Arizona's Technology Workforce

ISSUES, OPPORTUNITIES & COMPETITIVE PRESSURES

This Executive Summary provides an overview of the high-level findings of the Arizona Technology Workforce Study. The purpose here is to articulate key messages for the different constituencies associated with the technology workforce in Arizona. The Summary articulates both the challenges and opportunities Arizona faces – and offers some ideas for overcoming those challenges and leveraging those opportunities.

The issue is critical for Arizona's prosperity. A technology ecosystem that produces homegrown talent and keeps that talent in state, attracts talent from outside the state, and retains and attracts technology businesses that employ such talent can go a long way toward making Arizona the kind of place our leaders have long envisioned. A place centered on more than sunshine, golf, and real estate – a place where new technologies are born and bred by innovative workers at value-creating firms.

It is important to note that the purpose of the Arizona Technology Workforce Study was to assess the issues, opportunities, and competitive pressures that Arizona's technology employers and employees face. It is not a vision paper for what Arizona's technology industries could – or should – become. But the Study authors hope it will become a foundational centerpiece for a conversation about the future of Arizona's technology industries. Based on the issues (and the Study's initial recommendations of ways to overcome them), the opportunities (and initial recommendations of ways to leverage them), what is a realistic vision for Arizona's technology industries? That is not a question the Study addresses, but one Arizona's leaders would be wise to take up.

In December 2009, Steve Zylstra, President and CEO of the Arizona Technology Council, approached the Seidman Research Institute at Arizona State University about conducting a workforce study that would focus on the manpower needs of high-technology companies operating in Arizona. Steve had heard repeatedly from some members of the Council about difficulties they had recruiting scientists and engineers to work at their facilities in Arizona. He wanted to know whether those concerns were isolated, part of a broader "urban legend", or whether many Arizona technology companies had been having an unusually difficult time locating qualified workers. He envisioned a survey of Arizona technology companies that would document their recruiting experiences. For the almost two years since, the Arizona Technology Council has continued to be deeply involved in the Study. The Study authors are indebted to Steve, his staff, and the Arizona Technology Council Workforce Study Committee for their involvement.

The Study was approved and funded by the Governor's Council on Workforce Policy (GCWP) as part of stimulus dollars granted from the America Recovery and Reinvestment Act awarded to the State of Arizona. The GCWP and the Arizona Commerce Authority were entrusted to use these dollars to invest in a study that provided the opportunity to help address the gap between available talent and open jobs.

The messages and ideas articulated in this Summary are borne out of the primary and secondary research conducted by the Study team from the L. William Seidman Research Institute at the W. P. Carey School of Business at ASU, including Kent Hill, Ph.D., Research Professor and Principal Investigator; Molly Castelazo, Consultant; and Dennis Hoffman, Ph.D., Professor of Economics and Director, L. William Seidman Research Institute.

The work undertaken in this 15-month long study was made possible with primary funding from the American Recovery and Reinvestment Act and through the support of the U.S. Department of Labor, Arizona Department of Economic Security, Governor's Council on Workforce Policy and the Arizona Commerce Authority. Additional support was provided by Arizona State University, Maricopa Community Colleges, Salt River Project, and the Arizona Technology Council and its members. To read the Study in full, visit aztechcouncil.org.

The purpose of the Study was to assess the supply of and demand for Science & Engineering workers in Arizona.[1] Ultimately, the aim was to answer the question: Is there a gap between supply and demand? While the Study relied on a range of inputs (including comprehensive secondary research), a centerpiece was the survey of and follow-up interviews with technology employers in Arizona.

SNAPSHOT OF SURVEY RESPONDENTS AND INTERVIEWEES

Number of Establishments Reporting Employment by Category	
Computer scientists	134
Engineers	110
Scientists	26
Total number of employees reported by category	
Computer scientists	6,093
Engineers	14,426
Scientists	740
Total S&E workers	**21,259**
Size distribution of establishments based on total S&E workers reported (number of establishments in size class)	
1000 or more	5
250-999	8
100-249	23
50-99	18
25-49	23
10-24	49
1-9	46

[1] Science & Engineering, or S&E, refers a broad category of technology-related employees that includes computer scientists, engineers, and scientists. Throughout the report the terms "scientists and engineers," "S&E workers," and "technology workers" are used interchangeably.

SUPPLY OF TECHNOLOGY TALENT IN ARIZONA

WHERE ARE QUALIFIED CANDIDATES COMING FROM?
Most recent hires came from within Arizona

Recent Hires Who Moved from Out of State			
	Percent of total recent hires		
	Computer Scientists	**Engineers**	**Scientists**
Percentage who moved from outside Arizona	**40.9%**	**38.9%**	**46.4%**
If less than half of the computer scientists you have hired came from outside of Arizona, why is that?	Number of responses		
There is sufficient local availability	68	52	8
We cannot get computer scientists from outside Arizona to move here	21	16	3
Other reasons	34	23	7

But most recently hired fresh graduates came from universities and colleges outside of Arizona

Recent New Grads Hired Who Graduated from AZ Schools			
	Percent of total recent hires		
	Computer Scientists	**Engineers**	**Scientists**
Percentage with a degree from an Arizona institution	**32.3%**	**43.7%**	**24.7%**
If less than half of the new grads you hired had a degree from an Arizona institution, why is that?	Number of responses		
Graduates from Arizona institutions do not have the specific skills we need	16	17	6
Few graduates from Arizona institutions apply, or they accept other offers	30	24	6
We have established recruiting relationships with schools outside of the state	17	18	3
Other reasons	54	42	9

A primary objective of this project was to survey local technology firms to document the hiring practices and recruiting experiences of departmental managers who have hired scientists and engineers to work in Arizona. Follow-up interviews were also conducted to clarify and provide more detail on the survey responses of large companies and a sample of smaller ones.

WHERE ARE QUALIFIED CANDIDATES NOT COMING FROM?

2-year schools – Very few interviewees talked about hiring out of 2-year technical schools or community colleges. Even among those companies reporting a relatively large number of employees with 2-year degrees as their highest educational attainment, most of those employees came in with at least two years of work experience, rather than fresh out of the 2-year school.

Workforce development and training programs – Only two interviewees mentioned having experience with Arizona's workforce development and training programs. That may be because these programs interface directly with workers; employers may be hiring "products" of Arizona's workforce development and training programs without knowing it. But there are nevertheless clear opportunities for more engagement between these training and development programs and Arizona employers.

IS ARIZONA TRAINING ENOUGH S&E WORKERS?

Based on a comparison of the flow of new science and engineering graduates to the size of the S&E workforce, Arizona is a relatively low producer of S&E graduates. However, virtually all Western states are low producers, and in states like California, Colorado and Washington – which have especially large S&E employment – the ratios of new S&E graduates to employed S&E workers are significantly lower than they are for Arizona.

It is clearly not necessary for a state to rely exclusively or even primarily on local colleges and universities to meet its S&E manpower needs.

S&E DEGREES RELATIVE TO S&E WORKFORCE
(Average of 2000 and 2009 Indexes; US=100)

State	Computer Science and Mathematics	Architecture and Engineering	Life, Physical and Social Sciences
Alabama	197	174	128
Alaska	51	51	22
Arizona	**88**	**84**	**95**
California	76	79	99
Colorado	74	98	92
Florida	87	93	101
Georgia	91	95	107
Illinois	111	105	110
Indiana	167	162	123
Maryland	103	70	74
Massachusetts	86	123	100
Michigan	119	100	99
Minnesota	76	73	90
Nevada	69	65	55
New Jersey	71	88	78
New Mexico	112	88	49
New York	166	144	116
North Carolina	83	109	95
Ohio	103	119	105
Oregon	76	82	85
Pennsylvania	158	140	118
Texas	78	76	81
Utah	134	136	127
Washington	57	59	63
Wisconsin	113	109	106

> ↘ A number of the career services personnel who were interviewed talked about having difficulty in getting the word out to businesses about all of the services they offer. Many said that they have a hard time engaging with employers who don't come to them directly.

HOW DO SUPPLIERS OF TALENT CONNECT WITH DEMANDERS OF TALENT?

Whether serving local demand or out-of-state demand for S&E workers, it's critical that Arizona's suppliers of scientists and engineers actively promote their technology talent – just as any business would market its products to potential customers. Arizona's technology talent suppliers have a number of ways they do that. All could do better (and employers have a role, too).

University programs

Arizona's three public universities all have career services offices that work to help students find internships and, ultimately, jobs. At ASU and NAU career services for technology-related programs are decentralized from the main career service center. At U of A there is one central career services office, but engineering and science liaisons have specific, deep knowledge and expertise in STEM-related industries and relationships with the employers in those industries. In all three cases, the goal is to offer employers an efficient one-stop portal that allows them to tap directly into technology talent at the school.

All three universities provide the "typical" career services: career fairs and mixers designed to facilitate introductions between students and employers; online job and résumé databases that allow students to search jobs and post résumés and businesses to post jobs and search résumés; on-campus recruiting; and career development to prepare students for a career in a given field. ↘ All three universities cited specific programs designed to help businesses of all sizes find the technology talent they need. Many also reported programs to specifically give employers what they have said they're looking for, including:

"We want companies to be thinking about how they can engage students early on. We help companies, especially the smaller ones who are a bit less sophisticated about these things, understand that the top students are doing internships, so if employers want those top students they need to look at internships as a strategic pipeline for hiring recent graduates."

■ **Internships and other hands-on experience** –There is an increasingly strong focus on work and internship opportunities during the students' schooling. Junior- and senior-year internships have existed for a long time; now the universities are promoting first- and second-year internships as well. They are working with employers to understand that internships can be a "strategic" pipeline for talent. On the other side, career services personnel are working with students to help them understand the importance of hands-on experience as a job qualification.

■ **University-industry collaboration** – All of the universities also reported collaboration directly with businesses. ASU Ira A. Fulton Schools of Engineering career services personnel, for example, first meet with the employer and use a consulting-like approach to determine what the employer's needs are. Then, they put the company on a "roadmap for engagement" – which might include job shadowing, capstone courses, and internships, in addition to attendance at the career events.

University-industry collaborations also include National Science Foundation (NSF) Industry/University Cooperative Research Centers (I/UCRCs), which, according to the NSF, "feature high-quality, industrially relevant fundamental research, strong industrial support of and collaboration in research and education, and direct transfer of university-developed ideas, research results, and technology to U.S. industry." I/UCRCs in Arizona include the Arizona Water Quality Center (WQC), Power Systems Engineering Research Center (PSERC), Connection One, and the Center for Embedded Systems.

Community college programs

The community colleges in Arizona provide some of the same career services as the three public universities do. But in other ways, the work they do to connect students with employers is quite different – because kinds of students they graduate and the kinds of skills they teach are different. Some of the unique programs they offer include:

■ **College-industry collaboration** – The Maricopa Community Colleges workforce development focus is more significantly on working to understand where the job demand will be in the future, and connecting colleges to that demand by creating programs to train students for work in those jobs. (And then marketing those programs to students.)

■ **Hands-on experience** – In response to the complaint that graduates don't have the kinds of hands-on experience necessary to develop technical competency, Maricopa Community Colleges are designing an apprenticeship program that will give both the hands-on experience as well as credentials that demonstrate a certain level of technical competency.

■ **Emerging technology workforce development** – There are also a number of innovative programs to train community college students to meet the needs of employers in emerging technology industries. The Advanced Technological Education (ATE), for example, is designed to support community colleges in educating their students in "cutting-edge" industries.

Workforce training and development agency programs

There are several programs in Arizona designed to help employees develop the skills they need to succeed in today's workforce. The state's largest provider of workforce development and training programs are One-Stop service centers, funded by the Workforce Investment Act (WIA).

Who uses One-Stop centers? Since the current recession began the One-Stop centers have been working with people at every skill level. One of the workforce development professionals who was interviewed said that the difference between what the One-Stops do, and who they work with, has been "night and day" since the recession began.

"At the Phoenix One-Stop centers there has been a huge increase in degreed professionals and technically trained workers seeking employment assistance." These are the "unlikely unemployed" – degreed professionals who were laid off in the recession and need to retool their skills for new jobs, "because their old jobs are probably not coming back."

What kinds of programs do the One-Stop centers offer? In addition to helping unemployed workers get the skills that will help them find a new job, the One-Stops also provide programs for people who are currently working but want to enhance their skill sets. In both cases, the One-Stop centers don't

typically run training programs themselves, but rather provide vouchers for job seekers who choose the provider (from a list of pre-approved entities) and the program under the guidance of a career advisor.

How do the One-Stop centers engage with employers? Most of the One-Stop centers, certainly the largest ones, have personnel dedicated to liaising with businesses. Typically, their activities fall into one of two categories: 1) job development, where they are helping a business find a single employee; and 2) job fairs, targeted recruitment, and targeted résumé searches.

One of the One-Stop leaders who was interviewed said that she meets with company executives "all the time" to discuss what they need and where the holes are in their workforce. But, she said, she is often hard-pressed to help when employers say that they're looking not just for particular certifications but work experience.

Nearly every company reported a desire for job candidates with some type of experience.

Work experience matters, but students take heart: Employers also talked about a willingness to hire fresh-outs when those fresh-outs had hands-on work experience. One aerospace interviewee said that she "couldn't say enough about the benefit of hands-on experience," including experience gained through internships and part-time jobs. She said that recent graduates who had that kind of experience have performed "markedly" better than new hires with no experience.

What are Arizona technology firms looking for in employees? What does a "qualified" candidate look like?

Firms are not just looking for *any* computer scientists or *any* engineers or *any* scientists. Qualification criteria firms use to define a "qualified" candidate include:

- **At least 2-3 years of highly relevant work experience**

- **Education** – at least a bachelor's degree, often in a specific field

- **Skill sets** – highly specific to the type of work the employee would do

- **Highly relevant hands-on experience**

- **Soft skills** – such as communication, creativity, high capacity to learn, adaptability, and leadership

  Why soft skills matter:

  1) Soft skills cut down on time-to-productivity

  2) Candidates with soft skills are best able to learn new technologies (important in a world where technologies change so rapidly)

  3) Soft skills are the hardest to teach

- **Foundational skills** – a solid footing in the basics of the field

- **Cultural fit** – an employee who meshes well within the company

Experience matters

Employers have a strong preference for job candidates with highly relevant work experience. Why does experience matter? The two most common reasons interviewees cited were:

1) Candidates with relevant experience are typically productive more quickly (they "hit the ground running"). One interviewee who said that experience is paramount described these candidates as "plug-n-play."

2) Candidates with relevant experience are more likely to possess the specific (niche) skills that companies require for some positions.

Work Experience of Recent Hires			
	Computer Scientists	**Engineers**	**Scientists**
New grads	22.7%	28.9%	19.3%
2-5 yrs work experience	33.3	37.7	22.2
More than 5 yrs work experience	44.0	33.4	58.5

Education matters

The vast majority of job candidates across all categories had at least a bachelor's degree. For all the recent talk about whether a four-year degree is really valuable anymore, the answer, in this case at least: if you want a technology job in Arizona, yes it is.

Education of S&E Workers			
Employment breakdown by level of educational attainment	**Percent of total**		
	Computer Scientists	**Engineers**	**Scientists**
No college	5.9%	2.1%	0.3%
2-year college degree	7.4	8.2	0.0
Bachelor's degree	67.2	60.9	18.7
Master's or Ph.D.	19.5	28.8	81.0

THE $64,000 QUESTION: IS THERE A GAP BETWEEN THE SUPPLY OF AND DEMAND FOR TECHNOLOGY WORKERS IN ARIZONA?

Q: Do Arizona employers have difficulty attracting qualified S&E workers?

A: Yes (at least somewhat)

How Difficult is it to Attract Qualified S&E Workers?			
	Percent of all respondents		
	Computer Scientists	**Engineers**	**Scientists**
Very difficult	23.5%	15.2%	10.8%
Somewhat difficult	53.0	52.0	87.2
Not difficult at all	23.5	32.8	2.0

But…

For nearly every firm reporting difficulty attracting "qualified" technology workers there was some more nuanced explanation of their supply/demand gap. Not enough technology workers had the right skill sets, or not enough had five or more years of work experience, or not enough had requisite soft skills, or not enough lived in Arizona. Interviews did not suggest that Arizona's universities are simply not graduating enough engineers, computer scientists, or scientists. Though, they might not be graduating enough "A" students in those fields, or U.S. citizens in those fields, or students with the "right" specialized skills or hands-on experience.

Reports of talent sourcing difficulty appear to have much more to do with demand for very specialized skills and/or very specific kinds of experience, rules employers are bound by, and/or an unwillingness or inability to pay to train recent college graduates than they have to do with pure quantity of technology employees in Arizona or an unwillingness of people to move here.

SO WHAT'S BEHIND THE FACT THAT MOST FIRMS REPORTED AT LEAST SOME DIFFICULTY ATTRACTING "QUALIFIED" TECHNOLOGY WORKERS?

Q: Is it that Arizona institutions don't graduate enough technology workers? Or, more generally, that there aren't enough technology workers in Arizona?

A: Not really, no.

Only a few employers reported a difficulty in finding qualified recent graduates. Certainly interviewees sourced from some schools more heavily than others (sometimes in Arizona and sometimes not) and when confined to recent graduates from only Arizona schools a number of employers did report supply constraints (typically for specific skill sets). But when considering all sources of supply of recent graduates, employers did not report significant constraints nor, in most cases, did they report particular difficulty in getting recent graduates from non-Arizona schools to move to Arizona.

When Arizona demand is set side-by-side with Arizona supply, only one interviewee reported true pure quantity constraints. For all of the other firms reporting difficulty attracting "qualified" technology workers there was some more nuanced explanation of their supply/demand gap.

Q: Is it that people don't want to move to Arizona?

A: Not really, no.

When asked if candidates ever expressed resistance to moving to Arizona, interviewees responded in some cases that candidates were resistant to moving anywhere (because of difficulty in selling a house, kids in school, spouse's job, etc.) but very few reported any resistance to moving to Arizona specifically. In the few cases when interviewees did report a resistance to moving to Arizona specifically, it was almost always because of a lack of industry concentration.

For a few, the resistance to moving to Arizona specifically centered on "bad publicity about Arizona's school system." Yet most interviewees (with just one exception) said that they were able to counter that negative perception by giving candidates information on the reality of Arizona's schools (that there are, in fact, many great public school districts as well as private schools).

Some issues that the report authors initially thought might underlie supply constraints (e.g., "Candidates don't want to move to Arizona"), it turns out, were not significant issues for many firms. In other cases, there were underlying factors that the authors hadn't considered (e.g., "I'm prohibited from hiring non-U.S. citizens") that are in fact a serious impediment for a number of Arizona's technology employers.

Interestingly, a number of interviewees outside of aerospace & defense and semiconductors listed those industries as relatively concentrated in Arizona. Yet many of the aerospace & defense and semiconductor interviewees themselves reported the same "lack of industry concentration" challenges the other firms did.

The U.S. is not experiencing a shortage of scientists and engineers but of native-born entrants into these fields.

Foreign-born workers have become critical to the highly educated S&E workforce.

Q: Is it that there's not a highly concentrated technology industry in Arizona (we're no Silicon Valley)?

A: Maybe.

A much larger number of interviewees reported a "lack of industry concentration" as the source of resistance to moving to Arizona and, more broadly, as the source of difficulty attracting "qualified" computer scientists, engineers, and scientists. This was true for firms in a range of sizes across industries.

- **Why does industry concentration matter to employers?** From the employer's perspective, a larger number of high-tech firms means a larger pool of experienced talent to choose from.

- **Why does industry concentration matter to employees?** From the employee's perspective, a larger number of high-tech firms means a larger pool of potential employers, which means more safety. If it doesn't work out at employer A, similar employers B, C, and D are just down the road.

Q: Is it a foreign-born vs. U.S. citizen issue?

A: In many cases, yes.

Instead of talking about general labor shortages, it would be more accurate to say that the U.S. overall has an adequate supply of scientists and engineers but only because of a sizeable influx of foreign-born students and technical workers.

Foreign-Born Share of Individuals in S&E Occupations by Highest Degree (%)			
	2005-09		
	Bachelor's	**Master's**	**Doctorate**
S&E occupations	18.6%	33.0%	41.1%
Computer & mathematical occupations	21.9	43.4	49.6
Architecture & engineering	16.4	30.3	53.3
Life, physical and social sciences	13.0	17.8	36.3
All other occupations	13.4	13.1	22.6

The most important factor shaping future trends in the U.S. market for S&E workers is a rapid increase in science and engineering capabilities in other countries of the world. Global developments – especially trends toward mass higher education in highly populated developing countries – are eroding U.S. dominance of science and technology.

As a practical matter, a relatively high percentage of foreign-born workers in S&E occupations wouldn't be an issue except that many firms are restricted (or prohibited) from hiring non-citizens. And all firms that hire a significant number of employees with H-1B visas, even when they can, report that it is an expensive, time-consuming process.

Q: Is it that American kids aren't interested in science and engineering?

A: Young Americans are trending toward careers in medicine, law, and finance, rather than science and engineering.

Some people attribute the decline in native-born interest in science and engineering to the fact that science is hard, or finance is sexier. But it's probably more about earning potential – wages and salaries of scientists and engineers have lagged behind those in other occupations requiring a high level of training and education. For young Americans to choose careers in science and engineering rather than medicine, law or finance, wages in S&E occupations must rise significantly. But if they do, many of these jobs would likely go overseas.

If at going wages businesses want to hire more scientists and engineers than are currently available then competition between employers will force wages up, and this will serve to address the shortage.

U.S. Wages for Select Occupations		
	Mean Annual U.S. Wages, 2010	Percent Change in Wages 2000-2010
All Occupations	**$44,410**	**35.0%**
Management Occupations	**105,440**	**54.6**
Chief Executives	173,350	65.7
Financial Managers	116,970	61.2
General and Operations Managers	113,100	61.1
Healthcare Practitioners and Technical Occupations	**71,280**	**48.5**
Surgeons	225,390	64.0
Family and General Practitioners	173,860	61.3
Registered Nurses	67,720	45.9
Radiologic Technologists and Technicians	55,730	49.5
Legal Occupations	**96,940**	**40.6**
Lawyers	129,440	41.7
Paralegals and Legal Assistants	49,640	28.0
Architecture and Engineering Occupations	**75,550**	**39.8**
Petroleum Engineers	127,970	60.1
Computer Hardware Engineers	101,600	44.9
Electrical Engineers	87,770	32.3
Mechanical Engineers	82,480	35.5
Industrial Engineers	78,450	31.0
Electrical and Electronics Engineering Technicians	56,690	37.6
Industrial Engineering Technicians	50,540	14.0
Business and Financial Operations Occupations	**67,690**	**39.7**
Personal Financial Advisors	91,220	35.3
Accountants and Auditors	68,960	43.4
Loan Officers	65,900	38.0
Life, Physical, and Social Science Occupations	**66,390**	**38.9**
Physicists	112,020	35.0
Biochemists and Biophysicists	86,580	46.6
Chemists	73,240	34.9
Microbiologists	72,030	35.8
Chemical Technicians	44,200	19.2
Biological Technicians	41,740	26.6
Computer and Mathematical Occupations	**77,230**	**33.0**
Software Developers, Systems Software	97,960	38.2
Computer Programmers	74,900	22.8
Network and Computer Systems Administrators	72,200	34.5
Computer Support Specialists	49,930	25.8

Q: Is it that suppliers and demanders are not connecting? A: In many cases, yes.

Interviewees who are suppliers of science and engineering talent – universities, community colleges, and workforce development and training agencies – outlined a range of programs designed to serve the needs of Arizona technology employers. Yet employers didn't, for the most part, report accessing those programs. So one significant issue may not be related to supply or demand at all, but rather to how supply and demand meet.

SO THE SKY ISN'T FALLING, BUT ARIZONA FIRMS DO FIND IT AT LEAST SOMEWHAT DIFFICULT TO ATTRACT THE TECHNOLOGY TALENT THEY NEED. WHAT CAN BE DONE?

What could policymakers do?

Reform immigration policies and non-citizen hiring restrictions – The greatest threat to the viability of high-technology companies in Arizona is the rise of science and engineering capabilities in foreign countries, especially developing countries with large populations such as China and India. The most important policy decision that will affect how firms in Arizona and other states can respond to this threat is immigration policy. If features of U.S. immigration policy, such as the H-1B visa, are further liberalized, it will be possible for many high-technology research and manufacturing activities to remain in the United States. However, if U.S. firms are not able to tap into the world market for scientists and engineers, an increasing number of these activities will go abroad.

For Arizona firms who rely heavily on government and defense-related contracts, an additional important issue concerns restrictions on the hiring of non-citizens. Arizona companies facing these constraints would be favored either by a relaxation of federal hiring standards or special provisions in the naturalization process which expedite the process of gaining U.S. citizenship for foreign-born technology workers or students obtaining advanced degrees at U.S. universities.

Strengthen U.S. capabilities in science and engineering – Proposals to internally strengthen U.S. capabilities in science and engineering, such as education reforms aimed at improving students' STEM skills, could be productive, especially if they are part of an overall effort to increase efficiency in the public school system rather than a plan supported with resources taken from other areas of education.

Promote greater technology industry concentration – At the state and local level, there are government policies that could conceivably ease the difficulties firms may be having finding science and engineering workers. In the company interviews, many interviewees cited low industry concentration as a primary handicap to attracting out-of-state S&E workers. Many supported economic development policies that would strengthen or encourage the formation of high-technology clusters in the state. To note, though, economists are generally skeptical of how effective local industrial policies can be (it's not easy to create your own Silicon Valley) and note the general inefficiency of state competition for national industries.

It is unlikely that a significant number of native-born students, especially those pursuing advanced degrees, will begin to choose careers in science and engineering rather than careers in medicine, law, business or finance unless relative financial rewards change. The most likely way in which this would happen is if supplies of new lawyers, MBAs and those with degrees in finance begin to outstrip the demand for these workers. Of course, this would be more of a market outcome than a policy choice.

What could educational institutions do?

Offer more hands-on training – One constructive change mentioned by many interviewees was for science and engineering departments at Arizona's colleges and universities to offer more hands-on training and further promote internship programs. One interviewee praised the benefits of the company's work with capstone students and suggested that colleges and universities do more work with companies to get students hands-on practical experience with the current technologies.

Align faculty resources with Arizona's "key" industries – If Arizona policymakers focus on promoting key technology sectors, then the colleges and universities could align their faculty and their curricula to produce graduates for work in those key industries.

Tailor curricula to business needs – Some interviewees reported that college and university professors seem "out of touch" with the newest technologies, given how rapidly they change. One interviewee would give professors more "real world" experience. Professors would teach more practical skills rather than purely theoretical coursework. Every professor would be required to work in his or her field for the summer.

Get the word out better – Reports from interviewees about their knowledge and perceptions of college and universities' programs differed dramatically from the reports from the colleges and universities about their offerings. Clearly, there's a significant gap in communication and/or understanding between the universities and the employers. For example, one interviewee said that it would help if the universities had a list of available students, the kinds of internships they were interested in, and their skill sets. All three of Arizona's public universities do indeed have that information in their searchable databases. So a significant reduction in hiring difficulty might come from better connecting colleges and universities as suppliers to employers as demanders of technology workers.

What could workforce training agencies do?

Better align workforce training programs to employers' needs – It's quite conceivable that policymakers could design – and then market – workforce training and development programs to make a big difference in alleviating some of the employers' supply pains. Perhaps the workforce development and training agencies could help offset the cost of training "new blood" – even tie training grants to incentives for hiring underemployed Arizonans and/or graduates of Arizona's schools (which they already do, to some extent and in some cases).

Get the word out better – The vast majority of interviewees didn't know anything about Arizona's workforce development and training programs. It may be that the programs need to better align with employers' needs, but it may also simply be that employers don't know about the workforce development and training programs as a supplier of talent (and/or a way to develop in-house talent to suit the business needs).

"A free flow of talent would enrich the company and it would enrich the university. Collaborative science is really important."

Most interviewees didn't know anything about Arizona's workforce development and training programs.

For some interviewees growing talent within the company (what one called a "build versus buy" strategy) is a strategic move. For other employers growing talent from within is simply a "model of necessity" for building up in-house a supply pool that is simply not large enough on its own to meet the firm's demands.

What could employers do?

Focus on new blood (build versus buy) – There are steps that companies themselves could take to ease labor supply constraints. A number of interviewees said that they were changing their policies which had in the past emphasized hiring experienced workers over recent graduates. More companies are now focusing on "new blood" – recent college graduates that they hire, train, and then promote from within.

Reassess requirements – It makes sense that if technology employers cannot attract qualified workers, one smart option is to change qualifications. Of course, this must be done in balance with the firm's clear need to hire talented, productive employees. But a number of firms did report at least giving consideration to, for example, lower minimum GPA requirements.

Put more effort into engaging with suppliers of talent – While the universities, community colleges, and workforce development and training agencies could do more to "market" their services to Arizona's employers, the burden shouldn't fall exclusively on their shoulders. Employers should take it upon themselves to learn about the wealth of resources offered by these suppliers of talent and the ways that they are ready and willing to help employers access technology talent. Employers could reach out to the Workforce System that is part of the Arizona Commerce Authority and to the state's educational institutions as resources to help find qualified talent.

Bottom Line

The Arizona Technology Workforce Study has put to rest a number of myths about the size and cause of the "technology talent gap" in Arizona. For one, Arizona is clearly not the repellant of technology talent that some make it out to be. And while popular conception certainly holds that Arizona employers can't find any good technology talent and that the gap between their demand for scientists and engineers and the state's supply of it is a chasm; that conception simply doesn't hold up on closer inspection. But, Arizona's technology employers do find it at least somewhat difficult to attract the qualified technology talent they need. There are challenges.

At the same time, Arizona's suppliers of S&E workers – universities, community colleges, workforce training and development programs – report a number of programs that, if employers leveraged them, could go far in assuaging many of the recruiting difficulties. And, there are policy changes that could help a lot too. Indeed, there are great opportunities for policymakers, educational institutions, workforce training and development agencies, employers, even employees and students, to work to strengthen the technology industry in Arizona.

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