently asked questions and crafted answers to them with the help of city employees, to generate useful content for the C&C website. While the service is no longer offered on the C&C website, the open source code is thriving, not only with on-going revisions being made by contributors here and off-island, but several cities in the U.S. and around the world, including Oakland, California, and Münster, Germany, have adopted the platform to create their own versions for their cities.

Frizzell attributes the level of success with this and other IT projects at C&C to two factors: having a centralized IT department within the county administration and the solid support that came down from the top. Perhaps more important than merely having the data available to the public is that the open data structure facilitated C&C to serve the public in a manner they wanted. Frizzell now thinks about how governments in Hawaii can innovate to use their data to explore and solve problems in the areas such as transportation (how can we use data to help reduce some of the heaviest traffic in the US?), and energy (how can we lower the highest electricity rates?). With tourism, Frizzell thinks there is an opportunity beyond the mere tabulation of visitor numbers. We have a cross section of the world visiting our islands. What if tourists from specific regions tried out new products planned for export to their region while visiting the islands? The companies can make quick improvements based on their feedback at a fraction of the cost of testing out the market by trial and error (similar to the strategy the Honolulu Coffee Company used to break into the Japanese market). Could the Hawaii Convention Center house such an initiative?

The open data movement continued with other events, such as the HON*Celerator, the State Digital Summit, and the Hawaiian Telcom University, generating interest in open data as a way for government to contribute to the innovation infrastructure. The policy leaders responded by passing Act 263 SLH 2013, related to open data at the State level, and Ordinance 13-39 at the County level.

Opening government data is not about creating jobs directly, but about making information available that businesses can use to develop services that are new, faster, and cheaper. The businesses, not government, in turn, create jobs. Because Google makes it easy to embed a map in any website, countless businesses and non-profits now have websites and apps that use their data, adding value, and creating jobs. Governments in Hawaii can be that catalyst.

Despite the loss of momentum usually accompanied with the election cycle, the interested parties powered through. Burt Lum, Jared Kuroiwa, Ryan Ozawa, and Wei Fang created a non-profit entity, Hawaii Open Data, to continue the work with or without government support. They teamed up with Common Cause HI to organize the Civic Celerator, a four-month code challenge, to come up with apps based on the data made available by the Hawaii Campaign Spending Commission. They are not waiting for the government to revamp their IT infrastructure to make more data available. Their next steps include a "data recycling center", where data obtained through Freedom of Information Act requests and other means are pooled into a shared database in a useful format.

Realizing Existing Potential: The Castle Redesign Project
Innovation in education and workforce development

Another example of our "healthy kids" actually involves the education of our keiki. Beyond charismatic entrepreneurs, the innovation economy requires workers with critical thinking skills and the ability to adapt to quickly changing environments. These concepts must be introduced early to expose the students to experience-based learning and entrepreneurship. Many innovation reports emphasize the importance of STEM education to expand our innovation workforce. Yet we cannot wait until the structural problems within our education system or the socio-economic issues that contribute to poor education are fixed. Are there ways to educate our workforce in ways suitable for the innovation economy within the constraints of our existing education structure?

"In this global economy, innovation in education is not so much about technology itself, but how we use technology to learn beyond our small community and expand our world view. With a unified state-wide education system, we have a unique opportunity to work systemically on the pipeline which is often overlooked."

— Kathryn Matayoshi, Superintendent, Hawaii DOE

Sometimes we have to hit rock bottom to accept that we need to change. The Castle School stakeholders did just that when faced with "reconstitution" for its 12 years of not meeting the U.S. Department of Education (DOE) standards. Faced with the unpalatable choices of shutting the school down, converting to a charter school, or bringing in mainland administrators to operate the school, the superintendent of the whole Castle-Kahuku Complex (from its pre-school all the way up to their high school) apologized to the public by stating that the school had failed the community, and proposed that the community be involved in designing the future for the school, while she herself took the helm for this challenge. Two local consultants were hired to coordinate this massive effort that involved interviewing over 1000 stakeholders in the community from students, parents and teachers, to administrators, non-profits and businesses in the area to see what motivated them to support (or not support) the school, to dig into the causes that resulted in the current situation. Trainers from Stanford University were flown in to demonstrate and facilitate design thinking sessions, where large scale brainstorming sessions can take place to solve problems (Wikipedia, 2014). They also leveraged entities beyond the 96744 zip code, such as Design Thinking Hawaii, a volunteer-based organization that assists in applying the design thinking process to reshape Hawaii.

The design thinking process helped break down the thick wall of mistrust between the school and the community, often times documenting their discussions in pictograms to avoid using words like "test" that had emotional baggage attached. The process uncovered that the teachers and the unions were not adverse to change, but they did not want to accept the responsibility for creating new curricula, even if they liked the concept of engaging the "whole child with the sense of place". The process resulted in a picture of an ahupua'a populated with resources they identified within their own community, including the Hawaii Institute of Marine Biology (a world-class marine sciences research facility), the University of Hawaii College of Tropical Agriculture and Human Resources (CTAHR), and Windward Community College, which could provide materials for the new curriculum.

The discussions quickly uncovered other non-profits and businesses that had facilities and/or curricula for training. Servco, for example, was tapped to provide a hands-on learning environment to service equipment. While they couldn't allow students to work on their production sites, they offered their process change management training to the students. It was a more prudent recommendation made by their HR director who knew this skillset was heavily sought after in the service industry, thereby providing students with an additional career path.

Community partnerships engage Po'okela Academy's students with their outdoor classrooms.
photo credit: Castle Redesign

As an initial step to try out the community-based curriculum, Po'okela Academy was formed. The at-risk students were identified and were offered enrollment in this curriculum. The application process involved the students' caretakers to commit to bring them to school on time, and the students had to go through an interview process, so they would be actively engaged from the get-go. Entities such as Paepae o He'eia (dedicated to caring for the ancient Hawaiian fishpond, with a program on aquaculture and stewardship of the land), and the Pacific American Foundation (which develops culture- and place-based curricula to improve the lives of Pacific Americans) that were involved in the Academy were often led by Castle Complex alumni, who transferred out to private or charter schools to complete their secondary education. These leaders were familiar with the environment these kids came from, knew how to engage them, and welcomed the opportunity to give back to the community. They quickly established themselves as role models for these students.

While the Castle-Kahuku Complex is far from completing their mission, they have already gained from the process thus far, something powerful and essential for success: their strong belief that the community is wealthy with opportunities, and with that understanding, a sense of pride and self-respect.

We must change our approaches to economic development because the world has changed. The set of basic ingredients required to nurture any industry, however, is no different when investing in an innovation economy: there must be appropriate infrastructure supporting that industry, capital flowing into the ecosystem, and developing talent necessary for the workforce. Here are some recommendations on our next steps.

Some Things Stay The Same

The agriculture economy did not appear overnight in Hawaii. Basic infrastructure such as irrigation systems had to be deployed. With the departure of larger plantations, the State government had to review its land use policy and come up with a strategy to ensure lands suitable for agriculture were still available to farmers, and protected from new development. Tourism requires airports and upkeep of the sites visitors enjoy. To continue to attract tourists, there needs to be a coordinated branding and marketing effort, and an entity, like the Hawaii Tourism Authority (HTA), where the needs of diverse tourism-related businesses can be addressed. HTA also acts as a hub to provide cultural grants aimed at enriching the Hawaii experience. There is also the Transient Accommodations Tax (TAT): a dedicated revenue stream to invest in various state-level tourism funds and the county governments.

As an example of educating the workforce with industry-specific knowledge, agricultural extension agencies excel at improving agricultural practices through farmer education, including agriculture, health, food safety, business management and marketing. For tourism, we have a systematic offering of training programs through educational infrastructures: the University of Hawaii School of Travel Industry Management, and the Brigham Young University's Hospitality and Tourism Management program, which were ranked in the top "20 best tourism degree programs" (TheBestSchools.org, 2014).

Infrastructure for the Global Economy

To found the innovation economy, we need to build up our capacity and support for these three components as extensively as we did for agriculture and tourism. For example, in the digital era, we need to have ubiquitous and affordable gigabit broadband as part of the physical infrastructure. The technological trends of social media, cloud computing, mobile technologies, and big data, make Hawaii's geographical remoteness irrelevant. Because they all rely on having a sound digital communication infrastructure, we need to redouble our efforts to make gigabit broadband available everywhere. Broadband technologies not only enable our community to improve the productivity of existing businesses, but they also encourage creation of new types of businesses, or even new industries, that are focused on exports.

The burden of establishing the infrastructure in the early stages usually falls upon the government. Due to the recession, investing in new programs and infrastructure has been a challenge. However, there are strategies that leverage small funds: from aligning with federal programs and partnering up with the private sector, to bootstraping where appropriate. A lack of funds does not have to prevent us from innovating. Policy makers and community leaders also need to be entrepreneurial if we are to establish the innovation economy in Hawaii.

We need to better position the counties and the state government to be able to take advantage of federal and private foundation grants and resources. These opportunities usually require multiple players to come together and there is significant overhead in the application stage, as experienced in the Google competition to select a beta site for their "fiber to the home" service. We have also missed a great opportunity with the American Recovery and Reinvestment Act of 2009 (ARRA) where the University of Hawaii won the application to

Economy / Components	Agriculture	Tourism	Innovation
Infrastructure	• Irrigation • Ag lands • Ag associations • Shared ag facilities	• Airports • Parks • Hawaii Tourism Authority	• **Gigabit broadband** • Co-working space, tech parks • **Leadership structure**
Capital	• Ag loan programs	• Cultural grants • Transient Accommodations Tax	• Investment capital • **Gap funding**
Talent	• Ag extension programs	• Tourism training programs	• Accelerator programs • Commercialization programs

drop fiber to every public library and public school. Because the private sector did not partner with the university, the conduit capacity is off limits to commercial traffic. Given that schools and libraries are close to residences, they would potentially have been great hubs for offering residential fiber services, as well as wireless hotspots.

"Geographic location and natural resources once determined a community's economic future. But today, we live in the Broadband Economy — a global economic engine powered by communications, whether it is fiber-optic cables stretching between continents, DSL connections in the home or mobile devices in our pockets. Now, it is the skills of the labor force, and the ability of business and government to adapt and innovate, that power prosperity."

— from Broadband Economies by Robert Bell, John Jung, and Louis Zacharilla

Broadband deployment is challenging because there are many players in a development project, from county permitting officers and construction contractors, to electricity companies that own the utility poles and telephone companies needing to meet their own regulations. Each of them has to keep in mind how broadband affects their plans. One piece of good news is that the C&C's rail project already includes plans to have fiber running alongside the transit route and to have each station include a public WiFi hotspot. This plan will provide a much needed digital foundation for transit-oriented development.

While the implementation details for broadband deployment cannot be prescriptively presented in a strategic report, there are many examples of how different communities formed and achieved their connectivity goals. The need for broadband is not a new idea for Hawaii, as the 2008 report by the Hawaii Broadband Task Force clearly identifies the vision and the goals (Hawaii State Auditor, 2008), with implementation recommendations presented by HTDC in an unpublished document. Other strategies are presented by think tank entities such as the Intelligent Community Forum, which showcases communities around the globe that have leveraged broadband to improve their citizen's lives. A simple step forward would be for C&C to require all new offices and buildings under their jurisdiction to be gigabit Internet ready. Just as the State requires their new buildings to be LEED certified, C&C in concert with other experts can come up with a new requirement for a broadband equivalent.

Infrastructure for Leadership

The innovation economy, unlike the more established tourism industry, lacks a central, statewide entity to coordinate the multidisciplinary innovation efforts and the funding needed for these initiatives. Because the nature of innovation starts with grassroots activities championed by smaller and less established groups, they are usually under the radar of state and county legislators. As mentioned in the broadband section, the interdepartmental and interdisciplinary nature of innovation makes it difficult to coordinate requests for funding for one project, especially when those funds may have to be expended by multiple departments. Because each budget line item appears under a different department, it is difficult to present a coherent overall plan to legislators so they can make their funding decisions. Well-intended funding priorities, therefore, can often result in a distribution of funds that will not result in high impact.

Other states committed to establishing innovation economies have already identified and implemented a solution to this problem: a state-level entity dedicated to innovation. According to the State Science and Technology Institute (SSTI), this is the most common approach to organize innovation activities. Just as Hawaii's tourism industry has a statewide entity for that multidisciplinary economy, HTA, Pennsylvania established the Ben Franklin Technology Development Authority. Dr. Rob Atkinson of the Information Technology and Innovation Foundation (ITIF) who has authored State New Economy Index reports, agrees that this type of model is good for implementation of the initiatives for an innovation economy. Pennsylvania's success was then copied by Ohio, with its umbrella entity, the Third Frontier Commission. The beauty of this approach is that it not only keeps the existing entities intact, but it also empowers them by freeing them from the fundraising process.

The idea of an umbrella entity itself is not as important as the advantage of pooling the funding, leveraging the strength in numbers of organizations that the entity represents. Collaboration does not magically occur simply because funds are placed under one umbrella, but the collective funding pool can make a significant difference by coordinating the funding by mission rather than organizations. This arrangement will avoid unnecessary redundancies (or division of funding for multiple agencies to achieve similar results where each agency is given insufficient funds to accomplish the goals). The collective funds will have more impact in our innovation

economy providing more opportunities that are bound to collide into each other creating an unexpected success. In addition, because the innovation segment is difficult to define, and innovation initiatives shift with technological and market trends, such a body can respond more quickly and effectively as a hub for local regions and communities.

It is possible to achieve critical mass without an umbrella structure, if key innovation entities are already engaged and a foundation for collaboration exists. Georgia and Kentucky both have multiple organizations as funding anchors (e.g., Georgia Tech and Georgia Research Alliance; Cabinet for Economic Development and Kentucky Science and Technology Council), with quality programs. This, however, is not the case in Hawaii. SSTI postulates that the high level of cooperation they exhibit might be due in part to the monetary connections between them that reinforce those relationships.

Of the states where most of their innovation activity or funding resides in one organization, there are two types of models: 1) organizations that primarily award funds to other entities to deliver services, and 2) organizations that, in addition to awarding funds to the other entities, also provide technical or financial assistance to the companies directly. The organizations under the second model may also implement projects where the structure of the organization is more advantageous (e.g., joint application for a grant). Examples of the first category would be Pennsylvania and North Dakota Department of Commerce. For future reference, if Hawaii is interested in studying the mechanics, the following states can be considered to be under the second category: Ohio, Arkansas, Mississippi, Maine, Maryland, Michigan, Oklahoma, Tennessee, Utah, Virginia, and Wisconsin.

Based on national best practices, this umbrella organizational structure has been explored to ensure consistent and continuous funding of state-level innovation programs, which can oversee the long development period required to establish the innovation economy independent of political and fiscal cycles (SSTI, 2014) (SRI International, 2014). Because the innovation segment is tough to define, and innovation initiatives shift with technological and market trends, such a body can respond more quickly and effectively as a hub for local regions and communities.

An umbrella entity for innovation in Hawaii could oversee the funding of the three components of the economy: infrastructure (from tech parks and incubators to the structures necessary for business development, such as shared manufacturing facilities), capital (from commercialization grants to seed capital and venture funds), and talent (from research and tech transfer to entrepreneurship and STEM education). There are also multiple entities within the State with domain expertise that can coordinate higher-level collaborations and support the already existing grassroots efforts, as well as other levels of government. The organizational structure presented above is not new, and therefore, we can learn from other states how best to approach it. Even within the state, there are already statutes that may be appropriate to incorporate into such a structure (e.g., the Research Corporation of the University of Hawaii's enabling statute).

Another way to address the lack of a "go-to" entity for innovation is to establish an advisory board that can speak to priorities in innovation. In many regions, they are referred to as the "innovation council", usually consisting of business leaders who are passionate about the cause not only in the entrepreneurial or technology fields, but leaders in currently dominant business sectors. Many councils are established outside of the government, although government policy leaders actively participate. Related government and private sector entities usually staff and fund these councils. This idea is not new to Hawaii, as the Lingle Administration attempted to engage community leaders on innovation by creating the Hawaii Innovation Council. It was unsuccessful, mostly due to the bureaucracy that limited the modes of discussion under Hawaii's Sunshine Law, but also because the deliverable and the expectations for the Council were not made clear. A previous similar attempt to stimulate the economy yielded more success: a 30 member Economic Momentum Commission (EMC) was formed in 2005, specifically to form an action plan to stimulate Hawaii's economy over the long-term (dKosopedia, 2007). Over a five-month period, they focused on actionable items to 1) enhance the quality of life, 2) improve employment, education and investment opportunities, and 3) upgrade infrastructure and review the master planning process. What if such a commission was established for innovation, and remained in session to help advise the umbrella organization for innovation, or to act as an advocate for the innovation economy year round?

With this type of arrangement, the innovation council leads the planning/policy efforts, and several key organizations (both public and private) lead the execution. With Hawaii Business Roundtable identifying the transformation to an innovation economy as their top priority, we should be able to engage the interest and time commitment of 7 or 8 key business leaders representing various industries that are well respected in the private sector. The rest of the seats can be filled by venture capitalists or angel investors, UH's director of research, heads of key government agencies, and legislative

Figure 7: Impact of the Third Frontier Program 2002

Based on figure provided by Ohio Department of Development

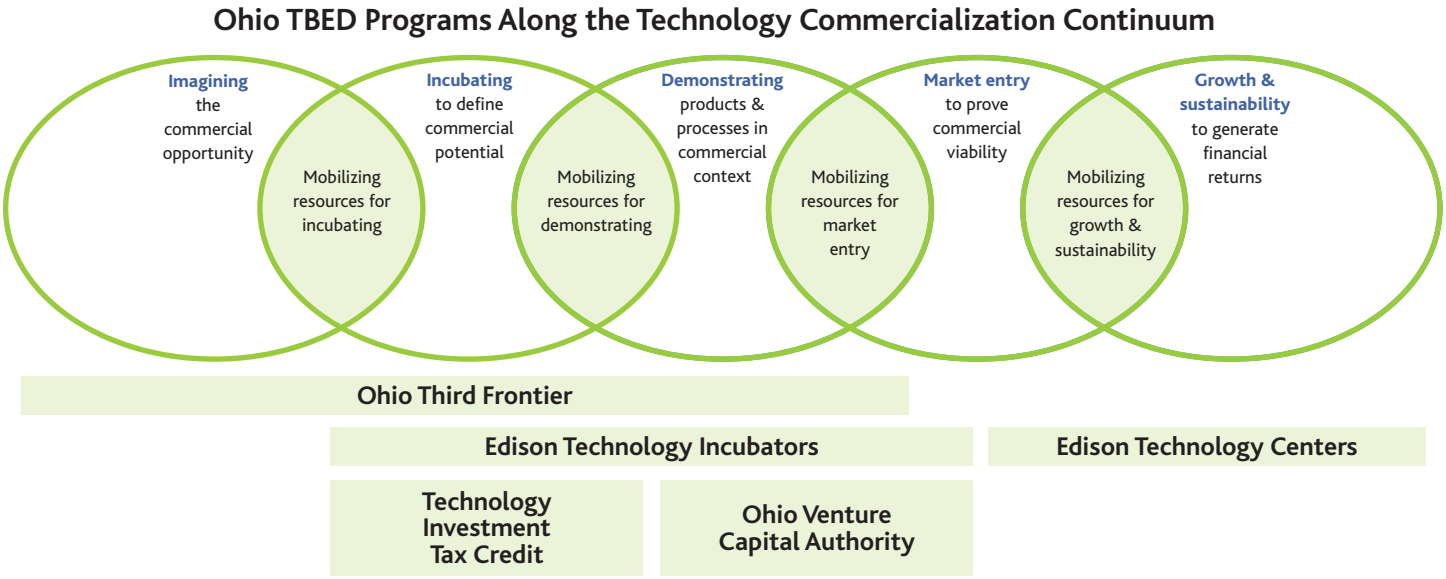


TABLE 1. OHIO'S MAJOR TBED PROGRAMS	
THIRD FRONTIER PROGRAM (2002)	**TOTAL AWARDS THRU 2008**
Research and Commercialization Collaboration	
Ohio Research Scholars Program creates 26 endowed chairs at Ohio Universities	$146.5M
Wright Centers of Innovation Program supports university-based Centers of Excellence in target technology platforms[1]	$295M
Research Commercialization Program provides funds for applied research	$190.1M
Wright Projects provides grants for capital equipment purchases	$52.2M
Entrepreneurial Support	
Entrepreneurial Signature Program pairs high-growth-potential technology startups with experienced entrepreneurs, risk capital, network in six regions	$84.8M
Pre-seed and Seed Funds award grants to pre-seed funds that invest in startups	$34.8M
Product Development Assistance	
Third Frontier Action Fund awarded grants to pre-seed funds and to companies for applied R&D leading to near-term commercialization	$18M
Ohio Research Commercialization Grant Program (SBIR III) awards grants to improve viability of technologies developed through Federal R&D projects	$11.2M
Fuel Cell Program supports applied R&D to help commercialize fuel cell components produced in Ohio	$39.9M
Advanced Energy Program supports applied R&D to commercialize advanced energy system components produced in Ohio	$19.9M
Cluster Development	
Ohio Innovation Loan Fund provides subsidized debt financing to established companies to develop next-generation products and services	$54M committed over program life
Targeted Industry Attraction Grants attract out-of-state companies in target industry sectors to locate new facilities in Ohio	$3.4M
Workforce Development	
Third Frontier Internship Program places highly-trained students (up to the doctoral level) with Ohio tech-based industries	$1.5M
Thomas Edison Program (1984)	
Edison Technology Centers (7) support the industrial competitiveness of Ohio companies in key industry verticals by providing access to technology and business expertise	Varies year-to year; currently $13M-$13.5M/year
Edison Technology Incubators (13) assist technology-oriented startups during concept definition and development stages, allowing entrepreneurs to concentrate on development of their core product/service	Varies year-to-year; currently $4M-$4.5M/ year
The Ohio Capital Fund/Ohio Venture Capital Authority (2003)	
Ohio Capital Fund "Fund of funds" mechanism increases venture capital available for early-stage investment in Ohio companies	$98.5M (of total $150M)
Ohio Technology Investment Tax Credit (1996)	
Technology Investment Tax Credit provides tax credit to taxpayers who invest in small, Ohio-based technology companies	$28.5M (of total $45M set aside)

[1] The five technology platforms targeted by the Third Frontier Program are: Biosciences; Advanced Materials; Advanced Energy; Instruments, Controls & Electronics (ICE); and Power & Propulsion.

leaders to create a 20–35 member council. With this method, again, the existing structures are kept intact, but the council would provide focused leadership that does not exist today. The starting budget for such an entity can be bootstrapped. Oregon's precursor to their Innovation Council, the Council for Knowledge and Economic Development's budget of less than $75,000 was pooled from public and private entities, which tackled innovation as part of their mission.

Because much of the research on best practices and the recommendations from past studies are already collated in reports such as the HTDC's A Framework for Developing a Statewide Innovation Plan, any leadership structure that is identified to champion innovation can complete a brief plan within six months, with an outside group/consultant managing the process. Broad statements on innovation have already been made. The council's deliverables, therefore, need to include specific recommendations that have the support of all the stakeholders.

Capital for Innovation

With leadership infrastructure in place, it is easier to champion a budget for innovation, which will have impact. A significant and consistent level of funding into the innovation economy is crucial, especially when the ecosystem is new and less robust. We need to learn from the failure of the High Technology Innovation Corp. (HTIC) where the enabling statute was compromised and unfunded, and therefore, unable to deliver on the right projects effectively. One source of the funding may be a percentage of the Hawaii Corporate Income Tax (CIT). The Hawaii Department of Taxation collected a little over $100 million in CIT in fiscal year 2013, approximately 38% increase over its previous year's total, as the collection amount is highly cyclical (Hawaii Department of Taxation, 2013). Because the CIT only accounts for a small percentage of the total tax revenue collections, any special assignment of a portion of the CIT to fuel Hawaii's innovation efforts will not negatively impact the general treasury of the State.

Other types of capital needed to fuel the innovation economy, such as risk capital, should be seen more as a measurement of the success of the rest of the innovation initiatives: if we have great talent and infrastructure, the market, in the form of risk capital, will follow. However, there are several reasons the "fly-over states" require assistance in getting the attention of venture capitalists. If there is not sufficient deal flow, risk capital will not follow. Hawaii has leveraged over $13 million from the U.S. Department of Treasury, and state funds contributed to the HI Growth Initiative through the LAVA fund leverage private sector dollars. An infusion of investment into our innovation ecosystem will further leverage the State's venture capital efforts.

Leveraging Capital in Universities

Major research institutions play a significant role in the innovation economy, because they address all 3 components of the economy: infrastructure (for education and research), capital (their foundations raising funds, and research grant and contract awards they receive), and talent (educating students but also attracting and retaining researchers). Land grant universities have a tall order in this economy, as they struggle to balance their growing expenses and adapt and update curricula, while their legislative funding and sources of federal grants get tighter.

UH faces this situation: in addition to educating the future workforce of Hawaii, the university's role in the innovation economy is to also foster "research as an industry". UH currently employs over 8000 researchers and professionals using these funds, which are mostly federal dollars being brought into our State. In the last 10 years, they have doubled their research funding to almost half a billion dollars. Their goal is to double that number again to a cool billion by 2022. This is a tough goal given the changing environment and policy in the U.S. Congress with fewer federal dollars set aside for research. Therefore, more significant than the absolute amount secured in research dollars is, "how much will the State leverage the research that resulted from this funding, to educate our future workforce, to further our knowledge, and to disseminate that knowledge?"

Beyond Research as an Industry: Transforming Hawaii's Technology Transfer

Most regions identify technology transfer as a key gap in the innovation economy. Research institutions across the nation take in significant funds and produce intellectual property, which can be a foundation to drive the innovation economy. Yet the cost of operating a tech transfer office often exceeds the revenue it brings in from licensing. Because most tech transfer offices are expected to be self-sufficient, they then grip tighter on their licensing agreements, often prioritizing exclusive licenses, which have a potential to bring in more revenue. However, in most cases, the math does not add up. Many technology transfer professionals, including Katherine Ku of the Office of Technology Licensing at Stanford (Ku, 2011), have stated that the "nickel and diming" of royalties does not pay off in the long run, even for very successful tech transfer offices. Donations to the institutions by grateful entrepreneurs have paid for buildings and endowed chairs in amounts that are

orders of magnitude more than a standard royalty percentage would have earned. How do we realize their economic potential without compromising the educational mission of universities? Here are two solutions that match our vision: transferring projects and leveraging community colleges as campuses for innovation.

> Association of University Technology Managers (AUTM) defines technology transfer as the formal transfer of rights to use and commercialize new discoveries and innovations resulting from scientific research to another party. Most universities transfer technology by protecting the discoveries through patents and copyrights, and then licensing them. In a typical model, companies purchase the license to further develop the discovery into commercial products or services.

The current discussions at universities focus on the conflicts surrounding tech transfer, which make it hard to agree and implement solutions: publications vs. patents (because the former is needed for tenure, and the later, not), education vs. research, revenues for the university vs. professors, and exclusive licenses vs. distributed applications. We must go back to the vision of land grant universities, which is meant to educate its citizens, and produce research and researchers. Exclusive patent licenses lock up opportunities to share the knowledge generated by the university. There are two innovative yet concrete ideas offered by Dr. Gerald Barnett of the Research Technology Enterprise Initiative. He advocates for tech transfer offices to shift from being focused on exclusive licenses, to transferring "projects" (Barnett, Transfer Projects, 2014), which he defines as a social and/or administrative structure created by a faculty initiative to pool common intellectual property (IP) and non-IP intangible assets (NIPIA).

Here is one scenario describing how a project is transferred. When a professor files her discovery with the tech transfer office, she holds a workshop for interested parties so she can present her technology to them. She charges a workshop fee comparable to the registration fee for national conferences (an item university accounting offices know how to deal with). The fee includes the license to use the technology. She might also charge an annual maintenance or a support fee. In this process, the technology is quickly deployed. With technology in the hands of companies, she secures immediate funding to continue her research; further, she also develops relationships with industry for future collaborations and receives feedback to guide her research.

Another idea articulated by Dr. Barnett expands the tech transfer activity and focus at the community college level (Barnett, Community Colleges, 2014). Because community colleges are distributed throughout the state but without restrictive intellectual property and research policies, innovation can take place among students of a variety of backgrounds, pairing up with their instructors. This idea transforms the community college campuses as coworking spaces for the students and instructors who want to innovate. Because Hawaii's community colleges are already outfitted with many of the tools for rapid prototyping and other innovation tools, and are rated among the best in the nation, we are poised to implement ideas sketched out by Dr. Barnett. They can be tasked to provide innovative solutions to their own community's challenges because community colleges focus on the workforce development needed by their community.

Despite the leadership challenges that plagued UH in the last few years, the new Vice President of Research and Innovation, Vassilis Syrmos, is hopeful because he sees a very different ecosystem for innovation than 5 years ago, with the level and quality of activities on the rise. His strategy is to consider already existing structure and infrastructure and develop them where possible, such as the tech transfer and commercialization organization HiTEX recommended by the Innovation Advisory Committee formed under MRC Greenwood's administration. He is, however, unafraid of forming new programs or changing UH's approach to innovation, such as UH's new startup accelerator, XLR8UH. It aims to address the gap in commercializing its research, acting as a proof of concept center, and offering up to $175,000 in seed capital for eligible XLR8UH companies. UH's investment is $1 million per year for the next three years; however, they aim to leverage existing UH initiatives, such as the Pacific Asian Center for Entrepreneurship (PACE), the Office of Technology Transfer and Economic Development (OTTED) which is currently awaiting the arrival of its new director, and their UPSIDE investment fund. Often criticized for rejecting the programs not created or initiated by UH or commercial opportunities that require partnerships, Syrmos now plans on actively encouraging their professors to go after the federal Small Business Innovation Research (SBIR) and the Small Business Technology Transfer (STTR) programs established for research commercialization. UH is looking to HTDC, which administers the matching awards at the state level and offers grant-writing assistance, to leverage this opportunity for its researchers.

Talent Development

With the recent alignment of state programs with private sector activities, such as accelerators and other entrepreneurial programs, the talent development component of Hawaii's innovation ecosystem is more robust than ever. One of the best

ways to nurture this component of the ecosystem is to provide meaningful opportunities for collaboration and sharing of information. Experience-based learning is being introduced in both the private and public schools systems, such as Schools of the Future, funded by the Hawaii Community Foundation, and the Grow Hawaii program. Specialized education for entrepreneurship spans from Lemonade Alley for K-12 to the Hawaii chapter of Founder Institute for adults.

One gap in talent development is the commercialization process. It is an important step in the innovation pipeline, as without it, an idea remains an idea rather than being developed into a product or a service. This process was further challenged after the tech bubble burst when venture capitalists and as well as angel investors started to focus their investments in later-stage companies. University research, usually known for requiring more lead-time to commercialization, faced further setbacks in their already low rate of tech transfer. Proof of concept centers (POCs) started to appear to fill the gap in funding but also in talent development, and often providing needed infrastructure, to be able to demonstrate feasibility of an innovation (Kauffman Foundation, 2008). In Hawaii, accelerators are trying to address some of the roles of POCs (e.g., UH's accelerator). As the community matures, we can establish POCs, which can focus on key emerging clusters, such as technologies for tourism or health care, and assist with the prototyping and the steps that follow from the accelerators. Both the public and the private sectors can leverage their excess building capacity to house these accelerators. Identifying the emerging clusters is important for the success of POCs, because that success largely hinges on specific expertise, equipment, and funding mechanisms available to address the unique challenges of a cluster. Some of the building blocks already exist in Hawaii, such as HTDC's matching funds for companies that win SBIR awards. The agency has integrated expertise and business assistance available from INNOVATE Hawaii (the Hawaii center for the federal Manufacturing Extension Partnership program). For the types of business assistance to be constructed into a user-friendly format for companies, there must be some level of specialization for the POC, such as food manufacturing technologies. Fixating on the origin of the innovation (e.g., from university research) is also less important, unless there is specific expertise required for all of the participants of the POC. We must be patient and not take the "top down" approach to dictate or pick the emerging clusters we want: innovation is a process that needs to take place on its own. The first emergence of a successful cluster can be often traced back to a single entrepreneur, who tenaciously aligned all the necessary resources, mixed with good timing and market conditions. Until the cluster emerges, policy makers' role is to invest in the innovation ecosystem. But once the cluster emerges, specialized proof of concept centers with appropriate infrastructure and expertise can be the catalyst to better leverage the new industry cluster. Only then, lawmakers can build cluster strategies.

Take the field of energy for example. The Hawaii Clean Energy Initiative, a goal to achieve 70% clean energy by 2030 with 30% from efficiency measures, and 40% from locally generated renewable sources, does not only have to be about trying to capture the more than $5 billion Hawaii spends in imported petroleum. While that level of import substitution could improve Hawaii's economy by ensuring those dollars circulate within our own economy rather than exporting them off-island, we need to think about how we are capturing those dollars back: by using energy innovations created elsewhere or by creating our own innovations, which could then be exported to other regions. These thoughts have led to the creation of Excelerator, an accelerator specializing in energy. Tech parks like the Natural Energy Laboratory of Hawaii Authority (NELHA) can position itself to specialize in accelerating energy innovation. Both the commercialization and the talent development processes take time, especially in a newer field like energy, where energy experts are not necessarily business experts, and entrepreneurs that speak both of these languages are rare. Collaborations beyond one's own domain and community, therefore, become critical. It is no wonder that most prestigious grants and competitions require matching funds and multiple partnerships representing various forms of expertise from multiple organizations, because such requirements increase the potential for success beyond the award to providing actual impact in the community. To put it another way: if we are avoiding a grant application because it requires matching funds or an elaborate level of partnering, then perhaps we need to rework the project scope, because without these components, the project would not have as much impact, if at all, when implemented.

Once a particular domain is emerging as a competitive area, Hawaii can follow the format NGA calls "institutes for collaboration" to bootstrap their innovation ecosystems (Sparks, 2011). Because innovation cuts across various industries and fields, most state agencies or universities do not identify innovation in the way other fields are recognized (i.e., there is no "Department of Innovation" or "College of Innovation"). Instead, "institutes of collaboration" have appeared in a few states (e.g., California, Oregon, Arizona, and Ohio) to develop innovations around a particular area where they seem to have an advantage. These institutes help align the many moving pieces and the ingredients necessary for an innovation ecosystem to have the maximum potential, by ensuring linkages for a robust innovation pipeline. The shift in paradigm, therefore, is accompanied by the states'

acknowledgment that the innovation economy is too complex to have a single state department or a university lead the initiative. One of the most frequently cited best practices in this area is the collaboration among the Oregon Nanoscience and Microtechnologies Institute (ONAMI), the Oregon Bio-Economy and Sustainable Technologies Center (BEST), and the Oregon Translational Research and Drug Development Initiative (OTRADI), envisioned by a strategic investment in these signature research centers championed by the state's public-private innovation council, Oregon InC.

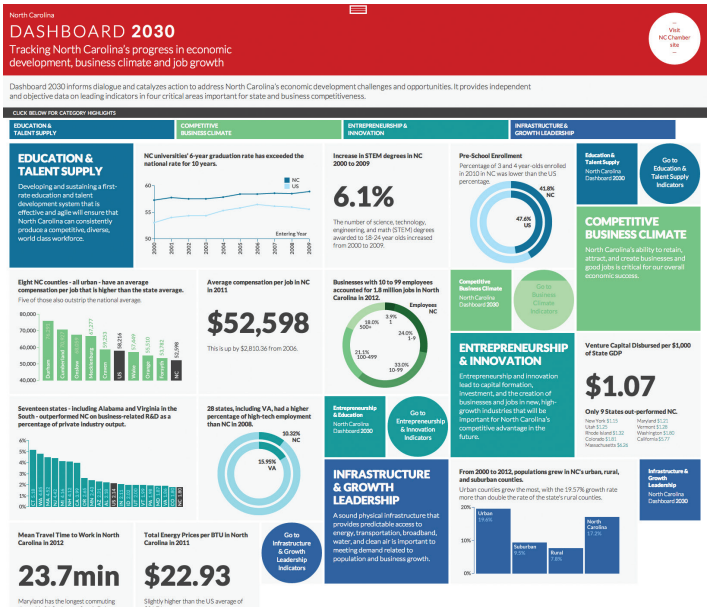
Recommendations on Metrics

Finally, we need to identify the size of the innovation economy as it stands now, so that we can track our progress. As with many aspects of innovation, Hawaii has made significant strides with innovation metrics, as the next section shows. Capturing the size of the innovation economy is challenging because it spans multiple industries and it continues to evolve. However, the estimated size of the innovation economy presented by HBR is a great foundation, as it includes fields beyond the technology sector, such as creative industries. Further, the value and methodology have been vetted by independent economists and economic development practitioners, from UHERO and DBEDT to CONNECT, a nationally-recognized innovation-based economy development group in San Diego. This report recommends that DBEDT use the same methodology in future analyses where a measure of the size of the innovation economy is required, to avoid confusion. From time to time, the master list of the industry categories (i.e., North American Industry Standard Codes, or NAICS) used in the measurement should be reviewed to ensure the categories are up-to-date and to capture new industries.

Size is not the only thing that matters. Because innovation cuts across multiple industries, it is difficult to gauge the overall impact of innovation in our State. This report recommends developing a list of occupational codes that reflect the innovation activities taking place in industries outside of technology, in addition to measuring the size of the economy using HBR's methodology. This second metric will present a different but equally important view of the innovation economy, by capturing innovation jobs that exist outside of tech. For example, a software programmer in a high tech company is captured by the HBR metric, but not if the programmer worked in an industry that is not in one of the industries identified, for example the hospitality industry. The purpose of the metric is not to assess the size of the innovation economy as an industry but to identify innovation jobs regardless of where the expertise is practiced. A preliminary list of innovation job codes was selected under the guidance of DBEDT and Dr. Timothy Slaper of Indiana Business Research Center for this report. The list only consists of job codes associated with science, technology, engineering and mathematics (STEM) fields, but in the next iteration, other innovation-based professions within the creative industries should be included, with the assistance of DBEDT Creative Industries Division.

If we want to focus on a particular area of innovation, the RIAN website has a comprehensive list of other relevant metrics, as well as how to identify deficiencies within a given metric (RIAN, 2014). A joint project of SSTI and the EDA, the guidelines can start to form a standard method of measuring different aspects of innovation so that state-to-state comparison may be possible in the future. The categories, listed under "Regional Innovation Assets", span from the obviously quantitative, such as risk capital, to more qualitative factors, such as quality of life. The project is useful because it provides a vetted method to capture factors consistently across the nation. Data gathering at this level can be overwhelming. It is more important to have the measurements be taken consistently and periodically, rather than wait to find ways to collect the whole set. This report recommends key metrics listed under key factors to be tracked by DBEDT's Research & Economic Analysis division (READ) (see Appendix C). READ has published multiple innovation-related data. The scorecard-type format is a quick way to present Hawaii's innovation indicators (DBEDT, 2008). Another recommendation is to display the key metrics in a dashboard format on DBEDT's website, such as the North Carolina Dashboard 2030.

Figure 8: Sample screen shot of the North Carolina Dashboard 2013



North Carolina Chamber Foundation

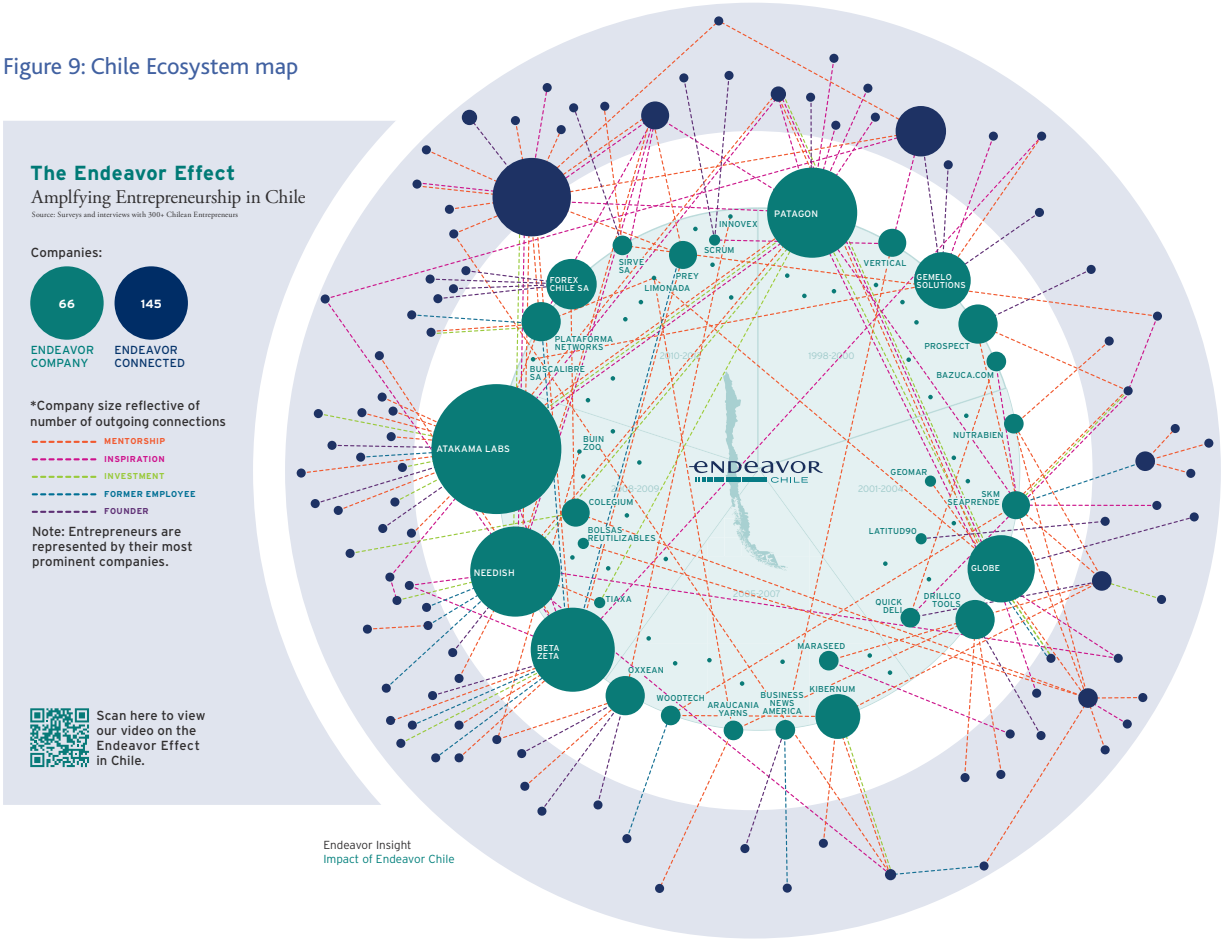
Because innovation is hard to define but we can identify it when we see it, we can go beyond the quantitative metrics to capture the growth of the innovation ecosystem. Because we want a high quality and densely populated innovation ecosystem, the community should invest in visual maps of the evolving ecosystem. Several representations may be needed: one to show the overall ecosystem identifying the entrepreneurs or the innovators and the supporters providing infrastructure, capital and talent; and another, to show how a specific business is fueled at different stages by different supporters, as well as what it contributed back into the ecosystem (e.g., a spin-off). Cambridge University in the UK has followed some key companies, which became the seeds for their innovation community. A similar more updated version was explored by Endeavor, a non-profit aimed at nurturing high-impact entrepreneurship in emerging and growth markets worldwide, for Chile (Endeavor Insight, 2012). Another example that celebrates the evolving ecosystem includes the Silicon Forest Map of Oregon. It makes sense for an innovation-based economic development entity to be in charge of updating such maps and visualizations. If such visualizations are web-based, for example, they can be dynamic as new nodes are added, and old ones removed or their relationships to other nodes displayed in different ways.

One metric that consistently appears on any innovation index is the number of patents. This metric is not as relevant for Hawaii unless our key innovations fall within industries that rely on patents. If we would also like to see the State's progress in tech transfer, a more appropriate metric is to track the date of first use or purchase of the license, rather than the total number of patents filed or licenses available.

It is essential that the State champion the data collection process with input from private sector organizations such as HBR, and other experts, such as UHERO. If the data is to be interpreted, there needs to be consistency in the method and the measurement process repeated if not annually, biennially. We strongly recommend that funding be allocated for future periodic data gathering and reporting, as well as continuing education for the key staff responsible, because both the choice of metric as well as the techniques to obtain them are still being formed for the innovation economy.

The most important overall recommendation is to identify a leadership structure and a leader that both public and private sectors respect, whether it is selecting an existing entity, creating an umbrella entity, or convening an innovation council. Without leadership, none of the other ideas will be effectively implemented. These recommendations can be considered as the first order of business by the innovation leadership of Hawaii.

Figure 9: Chile Ecosystem map



Endeavor Insight
Impact of Endeavor Chile

APPENDICES

Appendix A: Measuring Innovation Economy Size & Impact

Where are we now: benchmarking with metrics

Hawaii Business Roundtable (HBR), working with UHERO, DBEDT, and CONNECT, estimated the current size of the Innovation Economy at approximately 65,000 jobs. The initial value of the metric serves primarily as a baseline, so that we can track the growth of the innovation economy in the future. Because most innovation-based firms start as side projects by already employed individuals, HBR's metric triumphs in capturing the extended proprietors, defined as "workers who are counted as proprietors, but classify the income as peripheral to their primary employment" (EMSI, 2012).

Hawaii Innovative Economy	Number of Establishments	Number of Jobs excluding Extended Proprietors[1]	Number of Extended Proprietors	Number of Jobs including Extended Proprietors
Core Tech Sector	1,552	20,557	6,703	27,260
Peripheral/ Facilitator Tech Sector	1,156	14,039	1,987	16,026
Creative Sector	1,284	9,350	11,852	21,202
Total Innovative Economy	3,992	43,946	20,542	64,488

The HBR figure combines what they refer to as the "core tech sector" (tech and innovation-based businesses such as software development and specialized manufacturing), the "peripheral/facilitator tech sector" (entities that support the innovation sector, such as business associations and medical labs), and the "creative sector" (e.g., film production companies). HBR follows the standard method of sizing an industry where all jobs offered by the qualifying entities are captured (e.g., the above figure includes occupations that are not innovation-based, as long as the company qualified to be categorized as innovation, just as the count of tourism industry jobs includes non-tourism-based occupations such as software developers hired by hotels). Using a standard method of capturing the size for innovation economy is important because it allows for an apples-to-apples comparison with other industries.

Because innovation can come from industries outside what we normally consider "tech", such as software developers hired by hotels, it is also prudent to have a separate metric that tracks only jobs that are innovation-based in all industries (i.e., janitorial staff hired at a tech company would not be included in this metric). Using the STEM occupation list as a foundation, economic development practitioners can expand the list to include key occupations that drive the innovation economy regardless of which industry employs them (e.g., a graphic artist employed by an airline). Only counting the professions within STEM, 2013-2014 figures yield almost 32,000 jobs, including the extended proprietors.

STEM Jobs in Any Industry	Without Extended Prioprietors	With Extended Proprietors
Total	28,362	31,661

The figures above and the categories of jobs selected to obtain that figure should be considered the initial baseline, merely to show a method of how one can capture the impact of the innovation economy by tracking innovation-based jobs regardless of industries. This report stated that innovation is not limited to technology industry for technology jobs, so the innovation job impact metric should also include occupations beyond STEM jobs. For example, jobs that create intellectual property, such as composers and film makers should be included. When adding occupation titles onto this list, domain experts (e.g., DBEDT Creative Industries Division for recommending job titles to be included in this measurement for film and the arts) should be consulted. Justification for adding new job titles to this list should be presented to economists in charge of the innovation metrics for discussion; further, it should then be vetted by a third party .

Data Sources and Calculations

Occupation Data: EMSI occupation employment data are based on final EMSI industry data and final EMSI staffing patterns. Wage estimates are based on Occupational Employment Statistics, i.e., Quarterly Census Employment and Wages (QCEW) and Non-QCEW Employees classes of workers, and the American Community Survey (Self-Employed and Extended Proprietors). Occupational wage estimates are also affected by county-level EMSI earnings by industry.

State Data Sources: The figures are derived from state data from the Hawaii Department of Labor and Industrial Relations, Research and Statistics Office

[1] Includes self-employment

SOC	Level	Description	2013 Jobs QCEW and Non-QCEW - base	2013 Jobs - QCEW, Non-QCEW, and self-employed	2013 Jobs full list - QCEW, Non-QCEW, self-employed, and extended proprietors	Median Hourly Earnings - base
15-1111	4	Computer and Information Research Scientists	83	83	83	$53.95
15-1121	4	Computer Systems Analysts	1,057	1,169	1,362	$32.59
15-1122	4	Information Security Analysts	345	345	345	$35.67
15-1131	4	Computer Programmers	622	736	890	$29.86
15-1132	4	Software Developers, Applications	797	858	955	$37.22
15-1133	4	Software Developers, Systems Software	686	724	784	$40.97
15-1134	4	Web Developers	281	433	699	$23.55
15-1150	3	Computer Support Specialists	2,306	2,361	2,531	$22.31
15-1141	4	Database Administrators	250	255	292	$30.93
15-1142	4	Network and Computer Systems Administrators	1,396	1,420	1,465	$31.24
15-1143	4	Computer Network Architects	364	372	386	$44.24
15-1199	4	Computer Occupations, All Other	1,513	1,550	1,615	$40.48
15-2011	4	Actuaries	78	78	78	$43.65
15-2021	4	Mathematicians	5	5	10	--
15-2031	4	Operations Research Analysts	197	197	199	$34.27
15-2041	4	Statisticians	110	113	124	$27.21
15-2090	3	Miscellaneous Mathematical Science Occupations	5	5	10	--
17-1010	3	Architects, Except Naval	547	776	970	$38.36
17-1020	3	Surveyors, Cartographers, and Photogrammetrists	304	328	355	$26.40
17-2011	4	Aerospace Engineers	104	104	104	$51.39
17-2021	4	Agricultural Engineers	15	15	15	$69.15
17-2031	4	Biomedical Engineers	29	29	29	$41.72
17-2041	4	Chemical Engineers	151	151	151	$47.56
17-2051	4	Civil Engineers	2,136	2,223	2,294	$36.72
17-2061	4	Computer Hardware Engineers	277	287	304	$44.42
17-2070	3	Electrical and Electronics Engineers	1,131	1,150	1,174	$42.41
17-2081	4	Environmental Engineers	288	288	288	$40.66
17-2110	3	Industrial Engineers, Including Health and Safety	315	317	318	$40.05
17-2121	4	Marine Engineers and Naval Architects	90	90	90	$34.43
17-2131	4	Materials Engineers	22	22	22	$56.33
17-2141	4	Mechanical Engineers	495	511	526	$39.59
17-2151	4	Mining and Geological Engineers, Including Mining Safety Engineers	5	5	5	--
17-2161	4	Nuclear Engineers	80	89	106	$43.91
17-2171	4	Petroleum Engineers	23	23	24	$71.86
17-2199	4	Engineers, All Other	786	874	979	$46.57
17-3010	3	Drafters	867	941	1,010	$23.35
17-3020	3	Engineering Technicians, Except Drafters	1,400	1,425	1,457	$30.99
19-1010	3	Agricultural and Food Scientists	137	149	182	$27.56
19-1020	3	Biological Scientists	614	618	622	$35.20
19-1030	3	Conservation Scientists and Foresters	249	253	278	$30.89
19-1040	3	Medical Scientists	350	352	352	$32.81
19-1099	4	Life Scientists, All Other	67	67	67	$33.20
19-2010	3	Astronomers and Physicists	207	207	207	$52.69
19-2021	4	Atmospheric and Space Scientists	74	74	74	$44.22
19-2030	3	Chemists and Materials Scientists	196	196	196	$25.38
19-2040	3	Environmental Scientists and Geoscientists	763	779	854	$30.06
19-2099	4	Physical Scientists, All Other	127	154	172	$48.90
19-3030	3	Psychologists	691	963	2,259	$36.72
19-3090	3	Miscellaneous Social Scientists and Related Workers	678	693	739	$39.68
19-4011	4	Agricultural and Food Science Technicians	110	110	110	$17.35
19-4021	4	Biological Technicians	581	581	581	$13.91
19-4031	4	Chemical Technicians	64	64	64	$13.94
19-4041	4	Geological and Petroleum Technicians	43	43	44	$19.64
19-4051	4	Nuclear Technicians	30	30	30	$25.85
19-4090	3	Miscellaneous Life, Physical, and Social Science Technicians	988	1,005	1,036	$21.57
11-3021	4	Computer and Information Systems Managers	717	746	811	$43.72
11-9041	4	Architectural and Engineering Managers	698	706	714	$53.48
11-9121	4	Natural Sciences Managers	220	220	220	$46.94
		Total	26,764	28,362	31,661	

APPENDIX B: University Technology Transfer

The number of patents issued and their royalty revenues are standard metrics used to assess technology transfer activities. However, patent filing is costly and time-consuming. More important is the actual use of that patent, by tracking the date of first use or purchase, to show that the research that is patented is actually being commercialized.

University of Hawaii Issued Patents				
	Number of patents	Royalty	Revenues	Number of licenses commercialized*
FY2005	7	998, 321		1
FY2006	3	915, 120		0
FY2007	9		210,025	0
FY2008	10	505, 361		1
FY2009	9		502,186	5
FY2010	7		107,702	4
FY2011	1		289,842	1
FY2012	4		150,950	1
FY2013	5		279,328	0
FY2014	9		146,991	0

List of UH Technologies Licensed and Commercialized*	Date of First Use or Purchase
Basaltic Termite Barrier	1993
Fruit Disinfestation Chamber	1995
HPV Test Kit	1997
New Anthurium Variety	1997
New Leucaena leucocephala Variety	1998
Xanthomonas Detection Assay	1998
Immunoassay for Detection of PCV	2001
UH Sunup and UH Rainbow Papaya Variety	2001
Anti-Connexin Mab Research Tool	2001
ABC Chinese-English-Chinese Electronic Dictionary	2002
Polyubiquitin Gene Promoters	2004
Filamin-B Antibody Research Tool	2005
ch-TOG Antibody Research Tool	2008
Reactor for Anaerobic Wastewater Treatment	2009
JM4 Antibody Research Tool	2009
CiP75 Antibody Research Tool	2009
Airway Software Model	2009
Ornamental Colcassia (13 patented varieties)	2009
Gene Chip Sensor	2010
Uncooled Long Wave Infrared Hyperspectral Imaging Interferometer	2010
Spatially Variable Etalon for Spectroscopy and Spectral Imaging	2010
MAb for Insecticide Thiamethoxam	2010
Heat Sink for Thermal Management of Electronic Devices	2011
Method of Producing Biodegradable Thermoplastics from Waste	2012

** The list only contains UH licenses for which a product or a service was made available for use by producers or by consumers (i.e., if licenses for which their licensees failed before the commercialization stage, they are not included).*

APPENDIX C: Innovation Performance Indicators

"If it isn't named, it doesn't exist. If it isn't counted, it's not important. That's why we need a report which identifies the complex nature of the innovation economy and start measuring it."

— Richard Lim
Director, DBEDT

We must take care to select metrics that are appropriate for what we want to foster, to avoid what software developers call "measurement dysfunction", where the act of measuring actually leads people to take actions contrary to the desired outcome, i.e., undermining the spirit while following the letter of the intent of the metric (Austin, 1996). If a factory manager who wants to encourage higher productivity for shoe manufacturing sets a bonus payment structure by counting how many left shoes they produced, the staff who made all left shoes could win that bonus, even though having all these extra left shoes would not be a desired result for the factory.

Here is an updated scorecard that DBEDT can generate annually for the first few years until the larger community embraces the economic transformation in innovation. Scorecards can display the macro level status simply, to show gaps and attract the attention of all the stakeholders. Once the initiatives and policies begin to form, more detailed and focused data analyses are necessary (e.g., if we identify a gap in the labor supply for software developers, we need to focus on brain drain/gain metrics, graduation rates for that discipline, curricula and programs offered in our educational institutions, and salary levels compared to other states). States like Oregon who have published macro level innovation indicator data switched their focus to more focused metrics within a particular area they wanted to measure.

APPENDICES

INDICATOR	Hawaii	U.S.	Performance[1] (compared with nation)	Latest Trend[1] (improving or worsening)
Capacity for Innovation				
Education				
H.S. grad. rate (2011-12)	82%	80%	+	↑
H.S. dropout rate (2011-12)	4.7%	3.3%	–	↑
College Readiness (2012, Ave. SAT score)	1445	1498	–	↓
College going rate of H.S. grads (2010)	63.6%	62.5%	+	↑
Freshman retention 4 yr colleges (2010)	70.8%	77.1%	–	↑
Freshman retention 2 yr colleges (2010)	54.2%	54.3%	–	↓
Percent of High school graduates ultimately earning a:				
4 yr college degree (2009)	42.2%	55.5%	–	↓
2 yr college degree (2009)	17.9%	29.2%	–	↓
Education attainment -% coll. degrees (2013)	31.2%	29.6%	+	↑
Research & Development				
Total R&D spending as a % of GDP (2011)	1.1%	2.8%	–	↑
R&D spending by universities and colleges as a % of GDP (2011)	0.5%	0.4%	+	↑
R&D spending by business as a % of GDP (2011)	0.4%	2.0%	–	↓
Patents issued per 1,000 workers (2013)	0.2	0.9	–	↑
Capital Availability				
Venture capital investments per $1,000 GDP (2013)	$0.03	$1.8	–	↓
Innovation Research Grants per $1,000 GDP (2013)	$0.10	$0.11	–	↓
Tech Transfer Grants per $10,000 GDP (2013)	$0.08	$0.12	–	↓
Workforce Development				
% College 2013-14 STEM degrees (UH Manoa 2013-14)	25.4%	n/a	n/a	↑
Life-long learning -% of 25-49 yr olds. (2009)	6.1%	7.0%	–	↔
Worker recruitment H-1B Visas per 1,000 workers (2013)	1.2	3.3	–	↑
Infrastructure				
Connectivity – Megabits per second download speed (2010)	3.4	3.0	+	↑
Innovation Sector & Support Assets				
% jobs in tech sector (2013)	3.4%	5.7%	–	↓
% growth in tech jobs (2008-2013)	-2.0%	1.8%	–	↓
% jobs in R&D (2013)	0.3%	0.4%	–	↔
% growth in R&D jobs (2008-2013)	-13.9%	1.5%	–	↓
Creative sector				
% jobs in creative sector (2013)	5.9%	6.9%	–	↓
Highly Trained Technical Workforce				
STEM occupations as a % of workforce (2013)	8.2%	10.2%	–	↑
Average earnings of STEM occupations (2013)	$62,455	$67,653	–	↓
Technology Diffusion				
STEM occupations in non Tech Industry (2013)	6.5%	10.2%	–	↑
Entrepreneurial Activity				
Startups per 1,000 workers (2013)	3.1	4.0	–	↔
Economic Transformation				
Growth & Efficiency				
Technology Contribution to Growth (2008-2013)	-4.5%	4.5%	–	↓

Labor productivity - real GDP per worker (2013)	$79,276	$84,920	–	↑
Diversification				
Diversification -% alignment with U.S. (2011)	87.9%	n/a	n/a	↑
Global Integration -merch exports per $1,000 GDP (2013)	$7.95	$95.37	–	↓
High Wage Jobs				
% of 4 Digit NAICS industry above $60K (2013)	31.3%	40.8%	–	↑
Median Income				
Median family real Income (2013)	$85,101	$68,556	+	↓
Median household real income (2013)	$72,719	$56,290	+	↓
Energy Efficiency				
Energy efficiency - mil. BTUs used per $1,000 GDP (2012)	3.9	6.2	+	↑

[1] +: above nation. –: below nation. 0: same as nation. ↑: improving. ↓: worsening. ↔: no change.

APPENDICES

INDICATOR	DATA SOURCE
Capacity for Innovation	
Education	
H.S. grad. rate (2011-12)	National Center for Education Statistics
H.S. dropout rate (2011-12)	National Center for Education Statistics
College Readiness (2008, Ave. SAT score)	The College Board
College going rate of H.S. grads (2010)	National Center for Higher Education Management Systems
Freshman retention 4 yr colleges (2010)	National Center for Higher Education Management Systems
Freshman retention 2 yr colleges (2010)	National Center for Higher Education Management Systems
Percent of High school graduates ultimately earning a:	
4 yr college degree (2009)	National Center for Higher Education Management Systems
2 yr college degree (2009)	National Center for Higher Education Management Systems
Education attainment -% coll. degrees (2013)	U.S. Census Bureau, American Community Survey
Research & Development	
Total R&D spending as a % of GDP (2011)	National Science Foundation
R&D spending by universities and colleges as a % of GDP (2011)	National Science Foundation
R&D spending by business as a % of GDP (2011)	National Science Foundation
Patents issued per 1,000 workers (2013)	U.S. Patent and Trademark Office/ Bureau of Labor Statistics
Capital Availability	
Venture capital investments per $1,000 GDP (2013)	National Venture Capital Association
Innovation Research Grants per $1,000 GDP (2004)	U.S. Small Business Administration
Tech Transfer Grants per $1,000 GDP (2004)	U.S. Small Business Administration
Workforce Development	
% College 2013-14 degrees in Sci & Tech	University of Hawaii
Rapid Response Custom Training	N/A
Life-long learning -% of 25-49 yr olds. (2009)	National Center for Higher Education Management Systems
Worker recruitment H-1B Visas per 1,000 workers (2013)	Yearbook of Immigration Statistics – Homeland Security
Worker recruitment: Ex-Kama'aina	N/A
Infrastructure	
Connectivity – Megabits per second download speed (2010)	Speed Matters Project, www.speedmatters.com
Innovation Sector & Support Assets	
% jobs in tech sector (2013)	EMSI and DBEDT, Hawaii's Targeted and Emerging Industries 2013
% growth in tech jobs (2008-2013)	Same as above
% jobs in R&D (2013)	EMSI – NAICS 54171 & 54172
% growth in R&D jobs (2008-2013)	EMSI – NAICS 54171 & 54172
Creative sector	
% jobs in creative sector (2013)	EMSI
Highly Trained Technical Workforce	
STEM occupations as a % of workforce (2013)	EMSI and Bureau of Labor Statistics (BLS)
Average earnings of STEM occupations (2013)	EMSI and BLS
Technology Diffusion	
STEM occupations in non Tech Industry (2013)	EMSI
Entrepreneurial Activity	
Startups - % of establishments less than 1 yr. old (2013)	BLS
% jobs in tech sector (2013)	EMSI

Economic Transformation	
Growth & Efficiency	
Technology Contribution to Growth (2008-2013)	EMSI
Labor productivity - real GDP per worker (2013)	EMSI and Bureau of Labor Statistics
Diversification	
Diversification -% alignment with U.S. (2011)	Bureau of Economic Analysis (BEA) and DBEDT
Global Integration -merch exports per $1,000 GDP (2013)	Census Bureau and WISER Trade Database
High Wage Jobs	
% of 4 Digit NAICS industry above $60K (2013)	EMSI
Median Income	
Median family real Income (2013)	www.deptofnumbers.com
Median household real income (2013)	www.deptofnumbers.com
Energy Efficiency	
Energy efficiency - mil. BTUs used per $1,000 GDP (2012)	Energy Information Administration and BEA

The nature of innovation is multi-dimensional, and so are the factors that feed into innovation activities. Many institutions tracking economic growth, therefore, often combine several factors and present the result as an index. State-level scorecards often include some of these rankings, and they are useful in tracking Hawaii's innovation growth with respect to other states.

Hawaii often compares itself to California, because of our proximity. However, the comparison often leads to unproductive conclusions in innovation because of the vast differences in our profiles, from population size to gross state product levels. California, mostly due to Silicon Valley, is head and shoulders above other states in the amount and concentration of available venture capital and the density of innovation ecosystem, not just compared to Hawaii but also compared to other major states also known for innovation, such as Massachusetts and New York. Further, Silicon Valley's level and type of success has not been duplicated elsewhere within the state of California: Los Angeles and San Diego independently established their own brands of entrepreneurship and innovation economy culture, just as Boulder, Colorado; Portland, Oregon; and other locales outside of California have.

Here are some comparable states and their profiles relevant to Hawaii's economic development:

States (2009 Gross State Product ranking)	ITIF State New Econ. Index 2014	Milken State Tech & Science Index 2012	Kauffman Index of Entrepreneurial Activity 2013	Profiles relevant to economic factors in Hawaii
Hawaii (38)	43	36	8	
Arizona (18)	17	16	35	Strong tourism and real estate as leading sectors; Strong and fiscally significant foundation taking leadership in economic development
Louisiana (24)	46	44	16	Diversification strategy from natural resource-based industries to heavy use of film tax credit to woo the film industry, infrastructure issues caused by natural disaster
West Virginia (39)	49	48	25	Despite leveraging strong federal support in the past, their innovation index score still places them in the bottom tier with Hawaii.
Maine (43)	28	39	19	Remoteness to markets, low acceptance of tech as an industry given their traditional sectors (timber and tourism)
Alaska (45)	32	41	2	Remoteness to markets, to Continental U.S.; strong federal support in the past

These states may be considered comparable states when reviewing the national indices such as those listed above.

Indices are useful for state-by-state comparisons, but they have their limitations. While the ITIF State New Economy Index probably captures the metrics important to this report's definition of the innovation economy, the overall score itself does not reveal many of the lessons we can learn from it. It is necessary to examine the components that make up their index and their subcategories:

ITIF The New Economy Index Category Subcategory	2014 ranking (2010)
AGGREGATED KNOWLEDGE JOB:	39 (37)
Information Technology Jobs	44
Managerial, Professional, and Technical Jobs	31
Workforce Education	15
Immigration of Knowledge Workers*	23
Migration of U.S. Knowledge Workers* (B07009: geographical mobility in the past year by educational attainment for current residence in the United States)	10
Manufacturing Value Added	50
High-Wage Traded Services	42
AGGREGATED GLOBALIZATION:	39 (30)
Export Focus of Manufacturing and Services	50
Foreign Direct Investment	23
AGGREGATED ECONOMIC DYNAMISM	42 (46)
Job Churning	31
Fast Growing Firms	32
Initial Public Offerings	36
Entrepreneurial Activity	26
Inventor Patents	40
AGGREGATED DIGITAL ECONOMY	41 (22)
E-government	24
Online Agriculture	26
Broadband telecommunication	40
Health IT	49
AGGREGATED INNOVATION CAPACITY	42 (41)
High-Tech Jobs	41
Scientists and Engineers	41
Patents	34
Industry Investments in R&D	34
Non-industry Investments in R&D	19
Movement Toward a Clean Energy Economy	37
Venture Capital	47

The table shows the categories and subcategories of the ITIF index which resulted in Hawaii ranking 43rd for 2014, down from 36 in 2012. The brightest spots for Hawaii are the migration and the immigration of knowledge workers and our entrepreneurial activity level. While a high level of entrepreneurial activity can indicate a high number of out-of-work individuals starting a business out of necessity, the Kauffman Index of Entrepreneurial Activity indicated that more people started new businesses in 2013 compared to 2009, because of available opportunities rather than out of necessity (78.2% vs. 73.8%) in the US. This statistic may reflect both the mindset of the workforce that entrepreneurship is desirable, and that the barriers to be entrepreneurial (e.g., cost of starting a business, availability of resources) have lowered.

With our particular definition of innovation economy, focusing on scalable exports that derive from entrepreneurship, the subcategories to watch for are: "Manufacturing Value Added" defined as the manufacturing value added per production hour worked as a percentage of the national average, adjusted for industry mix. Unless there is a larger difference between the cost of raw materials and processes required versus the value of the final product, businesses cannot typically offer higher wages. This metric reflects how productive we are in leveraging our resources to yield higher value for each hour worked. Other related subcategories are "High-wage Traded Services" and "Export Focus on Manufacturing Services". Certain industries consistently have a higher rate of entrepreneurial activity than others, such as services, while others like manufacturing score low. However, there is no natural constraint within the industry profile of manufacturing that limits the rates in entrepreneurship, because places like Shenzhen in China have established a manufacturing ecosystem where innovation activities are fueled by their ability to demo and deploy new products, bustling with entrepreneurship (Ito, 2014).

In Hawaii, the amount of value added manufacturing is even more of an issue, because of the higher transportation cost. If most of the manufacturing within our state is low-value added, it most likely indicates that the manufacturing activities are for local consumptions only and not geared for export. To expand this area, we can provide infrastructure and offer business assistance to transform manufacturing activities directed only for local markets to the export market. Businesses require assistance to scale up, or even rethink their product. For example, we can invest in an incubator space and programs for farms to share bottling facilities so they can transform their produce to high-value add items such as sauces and

jams. Existing programs such as INNOVATE Hawaii (NIST MEP Center of Hawaii) who offers business assistance for export methodologies, can provide workforce education.

The subcategories germane to innovation resources can be divided into infrastructure ("Broadband Telecommunication"), talent ("Information Technology Jobs" and "Scientists and Engineers"), and capital ("Venture Capital"). As identified previously, broadband is a key infrastructure for the innovation economy. Hawaii's ranking has declined significantly in this area from 26th in 2012 to 40th in the "Broadband Telecommunications" category which presents a weighted measure of broadband adoption by individuals and average download speed. The talent subcategories can be treated as both the level of resource needed and the consequence of more innovation activity. The subcategories for the Milken Institute's State Science and Technology Index show similar gaps in key professions correlated with innovation activities, especially in software development. The "Venture Capital" category ranking is deceiving, because the ranking may suggest a linear distribution of scores among the states, when in fact, the results are usually bi-modal: a few states such as California and New York hold the lion share of the venture capital in the U.S. followed by a distant second group of "up and coming" states like Utah, which make up the top states, and then the majority of the states lumped into the capital-poor states. Here, it is best to see how much private and federal dollars are being leveraged for every state or local dollar, until we can form a critical mass to attract more risk capital from elsewhere.

Overall the ITIF index best reflects the key factors we want to track for the type of innovation economy Hawaii should embrace, with the exception of the "Movement Toward a Green Economy" category which presents a "weighted measure of the change in energy consumption per capita and the clean energy share of total energy consumption". While it is a relevant topic for Hawaii, with the highest electricity rates in the nation, their methodology includes a calculation which takes the ratio of all energy consumption to the renewable energy and nuclear energy. Because Hawaii does not have nuclear energy, states heavily reliant on nuclear energy would have ranked higher. DBEDT reports on a more relevant tracking of Hawaii's movement towards a green economy, using the Energy Information Administration's data on consumption in BTU per GSP, where Hawaii has been improving in this category (EIA, 2014).

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Enterprise Honolulu (EH), the Oahu Economic Development Board, is a non-profit, funded primarily by the private sector. The organization strives to grow Oahu's businesses by transforming Hawaii's economy through innovation.

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