What is the difference between disruption and transformation? I can look to my own backyard for some examples. When we lived in Wisconsin, we brought home a new labradoodle puppy. The chipmunks who lived in our yard were utterly surprised by this change. They were disrupted out of their habits and homes by our new dog. In the end, they decided that our neighbor’s basement would be a much better place to live, which passed the disruption on to Rick and Karen, our neighbors.
In our current backyard, baby squirrels come down out of our tree every spring to practice jumping and climbing, often with funny results. You wouldn’t think a squirrel could completely miss a tree from just a few inches away. Yet the squirrel pups continue to work on their skills, and soon they have transformed themselves into graceful and amusing acrobats dashing about our wooded backyard.

For many people, the change in digital technologies has been and will continue to be a great disruption to their livelihood, their social interactions, and their worldview. Like the chipmunks, they react against or flee from this new force. Other people, however, see the developments in digital technologies as a way of transforming their work, their lives, and their society. They see an opportunity to provide real-time medical aid, to reduce traffic fatalities, to enable fuller lives for people with a variety of impairments, and to deliver a lifelong learning experience. Like the squirrels, they will work to transform themselves with new skills and abilities in order to build better lives.

If those of us in higher education want to be in the latter group, we need to understand the three phases of technology shift. And we need to utilize two tools to shape the workforce in order to respond to the changes caused by the new digital technologies. These tools and understanding will help us build a strategy for transformation.

**Three Phases**

Technology shifts have shapes and stages. Historically, they roll through civilizations following a regular pattern with three phases: refinement of the technology, innovative disruption, and societal transformation. It is important to understand where we are in this process in order to plan for future impacts and opportunities. This context also explains what can and cannot be known at any particular time, providing the groundwork for scenario planning and job pathways mapping.

**Refinement**

The refinement phase is marked by the introduction of improvements to the original technology. For instance, the internal combustion engine was an improvement to the steam engine, and the electrical grid distributed power away from its point of generation during the Industrial Revolution.

During this period, technologies are being refined and improved, and the infrastructure that supports these technologies is being matured (e.g., the railroads and the electrical grid were being built out). A characteristic of this phase is that new technologies replace existing technologies one for one. For example, electric lights replaced gas lamps, and electric trolleys replaced horse-drawn trolleys. In the case of digital technologies, computers replaced the people who added up columns of numbers or calculated trajectories. Machines replaced pocket address books, hardback encyclopedias, paper calendars, and wall phones—among many other objects.

During the refinement phase, computing became cheap, ubiquitous, and continuously connected. Computing power, storage, and connectivity grew exponentially while the computer’s form factor shrank to the size of a hand. The internet, digital cellular networks, and Wi-Fi brought the network to devices everywhere, not just on a desktop connected to a modem. This maturing of the technologies and of the supporting infrastructure allowed us to move into the next phase.

**Disruption**

The disruption phase is marked by entirely new inventions. During the disruption phase of the Industrial Revolution, the washing machine, refrigerator, car, and radio appeared. Henry Ford invented a whole new manufacturing process that allowed for the mass production of cars. His architect, Albert Kahn, created a radically new design for manufacturing plants. Introduction of the car and road system completely disrupted the horse-based transportation system that had existed before.

In the disruption phase of digital technologies, artificial intelligence (AI) is supplementing diagnostic medicine with wearables that detect heart arrhythmias, and the cellphone and wireless technologies are providing the ability to find a restaurant and book a table in almost any city while on the go and listening to music or watching a video. (See the “Digital Technologies” sidebar.) Many Third World areas have leapfrogged the Industrial Revolution technologies of land-line phones and brick-and-mortar banks, moving straight to smartphones and micropayments.

This introduction of entirely new technologies causes waves of disruption to society, to existing economies, and to practices and norms. In time, the technological disruption becomes mature enough that the final phase begins to take shape.

**Transformation**

In the transformation phase, society itself is transformed to new norms supported and enabled by the capabilities of disruptive technologies. In his TED Talk “The Magic Washing Machine,” Hans
Digital Technologies

Digital Technologies can be thought of in three layers: Customer Experience Delivery; Automation and Intelligent Systems; and Enabling Technologies.

Customer Experience Delivery
Some have said that the Information Age is over and that we are now in the Experience Age. User experience design, hyper-personalization, and mobile devices are three key trends focused on using technology to deliver exceptional experiences for customers. These form the upper-most layer of digital technologies.

- **User experience design** builds on the design thinking trend that became popular in the 1990s and 2000s. It puts the users, the problems or tasks they are trying to solve, and their experience at the fore of the design process. This design idea was at the core of Steve Jobs’s statement that “no product should need a manual.” Using a product should be so intuitive to users that they can just do their tasks on their own.

- **Hyper-personalization** provides information tailored just for the customer—information that is timely and that is location and context aware.

- **Mobile devices**, tablets, and wearables (e.g., smart watches) mean that the experience can be delivered to the customer on any device, at any place, and at any time.

An example of a hyper-personalized experience that was designed with user experience design practices occurs when you are on an airline flight and receive a text saying, “Your bag is now on carousel 8.” The text is tailored just for you: it is about your context (getting off an airplane and picking up your luggage) and is focused on solving your immediate problem (finding your bag).

Automation and Intelligent Systems
Artificial intelligence, machine learning, and algorithms all fall into this second, middle layer. Together they build smart systems that can perform complex tasks and learn new tasks. They are used in image recognition (e.g., finding faces in photos or performing optical character recognition) and complex pattern recognition (e.g., using an Apple Watch to detect heart arrhythmias). These autonomous and intelligent systems are rapidly expanding their capabilities and applications into administrative tasks, autonomous vehicles, order fulfillment, farming, and customer support (among many other uses).

It is these technologies that take the information about you, your flight, and your bag and build the automatic notifications that help you navigate the airport. Operating in the middle of the digital technology stack, they gather data from layers below, perform deep analysis, and act on the outcomes. Those actions vary widely, from braking automatically when you get too close to another car to finding patterns in brain scans to detect disease.

Enabling Technologies
The two upper layers build on many enabling technologies in the bottom layer, for example:

- **In the internet of things (IoT)** everything is now on “the network”—from refrigerators to lightbulbs, tractors to moisture-level sensors, trashcans to smart watches. Beacons detect when devices pass by (e.g., smartphones in stores or robots in a warehouse). Smart thermostats know when residents arrive home. The fact that everything is on the internet means there is data everywhere and this data can be used by autonomous systems to perform more and more tasks.

- **Big data** is the term for all of this data that is being produced by IoT devices as well as by people (e.g., on Twitter, Facebook, OpenTable, Yelp). Because there is so much data, complex patterns can be found. With all of this data on the internet and available in real time, you can get instant notification when your bag is removed from the airplane.

- **Cloud computing** is software that is run by a third party and is available over the internet, usually via a web browser. The user does not have to install or maintain the core application. Cloud computing allows for rapid development and deployment. It also allows IT organizations to focus on their core competencies rather than running a computer center and maintaining physical hardware.

This enabling layer provides the computing, the data, and the connections that allow the other layers to act on the data and then deliver an amazing experience.

Note
Rosling argues that the washing machine freed up time for women, who then could get work outside the home, organize themselves politically, and finally, get the vote. Similarly, the invention of the car radically changed our economy, the way our cities are built, and our lives. Ford’s assembly line changed craftsmen, who had previously worked in cottage industries building carts or wheels, into part workers who each did one step in the process. This change in working conditions led to the rise of the union as a force in economics and politics, radically reshaping our culture.

In the transformation phase of digital technologies, we are starting to see societal transformations occurring within world economies in the form of retail disruption and a workforce shifting to the “gig economy” but the full impacts and transformation have yet to occur. We are on the cusp between disruption and transformation (see figure 1). We do not know what will happen to society as new technologies roll through the economy, the workforce, and our personal lives. Whole new technologies will still appear (disruption) as the current set of digital technologies matures and drops in cost and in complexity to implement. For example, Apple’s next release of the macOS Mojave has built-in machine learning capabilities that will simplify the application of machine learning for developers. Intel has just launched Movidius Neural

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Figure 1. On the Cusp between Disruption and Transformation

We need strategic workforce development to constantly readjust employees’ skills and competencies as the disruption phase progresses to transformation.
Compute Stick (NCS), a USB 3.0 stick that provides high-powered visual recognition AI at the hobbyist price of $80. Scientists have built on the Apple Watch to detect a variety of conditions such as sleep apnea and hypertension. Elon Musk’s Solar Roof tiles, along with ever cheaper solar and wind power, could reshape the electrical grid and the entire coal and natural gas workforce and economy.

Workforce Changes and Strategy
Because of all of this rapid advancement in digital technologies, we do not yet know what the digital transformation will bring to the workforce. Jobs of all kinds—in the medical profession, in blue-collar trucking and oil/coal extraction fields, in high tech—will be radically changed during the next decade. This amazing shift in the structure of our society will be extremely difficult to navigate gracefully.

And of course, higher education will not be immune to these changes. Both staff and students will need new skills for success in their jobs and their education. Users’ expectations for hyperpersonalized experiences driven by AI and big data will exist for higher education just as it exists for retail and airlines. There will be a strong drive for efficiency through the automation of administrative tasks as colleges and universities face tight budgets and increasing student loan debt. The need for intelligent systems to gain an edge will apply not only to research but also to student-recruitment efforts. As a result, those of us in higher education IT organizations must be strategic about how we develop our workforce so that they will have the skills to respond to these forces across our institutions.

We need strategic workforce development to constantly readjust employees’ skills and competencies as the disruption phase progresses to transformation.

So if we want to be squirrels, gracefully transforming ourselves as we navigate the ever-changing digital woods (how far can I push this metaphor?), we need to be thoughtful about how we grow workforce skills and competencies. Two tools can help create a roadmap for workforce development goals and build a common vision for the transformation.
Apply This

This facilitation plan involves two half-day sessions, with work occurring between the two half-days. Ideally, the sessions would be scheduled one or two weeks apart, but not longer. The overall question for the sessions is, “How does our workforce need to change over the next ___ years?” The time horizon chosen should be far enough out for there to be significant changes but not so far that you cross into the world of science fiction. Four to ten years would be a good range to choose from.

First Session: Scenario Planning
The goals of this session are the following:
1. Ground session attendees in the drivers and concepts of the digital transformation as input into scenario planning
2. Brainstorm additional drivers both internal and external to the institution
3. Rank the drivers on their impact and likelihood, and decide which are most important to the scenario planning (a matrix can be used)
4. Come up with a set of scenarios
5. Pick three to five scenarios that are representative and that everyone understands

Agenda for the Scenario Planning session:
1. Welcome and agenda (5 minutes)
2. Describe the digital transformation: shape of a transformation; digital technologies (30 minutes)
3. Discuss the digital transformation: thoughts; big ideas; questions (15 minutes)
4. Brainstorm other drivers/forces (15 minutes)
5. Build a common list of drivers/forces (15 minutes)
6. Break (time as needed/available)
7. Explain scenario planning (10 minutes)
8. Work in small groups: develop one or more future scenarios (30 minutes)
9. Share scenarios from each group (30 minutes)
10. Choose top three to five scenarios (20 minutes)
11. Work in small groups: determine the roles/skills needed to adapt to each scenario (30 minutes)
12. Report out: big ideas; questions; plus/delta (10 minutes)
13. Introduce job pathways mapping and homework (10 minutes)

After this session, individuals or small groups should brainstorm their own job pathways. They can look online at job listings at high-tech companies or other higher education institutions.

Second Session: Job Pathways Mapping
The goals of this session are the following:
1. Ground session attendees in the scenarios and why they are important
2. Gather ideas for workforce development
3. Identify a set of skills and competencies that are most strategic for the IT organization to develop
4. Build an action plan for developing these skills and competencies

Agenda for the Job Pathways Mapping session:
1. Welcome (5 minutes)
2. Revisit the scenarios (30 minutes)
3. Review the skills and roles that need to adapt (15)
4. Gather any new insights about the scenarios or new scenarios (15)
5. Break (time as needed/available)
6. Share job pathways (30 minutes)
7. Determine which skills are most important (20 minutes)
8. Decide which skills have the greatest gaps (20 minutes)
9. Discuss common skills and competencies (15 minutes)
10. Break (time as needed/available)
11. Update job pathways based on the discussion (30 minutes)
12. Align current roles to job pathways (30 minutes)
13. Outline next steps (20 minutes)

At the end of these two sessions, the attendees should have identified some common themes and common skills and competencies that the group thinks are important to develop. Next steps can include bringing in outside training, attending conferences and workshops, choosing people who will learn about one new skill or competency and report back to the group, and/or creating small coaching triads to work on developing a new skill or competency.
a common vision for the transformation: scenario planning and job pathways mapping. (See the “Apply This” sidebar for a facilitation plan.)

Scenario Planning
Many people think that scenario planning is about predicting the future. But the true goal of scenario planning is to find the institutional or organizational areas that need to be adapted so that they can meet a number of possible futures.

In scenario planning, three or four future states that represent different possible outcomes from known forces and their inhibitors are identified. Planners then ask questions about “what needs to adapt” in order for each of these future states to be negotiated successfully. This is the important bit: often, the same things need to adapt for various futures. They might have to adapt differently, but they still need to change or adapt. Planners then work on making those things as easy to change, or as adaptable, as possible—which might mean refactoring technology, reworking the IT organization, reskilling the workforce, or redesigning business processes. A simple example can be found in buying an old house. There are several possible scenarios. The roof could leak, resulting in water damage; old plumbing could burst, causing water damage; an old furnace could fail, filling the house with smoke; or a hot water heater could break down, again leading to water damage. The key is that the same two things need to adapt to successfully respond to any and each of these scenarios: insurance and savings. It doesn’t matter which scenario happens; insurance and savings would be needed. Therefore, almost all homeowners have insurance and savings in case of an emergency. It isn’t the accurate prediction of which thing will fail that is important. The trick is to find what is needed in order to successfully adapt to most or all of the scenarios.

A second example, this one from higher education, concerns student enrollment in the future. Student debt is at a crisis level in the United States: $1.524 trillion as of March 2018. There is also a huge need for lifelong learning and adult education. If we take these facts as two drivers, we can think about the following possible scenarios:
1. The bulk of college/university enrollment will shift from traditional four-year undergraduates and graduate students to adult learners who are looking to reskill after a job loss or to maintain their job.

2. Traditional four-year undergraduates will become ten-year undergraduates as they work full-time while obtaining their education.

3. Students will no longer be focused on a degree. Instead, they will want badges and credentials that show they have gained a skill or set of skills so that they can advance at work.

What would need to be adapted for each of these three scenarios?

### 1: Lifelong learners become the majority of enrollment.

| External Drivers | • Job market changing rapidly  
|                  | • New technologies and inventions impacting job duties and roles  
|                  | • Globalization creating economic challenges and opportunities  
| Internal Drivers | • Desire to grow enrollment to meet funding gaps  
|                  | • Lack of space to grow traditional on-campus enrollment  
|                  | • Strategic goal of community/workforce development  
| Future Goals     | • Expand support for online, self-paced learning  
|                  | • Focus marketing to adults  
|                  | • Change policies about enrollment, applications, eligibility  
| What Needs to Adapt? | • The LMS will need to host more online, asynchronous courses and multimodal courses (blended courses).  
|                  | • Curriculum design will need to include courses targeted for lifelong learners and more adaptable course progressions.  
|                  | • The SIS will need to support different requirements regarding enrollment, eligibility, degrees, etc.  
|                  | • Marketing will need to focus on new demographics, with more personalized/targeted marketing.  

### 2: Ten-year undergraduate degree becomes the norm.

| External Drivers | • Student debt load preventing full-time enrollment  
|                  | • Cost of living causing more students to work full-time while attending college/university  
| Internal Drivers | • Desire to support undergraduates  
|                  | • Need to maintain enrollment numbers  
| Future Goals     | • Expand support for online, self-paced learning  
|                  | • Change policies about enrollment, applications, add/drop  
|                  | • Enable LMS and SIS to support badging and competencies  
| What Needs to Adapt? | • SIS will need to support different requirements (e.g., enrollment, eligibility, badging).  
|                  | • New data and analytics capabilities will need to produce measures of success when the four-year graduation rate is no longer viable and will also need to track student progression and success.  

### 3: Badging and credentialing overtake degrees in importance.

| External Drivers | • Student debt load preventing full-time enrollment  
|                  | • Cost of living causing more students to work full-time while attending college/university  
|                  | • Demonstration of skill attainment increasingly being required to advance at work  
|                  | • Rapid changes in skills needed for work leading to constant lifelong learning  
| Internal Drivers | • Desire to create more graceful entrances and exits for students  
|                  | • Need to support more types of learners to increase tuition income to fill budget gaps  
| Future Goals     | • Expand support for online, self-paced learning  
|                  | • Change policies about enrollment, applications, add/drop  
|                  | • Enable LMS and SIS to support badging and competencies  
| What Needs to Adapt? | • LMS will need to allow badging and credentialing.  
|                  | • Curriculum design will need to redefine learning outcomes in terms of badges and credentials.  
|                  | • SIS will need to support different requirements reporting for earning badges and credentials.  
|                  | • Data and analytics capabilities will need to produce measures of success based on badges and credentials, provide analytics about enrollment and attainment in different badging and credentialing areas, and track student progression and success.  

Common to all three of these scenarios is the need for the Student Information System (SIS) and the Learning Management System (LMS) to be adaptable. If the SIS and/or the LMS are rigid and hard to change, they are key systems to refactor or replace. In this process, the staffing needs are just as important to consider as the technical issues. Business architects, business analysts, and solution architects are important roles going forward. Business architects help determine the organizational design and business processes for both the present and the future. They also help define the strategic goals and roadmaps. Business analysts manage the requirements and conduct impact analyses of various suggested changes. In some organizations, they would also configure systems as solutions are implemented. Solution architects can design a loosely-coupled, adaptable system that more easily scales going forward.

Curriculum design appears in two of the scenarios. Curricula need to be designed away from traditional on-campus undergraduate progressions.
The key to thinking about the future creatively and productively is to find three to five scenarios that ring true for the institution and the IT organization. From this work, needed skills and positions can be identified, providing inputs for job pathways mapping.

**Job Pathways Mapping**

Job pathways map the progressions a person can take to move from a job to one or more new jobs. For example, in the January 2018 World Economic Forum report “Towards a Reskilling Revolution: A Future of Jobs for All,” job pathways are used to show possible employment opportunities for displaced workers. The pathways capture the number of opportunities (i.e., how many positions are available for each displaced worker) and the salary for the new position. They also show how positions link together to make a larger job transition.

In higher education IT organizations, job pathways can be used to talk about the skills required for a person to move from his/her current position to a position that is needed in one of the scenarios noted above or another scenario. For this work, a job pathway is best when it maps to several possible future roles. In addition, a job pathway that shows more than one step forward is good for longer-term career planning.

For example, let’s say a Java developer on the SIS team is interested in being closer to the student experience. A job pathway could be created to show how this employee could become a business analyst, then on to become a business architect or a user experience designer (see figure 2). Note how the skills build on each other as the person advances. What the employee learns as a business analyst is foundational in the move up to the positions of business architect or user experience designer.

A second example is a data center engineer whose job is being phased out by a cloud-first strategy. This pathway might take the employee to becoming a cloud platform engineer and then on to the position of cloud financial engineer (see figure 3).
Figure 2. Job Pathway for a Java Developer

Java Developer

Business Analyst
Skills: Business Processes Analysis, Requirements Management, Data Modelling, User Scenario Development

Business Architect

User Experience Designer
Skills: User Story and Persona Development, Prototyping and Wireframing, Facilitation, etc.

Figure 3. Job Pathway for a Data Center Engineer

Data Center Engineer

Cloud Platform Engineer
Skills: Vendor Platform Management, DevOps Automation

Cloud Financial Engineer
Skills: Vendor Management, Fiscal Management, Strategic Planning
One critical aspect that often gets overlooked is the above-the-line competencies (“how you do” the job) that are needed in various positions. The below-the-line (“what you do”) competencies are often easy to capture (see figure 4). For instance, the data center engineer needs to switch from running on-premises virtual machines and configuring servers to managing instances and containers in one or more cloud platforms. But what about the above-the-line competencies? Will the employee need to be more collaborative? Will he/she be required to gain vendor-management skills? Will communication become more critical in the new positions? If the data center engineer moves all the way up to the cloud financial engineer position, above-the-line competencies will be necessary: negotiation; vendor management; fiscal management; strategic
thinking. Job pathways must capture both the below-the-line and the above-the-line competencies.

**Conclusion**

In any scenario planning and job pathways mapping, IT leaders must be clear about their expectations and must also manage employees’ expectations. If leaders appear to be promising workforce and skill-development opportunities but do not have the funds or resources to deliver these opportunities, they will likely anger and alienate their teams. Staff will wonder: “Why did we waste all this time and effort when nothing will change?”

IT leaders need to be clear, up front, about the expectations, the processes, the goals, and the opportunities. Is this work that cannot be funded and that the employee is expected to pursue on his/her own? Is there a budget for workforce and professional development, and will it be used to prioritize investments? How will investment decisions be made? By whom?

If we are going to positively transform the employees in our IT organizations into the workforce needed for the digital transformation, we must have the resources to invest in strategic workforce development. Doing scenario planning and job pathways mapping will build a shared vision of the changing future. Staff will see a role for themselves in that future and will have a roadmap for skill development. Meanwhile, IT leaders will understand the internal and external drivers behind possible scenarios, will gain insight into what aspects of the organization need to adapt, and will have a vision of the competencies required for a future-ready workforce.

A shared vision for the future, a roadmap for growing and adapting, and sufficient investment in the skills of the future are what will allow us to transform gracefully. These things help shift the fear of change and the pain of disruption into the positive opportunities of the digital transformation.

**Notes**

1. Chris Eagle, an IT strategist and enterprise architect at the University of Michigan—Ann Arbor, discussed these three phases in his talk “The Changing Shape and Value of Enterprise Architecture,” Itana Face2Face 2017.

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