Information as a Paradigm

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Introduction

Kansas has always held a unique distinction as the "center" of the United States, as determined by the technology of the day. Using the best technologies available in 1912 — the year New Mexico and Arizona became states and completed the Lower 48 — the U.S. National Geodetic Survey determined the nation's geographic center to be near Lebanon, Kansas. Of course, technology has changed dramatically since then, and today advanced mathematical models say that the geographic center is actually 20 miles west in Kansas, closer to Phillipsburg.

Similarly, the presumed location of the nation's geodetic center, which is different from its geographic center, has also changed over the years. In 1927, a point in Kansas known as Meades Ranch, about 40 miles south of Lebanon near Lucas, was declared the geodetic center of North America. It held this title for the next 56 years until new technologies led to the establishment of the North American Datum of 1983 and the World Geodetic System of 1984.

Today, the most modern mapping technology is Google Earth, earth.google.com. But guess what? Google Earth *still* lists Kansas as its default center. If you zoom in when Google Earth opens, you arrive at an aerial view of Meadowbrook Apartments, right across the street from KU! Admittedly, that fact has less to do with mathematical models and more to do with the fact that Google Earth creator Brian McClendon is a proud University of Kansas graduate whose world once revolved around KU. And his apartment in Meadowbrook is now memorialized each time someone opens Google Earth.

The point is, information and technology — and their intersection in the area of information technology (IT) — matter a lot and continue to change the world. Information technology is the breakthrough development that has opened all kinds of doors for society and civilization. This paper proposes information technology as a paradigm, both for advancing our agenda at KU in research excellence as well as for a basis of everything we do.

Information Technology as a Paradigm

We are in an information age. Computer science, information, and IT have made huge advances in the last few decades. Now is the time and place for them to have a major effect. They are powerful tools, ready to be used in all sectors of society. Advances in computer technology have fundamentally changed the way we live. In fact, computer technology has become the infrastructure that drives commerce, entertainment,

healthcare, national security, transportation and innovation.

In 2009, a panel of eight judges from the Wharton School of the University of Pennsylvania named the top innovations of the past 30 years. The panel received some 1,200 suggestions, ranging from lithium-ion batteries, LCD screens and eBay to the mute button, GPS and suitcase wheels — a list that illustrates the incredible pace of innovation over the past 30 years. Not surprisingly, most of the top 20 innovations on the list were technological and medical advances. Also not surprisingly, the Internet topped the list. And nearly all of the top 20 innovations were directly tied to IT or influenced by IT, specifically computer science.

For the first few decades of computer use, IT did not have a measurable effect upon the economy and economic productivity. But starting in the mid-1990s, there has been a dramatic increase in economic productivity in the U.S., and IT is the major driver. Harvard economist Dale Jorgenson and colleagues determined that, in the years following 1995, IT accounted for the majority of the growth in productivity in the U.S. economy[1].

The National Research Council's Computer Science and Telecommunications Board illustrates the growth of the IT economy with a chart commonly referred to as the "tire tracks" diagram (see Figure 1).[2] The lines of the tire tracks diagram resemble the grooves left by a tire — the thin red line on top indicating when research was performed in universities, a thicker blue line in the middle shows when research labs were working in the space, and a dotted black line indicates products being introduced. When the dotted black line turns green, that indicates when the technology became a billion-dollar sector.

When presented this way, there are three very clear takeaways that emerge about the growth of these billion-dollar sectors: First, each one of these sectors can trace its formation to university research and, in almost all cases, to Federally-funded research. Second, it takes a long time for the research to pay off, in most cases one or two decades. And third, the research ecosystem is fueled by the flow of people and ideas back and forth between university and industry. This system has made the United States the world leader in information technology.

Technology as the Infrastructure for Grand Solutions

KU has recently embarked upon a transformative strategic plan to chart the university's path toward excellence as a top-tier public international research university. Aptly titled *Bold Aspirations*, boldaspirations.ku.edu, the plan sets out the new, higher expectations KU has for itself as a university and the priorities that we will pursue. As part of the plan, KU research is being targeted toward four societal "grand challenges"— challenges so complex that they cannot be solved by any one discipline and require inherently multidisciplinary approaches. We call these four grand challenges our strategic initiative themes:

- "Sustaining the Planet, Powering the World" — focusing upon energy, climate, and sustainability

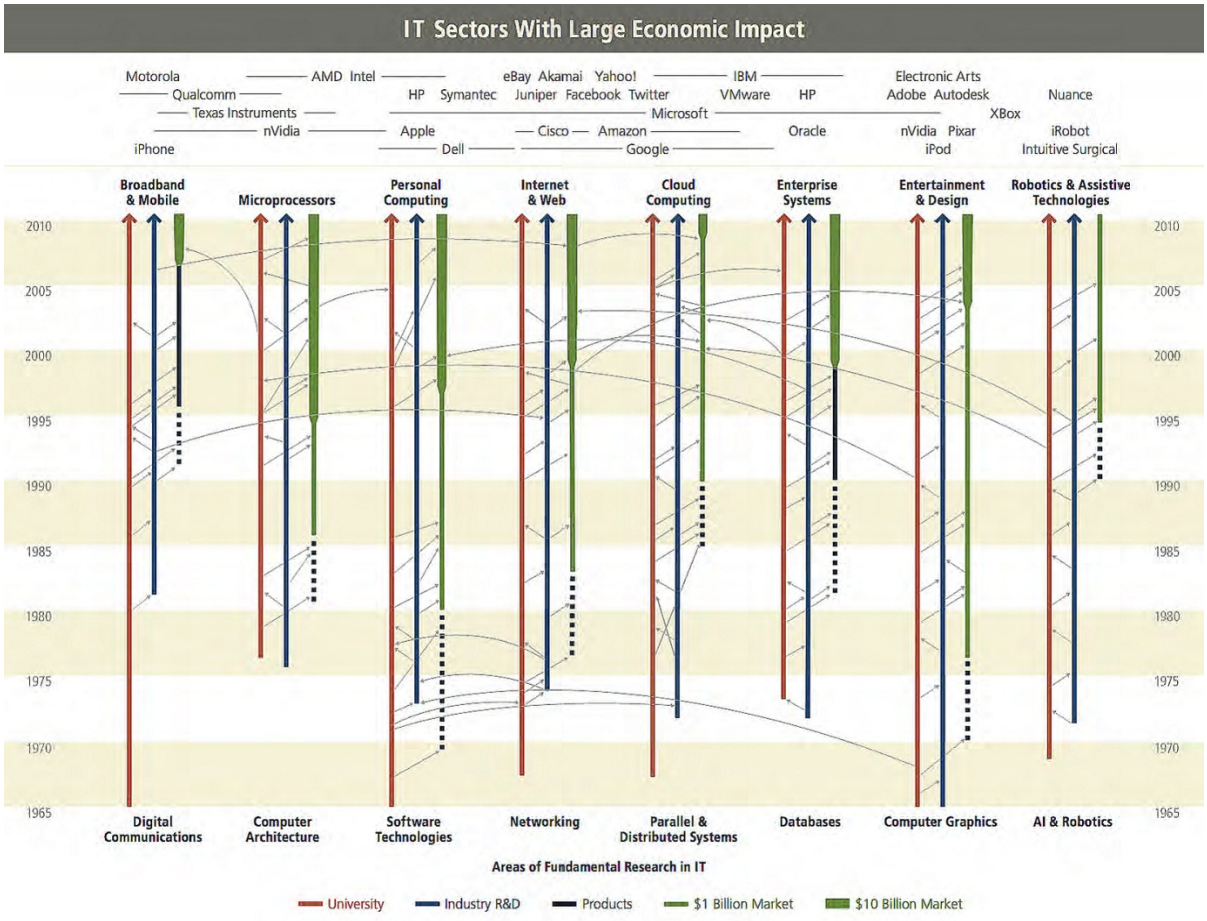

Figure 1: The "tire tracks" diagram, so named because of its visual resemblance to the tracks that an automobile tire makes, was put together by the Computing Research Association to represent the tremendous growth of various sectors of the IT economy over the last few decades. Each sector is represented chronologically by a vertical column, with time moving from bottom to top. The red line on the left for a sector indicates when Federally-sponsored research was performed in universities. The middle blue line indicates corporate research in the sector. The dotted black line indicates when the first product was introduced in the sector, and the time at which the dotted black line turns solid green indicates when the sector became a billion-dollar industry. Where the line thickens indicates a $10 billion sector. The gray arrows indicate the flow of people and ideas among sectors. Some of the specific billion-dollar companies that have emerged from these developments are listed at the top of the chart.

- "Promoting Well-Being, Finding Cures" — focusing upon health and well-being
- "Building Communities, Expanding Opportunities" — focusing upon local, national, and global communities
- "Harnessing Information, Multiplying Knowledge" — focusing upon the transformative power of information

It's the fourth theme listed above — "Harnessing Information, Multiplying Knowledge" — that forms the core of this paper. It is crucial components of the previous three themes and drives the future of KU. IT is, in fact, a paradigm for what the university does.

A great example of the role of IT across research areas can be seen in the list of 14 grand challenges in engineering assembled by a committee convened by the National Academy of Engineering, listed at www.engineeringchallenges.org. According to some observers, notably Ed Lazowska at the University of Washington, eight of the 14 goals on the list require a predominant role in computer science. In the six remaining areas, IT will play a significant supporting role by providing the infrastructure for solutions.

Using Technology as Infrastructure at KU

IT is not only a key driver for research at KU. We are also using IT in a broad sense to build an infrastructure for innovation. One example is our new Center for Online and Distance Learning (CODL), which helps faculty build online or hybrid courses and also serves as a central point for students to access online learning. More specifically, the CODL is using technology to create deeper and better learning experiences, more efficient classroom experiences, and more opportunities for faculty and students.

Another example of how KU is using technology as infrastructure is the Open Learning Initiative, which offers online courses to anyone who wants to learn or teach. KU is also exploring other such hybrid teaching models, which can offer various advantages. For example, online learning modules track student mastery of basic core concepts for a course. This allows the faculty member, through the gathering of data in the online course, to know where and how each student is progressing. Additionally, these models permit students to repeat parts of the course until they attain mastery, allow class time to instead be spent integrating basic knowledge, and can demonstrate a baseline of mastery in all foundation courses in a discipline.

Another example of how KU is using technology as infrastructure is the university's 2009 adoption of an open access policy, which makes faculty members' scholarly journal articles available online for free. KU was the first public university to adopt such a policy. The main points of the policy are straightforward: faculty members grant a non-exclusive license to the university to share a copy of their paper; faculty members give a copy of papers to the university for open dissemination; and faculty members may notify the university of their waiving of the license granted at their discretion for any individual paper. KU Libraries hosts a public portal called KU ScholarWorks that provides

free access to all faculty publications under the policy.

KU is also using technology to maintain Faculty Professional Records Online (PRO), a faculty activity database that serves as a repository for faculty scholarship, simplifies evaluations, creates searchable experts lists, and identifies clusters of strength across disciplines. The PRO database feeds additional outreach, allowing us to highlight our faculty's accomplishments and connect them with various groups such as policymakers, media, entrepreneurs, and other stakeholders. PRO also helps grow our open access portal KU ScholarWorks mentioned above by feeding articles and books by faculty members into the repository.

Last, but certainly not least, we are using technology as infrastructure at KU by building capabilities for sophisticated analytics that allow us to examine our effectiveness and productivity as a university. A good example is our partnership with Academic Analytics. Figure 2 illustrates one of the graphics we generate to study program effectiveness. In the chart, the scholarly productivity of seven different KU programs and department are represented by the red line, contrasted with AAU member schools (in blue) and large research schools (in green). This diagram is useful in a number of ways — like helping to determine which programs to invest in. If we see strong programs (like departments A and B, for example), we can dig deeper to further examine the sources of their strength. Are there pending retirements that will weaken these programs? Would additional senior hires improve a department's national rank to the next level? Can pending retirements and replacements change a department's productivity level? For other cases, we could ask if this program is one that has slipped so far down that we should stop investing in it? Is it a program we may want to transition to "non-research" focus? These are the types of crucial questions and strategies that can be addressed as a result of information technology.

Culture of Scholarly Engagement

The state of Kansas demands a flagship university in the top tier of public international research universities. This is a reasonable demand, because as Richard Florida observes, great universities are magnets for innovative minds, and innovation is the key to a flourishing and diversified economy.[i] For that reason, one of the goals of KU's strategic plan *Bold Aspirations* is to promote a vibrant culture of scholarly engagement. To do so, KU continues to actively engage with communities throughout Kansas and the world, with a focus upon entrepreneurship, commercialization of technology, and vibrant business partnerships. All of these depend upon IT.

A great example of this engagement has been the KU Cancer Center's multi-year drive to achieve National Cancer Institute (NCI) Cancer Center designation. In July 2012, KU met this goal. The university and its partners continue to invest in the KU Cancer Center, and university officials plan to apply for Comprehensive Cancer Center status in 2015. The research and investment revolving around NCI designation touches upon each of KU's strategic initiative themes, and IT plays a key role.

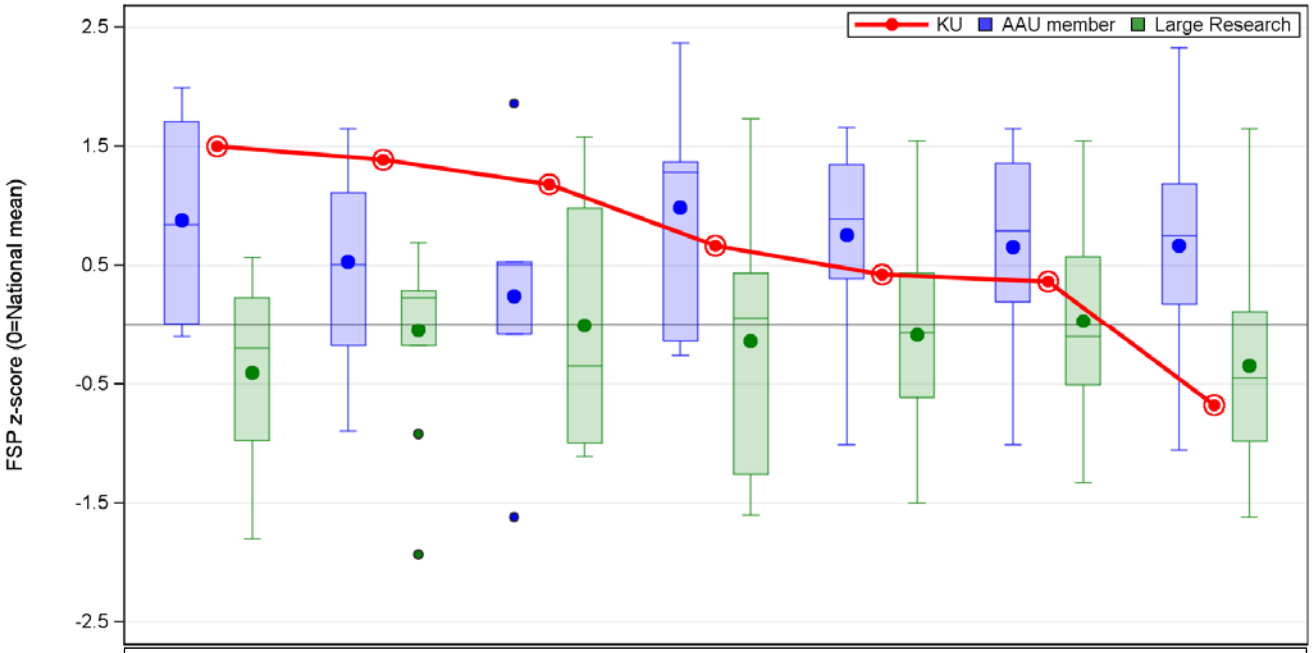

Figure 2: This "whiskers" diagram was developed at the University of Kansas to indicate the standing of departments at KU relative to national research university peers. For each of seven academic programs listed from left to right, the red line shows the KU ranking in that program relative to national norms. Each unit represents one standard deviation above or below the mean. The blue box indicates the performance range for the 34 public U.S. universities that are members of the prestigious Association of American Universities, which KU has belonged to since 1909. The box captures the 25th–75th percentile range, with the median indicated by the horizontal bar and the mean indicated by the blue dot. The full range is indicated by the "whiskers" above and below the box, and if there are extreme outliers, those are indicated separately by blue dots above or below. The green boxes similarly indicate the performance of the non-AAU large public research universities.

KU has also recently transformed the KU Center for Technology Commercialization (KUCTC), the entity charged with spearheading technology transfer and commercialization efforts. Over the past two years, KU has hired four national experts to propel KUCTC forward. The first two have built records of accomplishment at Purdue University: Julie Goonewardene, president of KUCTC, focuses upon commercialization, licensing, and startups, and she also serves on the board of the American Medical Association; Julie Nagel directs business relationships and our Strategic Partners Program. Becky Voorheis, an experienced Silicon Valley entrepreneur, assists our faculty with company startups. And Rajiv Kulkarni, our director of technology transfer, came to KU in February 2012 from the University of Utah, a national leader in technology transfer. These hires represent a growing focus upon commercialization and entrepreneurship at KU.

KU is also home to the Bioscience and Technology Business Center (BTBC), a statewide incubator network that has 24 tenants spread across four buildings in Lawrence and Kansas City. The tenants include a diverse range of bioscience and technology-based businesses, ranging from KU startups and growth companies to large corporations like Garmin and Archer Daniels Midland. By locating in the BTBC, tenants get access to KU facilities and researchers and also receive various business support services from BTBC staff. The BTBC system's flagship facility in Lawrence reached 100 percent occupancy just 18 months after opening, and plans are in place to more than double that facility's square footage.

KU will soon launch a faculty expertise portal designed to help users quickly find out who is doing what at KU. The portal will gather data and do semantic matching automatically from our PRO database. Thus, it's a great tool for companies to find faculty with desired expertise. It's also great for potential graduate students to find out about areas of interest, or even for faculty at KU wanting to partner with other faculty on new projects.

KU will also use information technology to support its new Strategic Partners Program, which is designed to identify and nurture partnerships between KU and the business world. We have started use of constituent relationship management software to enhance our ability to interact with prospective students and current students. The same software can be used to track KU connections with industry. It will identify the range of partnerships already in place and, through the use of data analytics, identify companies to expand engagement.

Additionally, KU continues to employ social media and related online tools to "take geography out of the equation." For example, technology is being used to build maps of capabilities and expertise, group stakeholders around topics via social media, and create a virtual presence that lets stakeholders connect with KU from anywhere in the world.

A Global Paradigm

While significant 100 years ago, it is no longer so relevant that Kansas is at the geographic and geodesic center of

the continental United States. Much of the entrepreneurial action these days takes place on the east or west coasts. However, it is significant that through IT, we can truly immerse ourselves anywhere in the world, link together key partners, and form vibrant collaborations. IT drives society, and it drives KU. Maybe it is fitting after all — and not just Jayhawk loyalty — that Google Earth is centered on Lawrence, Kansas. Through our research at KU and as a core part of how we operate, we use information in fundamental ways to improve our understanding of the world and to make it a better place.

References

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