FROM EDUCATION TO WORK: IS ARIZONA PREPARED?

The Alignment Project Report

Submitted To:
Arizona P-20 Council
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EXECUTIVE SUMMARY

Arizona leadership, the business community, and educators all agree that a well trained and educated workforce is the foundation for a growing economy. Ongoing work is being conducted to identify targeted growth industries and to fully define the occupations within each industry. Most importantly, this work is attempting to identify the skills and education requirements of high demand occupations, and assess the linkages and gaps between high school graduation and requirements for entering the labor force or post-secondary education.

To conduct this analysis, both objective research data and subjective opinions about what is needed to prepare for work or post-secondary education were gathered. Using national data on industries and occupations, Arizona-specific databases, national best practices, and considerable input from the business and education community, we were able to define occupations in targeted industries and define, through several nationally recognized sources, the training and education required to enter and successfully compete in key occupations. In addition, we identified the requirements for post-secondary education in Arizona and compared them to high school exit expectations.

This report examines the expectations for high school graduates that have been defined through:

- Analysis of workplace demands, with particular focus on Arizona industries,
- Analysis of post-secondary demands, with particular focus on Arizona institutions, and
- Analysis of national trends and research findings regarding the demands of the workplace and of post-secondary institutions and the ingredients of successful high school preparation.

The report also provides an analysis of the way Arizona's current requirements for high school graduation and academic programming compare with these expectations, that is, the extent to which Arizona high schools are in a position to prepare graduates to meet the expectations of post-secondary institutions and employers.

1. RECAP OF EDUCATION FINDINGS

Findings concerning high school requirements and post-secondary education include:

- The secondary system in Arizona is not well aligned with the requirements for post-secondary study and the workplace – Arizona's high school graduation requirements do not adequately prepare students for post-secondary study and careers,

- The academic programming and graduation requirements in place in Arizona high schools are not sufficient to equip students with this set of necessary skills and knowledge. Students may graduate from Arizona high schools without having taken the courses required for post-secondary admission. Moreover, there is scant evidence of agreement between the secondary and post-secondary communities about what should be required of high school graduates in terms of the actual content of required courses. In addition, course title alone is not a sufficient indicator of quality or rigor.

- The expectations for Arizona students embodied in the requirements for graduation, the state's academic standards, and the performance levels required for passage of the state graduation assessment appear to be significantly less demanding than national experts recommend.

- Significant numbers of Arizona high school students are not meeting Arizona requirements.

- Arizona does not provide adequate oversight and management of the bridge from high school to further schooling and career.

- Data gaps prevent Arizona from pinpointing alignment gaps. In particular, data that could be of significant value to the state in strengthening the bridge between high school and college--such as documentation of the need for remediation for entering students across Arizona colleges and universities, of the educational and occupational outcomes for Arizona high school graduates, or of the varying ways in which districts augment the state requirements for graduation--are not currently collected or publicly available.

2. RECAP OF INDUSTRIES AND OCCUPATIONS FINDINGS

Findings concerning training and education requirements for key occupations include:

- Only 1.6% of new jobs in Arizona's growing occupations paying above the median wage will *not* require some post-secondary education.
- Arizona's strategic industries varied greatly by median wage and growth in actual numbers of jobs; however, they are all critical to Arizona's economic health because of high growth and/or high value.
- There is a gap between educational attainment levels needed for occupations in demand compared to the current workforce.
- Workforce preparation for key occupations will require an understanding of the uniqueness of each industry.
- Understanding of skill levels across secondary education, post-secondary education and industries requires analysis of several classification systems since no one skill metric exists to provide a common language across the three sectors.
- The top three knowledges and top three skills for the 70 key occupations include reading comprehension, active listening, critical thinking, English language, mathematics, and customer and personal service.
- Roundtable discussions held with business leaders corroborated findings from the various classification systems and enhanced the understanding of specific industry needs.

3. ALIGNMENT: KEY FINDINGS

Arizona has consistently ranked among the top five states in job creation for the last several years. The industries Arizona has targeted to sustain job growth into the future include many high wage occupations that require significant skill levels and educational attainment. The challenge Arizona faces is different from that facing many other states when it comes to future job growth. Many states are trying to create an environment that will bring high paying jobs, while Arizona needs to prepare for an environment that is expected to produce good paying jobs.

High schools are critical in developing a workforce ready to participate in the growth expected in Arizona. Currently, Arizona high schools are not successfully providing all students with the skills and education level needed to fill the key occupations of the future.

Analysis of national data, labor market information, and interviews with key stakeholders, as well as analysis of Arizona's education system has revealed five significant themes regarding the preparation of Arizona students for the future. These themes are presented as targets for improvement—for each we have identified the primary gaps that need to be addressed.

3.1. ARIZONA'S SECONDARY SYSTEM IS NOT WELL ALIGNED WITH THE REQUIREMENTS FOR POST-SECONDARY STUDY AND THE WORKPLACE

There is a significant gap between current requirements for high school graduation in Arizona and the admissions requirements of the state's university system. Because the requirements are not well articulated across different parts of the education system, students may proceed through Arizona high schools without taking required courses in a sequence that allows them to become eligible for admission to the four-year institutions. Students who do not perceive themselves as college bound at an early stage are at a particular disadvantage, because they may meet graduation requirements while taking a sequence of courses that neither meets basic four-year college entrance requirements nor provides them with the necessary skills and knowledge for success in the workplace.

Gaps

- Graduation requirements are insufficient; the required numbers of courses in several areas fall short of what is needed/recommended for both college entry and career success.
- The state standards do not appear to hold students to sufficiently ambitious and explicit expectations.
- The state assessment, AIMS, used as a graduation requirement, is a 10th grade assessment, and does not appear to set a sufficiently high bar.
- Large percentages of Arizona students are not performing well, even in terms of the state's current standards of proficiency and success, as demonstrated by scores on AIMS, dropout rates, and other indicators.

- The state is not effectively managing the articulation between high school and post-secondary institutions and the workplace by guiding students successfully, ensuring they meet requirements, or collecting and acting on data that could identify specific areas of need.

Clearly some Arizona students fare very well. Nevertheless, this report has demonstrated that significant challenges exist for ensuring that high school youth are well prepared for productive futures. The demands of the new economy dictate higher levels of education, and success in higher education requires a level of preparation that is elusive to many. This constitutes a call for action. Arizona can take advantage of the range of tools for improving high school performance – and also for aligning standards, curriculum and instruction, professional development and assessment -- to position its high schools to meet the needs of its citizenry and to foster economic growth.

3.2. READINESS FOR POST-SECONDARY STUDY NEEDS TO BE THE FLOOR FOR HIGH SCHOOL GRADUATES NOT THE CEILING

The skill requirements needed to fill the jobs in Arizona's strategic industries will require some post-secondary education. While not every high school student will go on to earn a two- or four-year degree, most high school students who want a high wage/demand occupation will need continued postsecondary training and education. Exhibit 2 in the report indicates the need to have every high school graduate prepared to take advanced training and have college ready skills, especially in math and reading.

Many high schools throughout the country effectively track students toward either college or work, offering different programming for each group, and this differentiated preparation is evident in Arizona as well. This approach does a disservice to all students. With 85 percent of projected new jobs requiring post-secondary education and work experience, high school graduates will need to be both college and career bound. In fact, an individual with a two-year associate's degree and two years of relevant work experience is just as competitive in the labor market as an individual with a four-year college degree and limited work experience. This circumstance obligates high schools to make sure that all students are prepared to take college level courses, and that all students develop both the hard skills (e.g. math and reading) and soft skills (e.g. teamwork, critical thinking) they will need throughout their careers.

Gaps

Interviews with Arizona industry leaders revealed that skilled occupations in strategic industries may not require a college degree but may require advanced level training. Those interviewed believed high schools were not emphasizing the need for rigorous preparation for students who were not planning to enroll in college right after graduation.

A significant alignment gap is also evident in the comparison of high school graduation requirements and the college entry requirements, most notably for math and science. High school graduation requirements include two credits each of math and science (this equates to two years of math and science.) However, the admissions requirements for Arizona's three four-year institutions include four years of math and three years of science. Even among students who meet requirements and matriculate at these institutions, many must take remedial coursework to prepare for college-level study once they arrive.

Table 5 shows that less than half of high school graduates meet the basic university eligibility requirements. Put simply, Arizona high schools are not adequately preparing many of their students, regardless of whether they aspire to a four-year degree, a two-year or other degree, or to enter the workplace directly. If Arizona is to provide its strategic industries with a skilled workforce, readiness to undertake college-level work will need to be a minimum requirement for every high school graduate. It is also unclear that the AIMS sets an adequate standard to drive high school expectations.

At present, a minority of Arizona's students are, as a result of counseling, parental encouragement or individual district requirements, taking college preparatory courses such as AP, taking ACT and SAT exams, and enrolling in college. Many others find that option foreclosed before they are ready to think realistically about their goals. Gaps in the achievement of population subgroups, lack of alignment between college entrance requirements and graduation requirements, and dropout rates all attest to this problem. At the same time, analysis of the demands of strategic industries reveals the inadequacy of the non-college preparation. The preparation of Arizona's students is critical because the key occupations that are expected to grow in Arizona can easily move to other states in which graduates are better prepared. Arizona, however, has taken a step forward in having work standards identified in the high school. How those standards are best integrated into the curriculum and properly assessed is a critical next step.

3.3. HIGH SCHOOL RIGOR IN APPLIED MATH AND READING COMPREHENSION IS CRITICAL

The occupational research conducted for this investigation validates the comments most often heard in the industry interviews – math and reading skills are critical. As outlined in Attachment 1 math and reading are the most critical skills needed in the growing occupations targeted by Arizona. Specifically needed are applied math and reading comprehension; employees will need not just to know mathematical equations but to know how and when to apply them. They will need to be able to use both mathematical formulas and problem-solving techniques to address problems in the job. They will need the ability to understand the meaning and purpose of written text in memos, policies, regulations and other work related materials.

Gaps

As discussed throughout this report, the achievement gap between disadvantaged students and their peers, low AIMS proficiency rates, difficulty entering and staying in college are among the indicators of insufficiently demanding high school expectations.

3.4. RELEVANCE IN THE CLASSROOM IS REQUIRED

To meet the demands of the future workplace high schools need to prepare students not only in the hard skills (i.e. math and reading) but also to develop student interest in and awareness of how those skills can be applied. For example, Arizona industry leaders in the life science field expressed the need to have more students interested in math and science by working to engage students with more exciting lesson plans and lab experiences. This need is confirmed in the national comparisons. For example, the National Science Foundation has Arizona ranked in the bottom quartile of states when it comes to producing college graduates in science and engineering.

Secondary career and technical education (CTE) can play an important role in helping Arizona students meet the demands of the new, knowledge economy. However, it is essential that CTE programs be of sufficient academic rigor as well as meet state-of-the-art industry standards.

The need for relevance in the high school classroom also extends to developing soft skills. The occupational analysis in this report demonstrates critical thinking, teamwork, and listening are almost as important as math and reading skills. Industry interviews also revealed the need for these soft skills in the areas of attendance and work ethic.

Gaps

Employers in Arizona and post-secondary institutions in Arizona are in accord with national researchers and policy analysts in defining ambitious expectations for high school graduates in terms of both hard and soft skills, as well as academic achievement. While the skills and knowledge needed for work in various industries and for post-secondary study at different levels and in different fields vary somewhat, core skills are needed irrespective of students' specific goals. This set of skills and knowledge includes, but is not limited to:

- Mathematics (e.g. arithmetic, algebra, geometry, calculus, statistics, and their applications);
- Science and scientific thinking (e.g. computer science and engineering, applied technology, life sciences, etc.)
- English language skills (e.g. reading comprehension/reading for information, writing and oral communications skills); and
- Thinking and learning skills (e.g. critical thinking, listening and observation skills, and judgment and decision making).

Similarly, ensuring that career and technical education, as well as other career awareness and exploration programs, are integrated with strong academic content, will provide opportunities for students to see the application of their studies to a variety of career paths.

Several areas of inquiry outside the scope of this report might warrant additional attention. There is genuine consensus among researchers, policy analysts and practitioners that high quality, rigorous standards are at the core of efforts to align systems. This report offers preliminary analysis of AZ content and performance standards, which suggest a need for detailed content analysis conducted by discipline-specific experts. In addition, comparison of instructional strategies, curricular materials and course content and rigor in and among individual high schools and districts was outside the scope of this report. Finally, Arizona secondary career and technical education programs, not explored in detail here, can be an important component of efforts to raise standards and prepare youth for postsecondary education and careers.

FROM EDUCATION TO WORK: IS ARIZONA PREPARED?

INTRODUCTION

Arizona is making considerable strides in designing an economic development strategy that positions the state for growth. The state recognizes that the key to economic success is ensuring that qualified workers are educated and trained for high-growth, high-wage jobs in strategic industries. Several long-term, intensive studies have been conducted for certain industries that provide the state with detailed requirements for occupations within those industries. The state recognizes, however, that additional industries need to be investigated, and that an analysis is needed to identify commonalities across industries to identify the education and training requirements of the key occupations predicted to grow in the future. An additional ingredient in this analysis is an assessment of whether high school preparation is adequate to prepare youth to go on to post-secondary education. Armed with this type of analysis, Arizona state leaders can begin to identify a course of action that will ensure its citizens are prepared to fill the jobs of the 21st century or succeed in post-secondary education; that is, that high schools are preparing students to enter the workforce or post-secondary education

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Arizona's P-20 Council, chaired by Governor Janet Napolitano, has focused on these issues as a part of its mission to ensure that all Arizona children, from preschool through college, have wide opportunities to learn and are held to high standards. A key goal for the P-20 Council is to improve the alignment of high school, college, and workplace expectations so that all students can be well prepared to succeed in post-secondary study and careers.

To that end, the P-20 Council engaged **Public Works:**

- Working with identified high-growth and emerging *industry* sectors to define the educational and training requirements for key *occupations* within those sectors;
- To identify the level of preparation required to adequately prepare youth for post-secondary education and careers; and
- To assess the alignment of K-12 public education with industry needs and post-secondary education requirements.

This analysis required an approach in which both objective research data and subjective opinions were gathered about what is needed to prepare for work or post-secondary education. Thus, **Public Works** gathered data on industries and occupations from national and Arizona-specific studies and databases, worked closely with the Governor's Office representatives to interpret initial data gathered, participated

in a P-20 Council meeting, interviewed P-20 Council members individually, talked with key stakeholders in business and education, and conducted business roundtables.

The report is divided into three sections.

In **Section I: Preparing Youth for Post-Secondary Education and Careers** we examine the expectations for high school graduates through:

- Analysis of Arizona's education system and the achievement and preparation of Arizona students,
- Analysis of post-secondary demands, with particular focus on Arizona institutions, and
- Analysis of national trends and research findings regarding the demands of the workplace and of post-secondary institutions and the ingredients of successful high school preparation.

This report assesses the current requirements for high school graduation compared to the academic preparedness of students for matriculation and success in higher education and compared to minimum requirements defined by the state's public university system. As in the analysis of occupations, information about academic preparedness and success was gathered from national and local data, key informant interviews, state leaders, and approaches recognized both nationally and locally for effective practice in this area.

This analysis looks at current Arizona high school performance requirements and university system admission requirements, and identifies the discrepancies. We also framed the issue of high school preparedness in the context of nationally accepted research and policy thinking about high school improvement and reform. Our research characterizes what a successful high school graduate looks like and compares this to preparation currently available in Arizona.

Section II: Industries and Occupational Analysis identifies key *industries* and *occupations* and analyzes the education and training levels needed to compete in the workforce of the 21st Century.

The first challenge for this analysis was to establish a common definition of *industries* and *occupations*. To do so, we used two widely accepted classification systems: the North American Industrial Classification System (NAICS) and the Bureau of Labor Statistics O*Net classification system to standardize definitions of industries and occupations. This lead to a reformulation of the original 12 industry sectors identified in the Request for Proposals as eight categories based on the NAICS and O*Net.

The second challenge was to define the educational and skill requirements identified for each *occupation*. No one "translator" is available to provide a common language or metric for discussing skills or education needed to succeed in the strategic occupations. We therefore used four generally accepted classification systems for identifying education and skill levels. These are:

- O*Net Job Zone
- Bureau of Labor Statistics Education and Training Levels
- O*Net Knowledges and Skills
- WorkKeys®

We reviewed the national data in light of information available that is unique to Arizona. Recent studies on four specific industries in Arizona identify occupations and readiness requirements for four industries – construction, advanced communications and information technology, sustainable systems, and bioscience. One study is pending final release (advanced manufacturing); however, state officials were able to provide some preliminary results that were also included in our research. A study of the tourism and travel industry is also underway; however, it will not be completed until later this year. For purposes of this study, we chose to move forward with our own analysis of the tourism and travel sectors and related occupations. The completed and pending studies do not, however, cover all industries needing to be targeted, nor do they look more globally across industries to determine commonalities or to assess if high schools are preparing students to meet the job requirements. This current investigation, therefore, did not duplicate the work of these studies, but focused on this cross-industry analysis, what educational and training requirements are needed, and how this compares to how well high school graduates are being educated to meet these requirements.

Finally, **Section III. Conclusion** brings together the occupational and post-secondary requirements analyses and lists the key findings that are drawn from the research. Observations are made concerning the alignment of K-12 graduation requirements with industry needs and post-secondary entry requirements. Current Arizona graduation requirements are compared with research about preparedness, and gaps in Arizona's current capacity to prepare students for post-secondary education and careers are identified.

SECTION I. PREPARING YOUTH FOR POST-SECONDARY EDUCATION AND CAREERS

INTRODUCTION

This first section of the **Public Works** study of the preparedness of Arizona's high school students for post-secondary study and the workplace focuses on the adequacy of academic preparation in Arizona. It begins with an overview of high school and the transition to post-secondary study in Arizona. We review specific aspects of Arizona students' achievement and the requirements for post-secondary study, and compare Arizona's standards and curricula and those that have been defined in other contexts, in order to gain perspective on the level of challenge presented in Arizona high schools. Finally, we set Arizona's circumstances in the national context of research and policy regarding high school preparedness. Attachments provide source material regarding the preparation of American youth for post-secondary study and careers.

The substance of this report is presented in two sections because two distinctly different types of analyses have been brought to bear on the broad question of how well Arizona's education system is aligned with the expectations of employers and post-secondary institutions in the state. Public Works has taken the approach that a meaningful analysis of the education and skill requirements needed to promote and sustain growth must be based both on a technical analysis of workforce needs and a substantive analysis of the complex factors that go into the successful preparation of high school graduates.

The findings regarding Arizona's education system are based on:

- A review of publicly available information regarding Arizona's high school offerings and graduation requirements, standards, and testing program;
- A review of admissions requirements for higher education in Arizona;
- Interviews with Arizona personnel responsible for aspects of K-12 and post-secondary education;
- A review of data and materials supplied by state personnel; and
- A detailed review of research, reports, and other materials from scholars and national research and policy organizations that have studied the bridge between high school and higher education, such as the Bridge Project at Stanford University, Achieve/The American

Diploma Project, the Education Trust, American College Testing, and the National Governors Association.

1. OVERVIEW: HIGH SCHOOL AND THE TRANSITION TO COLLEGE IN ARIZONA

Arizona's population of high school-age students is among the fastest growing in the nation, and the rapid growth is projected to continue for at least the next decade. There is reason for concern that some of these students may not be as well prepared for post-secondary study and careers as they could be. We begin with the specific questions this report is designed to address:

1. Are Arizona high school students well prepared for post-secondary study and careers?

2. Is high school preparation in Arizona well coordinated with higher education requirements, both for admission and for successful completion of coursework?

3. Do Arizona's K-12 and higher education systems provide adequate oversight and management of the bridge from high school to further schooling and career?

4. Are Arizona's high school standards challenging, by comparison with other definitions of what high school students should be expected to know and be able to do?

The answer to all four questions appears to be "no."

Regarding **question one**, achievement data, the evident need for remediation among many recent high school graduates beginning post-secondary study, and the concerns that employers and higher education faculty raise about the qualifications of many recent graduates all indicate that some Arizona high school students are not adequately prepared.

Regarding **question two**, there is a significant gap between current requirements for high school graduation in Arizona and the admissions requirements of the state's university system. Because the requirements are not well articulated across different parts of the education system, students may proceed through Arizona high schools without taking required courses in a sequence that allows them to become eligible for admission to the four-year institutions. Significant numbers of students – particularly minorities and low income students – either drop out of high school or graduate unqualified for a four-year institution. Significant numbers of those who enroll in both two-and four-year institutions must enroll in remedial courses to master material that should be covered in high school, which means that, in effect, their learning of basic skills is paid for twice. While the percentage of Arizona residents possessing a

bachelor's degree is similar to the U.S. average, the growth in this percentage has slowed in recent years. Moreover, while Arizona has a large number of highly educated retirees, the number of BA holders among the labor force is lower.[i]

Regarding **question 3**, Arizona has in place a system for coordinating the transition from two-year institutions to four-year institutions that has served as a model for other states. However, comparatively little coordination is institutionalized between the K-12 system and the two- and four-year systems. Data that could be of significant value to the state in strengthening the bridge between high school and college (such as, for example, documentation of the need for remediation across Arizona colleges and universities, of the educational and occupational outcomes of students who enroll in Arizona high schools, or of the varying ways in which districts interpret and state requirements graduation) are not currently collected or publicly available.

Regarding **question 4**, initial analysis of Arizona's defined academic standards for high school students and the requirements for graduation—including the performance thresholds necessary for passage of the required AIMS assessments—and comparison with standards and expectations defined in other contexts both suggest that Arizona's expectations of its high school students are relatively low. Detailed content analyses of the standards and evaluation of the AIMS assessment and its defined performance standards conducted by objective subject matter experts would provide a far more detailed picture of expectations in Arizona, but initial review suggests that the bar could be set significantly higher.

This report makes no recommendations regarding steps the state might take to address issues raised. The analysis of Arizona's system, set in the context of national experts' thinking about the issues with which the P-20 Council is concerned, is intended to provide the basis for both decisions about what additional detailed analyses might be needed--such as a comprehensive, subject-by-subject evaluation of high school standards-- and decisions about policy or other actions that could strengthen the system.

2. ARIZONA INDICATORS

2.1. NEED FOR IMPROVEMENT

Arizona has reason for concern about the achievement of its young people. Not enough students complete high school on time. Of those who do, far too many are not adequately prepared for post-secondary study and careers. A significant achievement gap is evident between advantaged and disadvantaged students for each of these indicators. Arizona received a grade of D for the preparedness of its students for higher education from the National Center for Public Policy and Higher Education, with particular reference to the preparation of minorities.[ii] Arizona was also cited in a recent *Education Week* article as a state that was moving against the tide evident in other states of raising the bar for a high school diploma. The recent decision to reduce the

required passing scores for the Arizona exit exam and allowing students to apply grades of A, B, or C in some courses toward their scores on these tests[iii] constitutes an effective lowering of the standard. In addition, it has been suggested that the 2005 increase in AIMS proficiency scores in 10th grade math may largely have been the result of a redefinition of the requirements for proficiency—rather than a meaningful improvement in achievement.

Other indicators collected by Achieve provide reason for concern as well. Just 26 percent of Arizona's eighth graders take Algebra, considered a "gateway" course, a prerequisite for the rigorous high school courses students need to enter and succeed in college. The national average is 31 percent, while the median for the top five states in this regard is 43 percent. According to the National Center for Public Policy and Higher Education, 69 percent of Arizona students graduate from high school on time, 35 percent immediately enroll in college, 22 percent are enrolled by sophomore year, and just 17 percent graduate from college on time. While these numbers are comparable to the national average, they are significantly below rates in top performing states.[iv] Another way of looking at educational opportunity in Arizona is using the "chance for college" rate developed by the Education Commission of the States, which measures the chance that a student will graduate from high school in four years and enroll in college within a year of graduation. For Arizona, that rate is 29.6 percent for all students, and just 15.6 percent for minorities.[v]

One might also consider the extent to which students require remediation when they move to post-secondary study. Individual institutions collect these data for themselves, and no source could be found for summary data on this issue. However, the data for the Maricopa Community Colleges, the largest in the system and among the largest in the nation, provide an indication of Arizona high school graduates' preparation. Of the 2004 graduates entering the Maricopa system in 2005, 16 percent enrolled in developmental English (remedial level) and 40 percent enrolled in developmental math. An additional 26 percent did not enroll in English at all, while 34 percent did not enroll in math at all. The rest of the students who did enroll in math break down as follows:

- 11 percent in Intermediate Algebra;
- 7 percent in College Algebra;
- 4 percent in other math; and
- 4 percent in Calculus.

Arizona has already begun to focus on its high schools. A detailed picture of improvement efforts currently being planned and executed in Arizona is beyond the scope of this report. However, a few examples illustrate the state's commitment to improving outcomes for all of its young people. For example, the Arizona Business & Education Coalition (ABEC) has held statewide community meetings designed to solicit the perspectives of business leaders, parents, and members of the state's Hispanic and Native American communities regarding the preparation of young people for college and the workplace. Similarly, driven by concern about performance on the state

assessment, as well as by concerns from the business and higher education communities about the preparation of Arizona high school students, the state's Department of Education formed a team to consider the needs of Arizona's high schools and strategies for reforming them. The Arizona High School Renewal and Improvement Initiative (AZHSRI) conducted focus groups to identify the concerns of some stakeholder groups. The concerns raised as part of the AZHSRI echo many of those articulated at the national level, particularly including the need for all students to have access to a rigorous, relevant, and comprehensive curriculum.[vi] Based on the AZHSRI recommendations, the Arizona Department of Education has begun implementing the Breaking Ranks II program, a set of integrated recommendations and activities designed to assist principals in developing and leading professional learning communities[vii]. Improving secondary career and technical education to increase academic rigor, ensure industry standards are met, and also "raise the bar" are critical.

Arizona has already made the decision to explore ways of improving outcomes for its high school students; now the state's challenge is to understand the needs of the students who are falling behind and to structure its academic programs to better serve all of its students. A variety of data are presented below to illustrate further the preparedness of Arizona students.

2.2. DROPOUT RATES AND TEST RESULTS

Arizona reported an overall graduation rate of 74 percent for 2002-03, with numbers for population subgroups that suggest significant achievement gaps, shown below. These numbers may not fully reflect the magnitude of the problem, however, because dropout rates can be calculated in numerous ways. Questions such as which of many possible ways should be used to count the baseline number of students from which the number who dropped out is subtracted, may influence the calculation. For example, three different ways of calculating the rate are presented by Standard and Poors *Schoolmatters* initiative, a clearinghouse of K-12 education data. For Arizona, *Schoolmatters* presents a cohort rate of 70.0 percent, a Cumulative Promotion Index of 67.7 percent, and a Leaver rate of 66.0 percent. The Education Trust supplies figures for each state that are designed to capture the likelihood that a child enrolled in ninth grade will graduate on time—that number for Arizona is 67 percent overall.[viii]

Table 1
2002-03 Four-Year Graduation Rate, by Ethnic Group

Group	Graduation Rate	Percentage of student population
White	81.9 percent	49.2 percent
Hispanic	63.1 percent	37.2 percent
Native American	58.5 percent	6.6 percent
African American	66.4 percent	4.8 percent
Asian	88.7 percent	2.2 percent
Total	74.0 percent	

Source: Arizona Department of Education

Assessment data give similar cause for concern. Arizona has a relatively new assessment for high school students, and has recently made passage a requirement for graduation. Results for the past four years show significant improvement. However, in 2005, just 63 percent of tested students met or exceeded expectations in mathematics, while 68 percent did so in reading, and 69 percent did so in writing.

The proficiency rates for AIMS became the focus of increased attention as the class of 2006, the first for whom passage was a graduation requirement, neared graduation. Recent score gains are encouraging; however, it is likely too soon to infer from them that achievement has improved. A pattern of short-term improvement after a new assessment has been introduced, followed by a leveling off in performance has been well documented in the psychometric literature, and is generally ascribed to growing familiarity with the format and expectations of the assessment.[ix] Other non-substantive factors may play a role as well; an analysis of the factors that account for the gains would provide valuable information for the state as it considers the rigor of its high school requirements.

Table 2
Percentages of High School Students Achieving Each AIMS Level

Mathematics

	Falls far below standard	Approaches the Standard	Meets the Standard	Exceeds the Standard
2002	51	20	20	8
2003	52	14	18	9
2004	52	18	20	11
2005	24	13	50	13

Reading

	Falls far below standard	Approaches the Standard	Meets the Standard	Exceeds the Standard
2002	15	25	47	13
2003	19	21	43	6
2004	24	26	43	6
2005	8	24	60	8

Writing

	Falls far below standard	Approaches the Standard	Meets the Standard	Exceeds the Standard
2002	17	26	57	1
2003	23	14	56	0
2004	5	27	60	9
2005	5	27	60	9

Source: Arizona Department of Education

Proficiency on a standardized assessment tells only part of the story, however. The AIMS tests are linked closely to Arizona's standards. A preliminary examination of sample test questions and performance level descriptors suggests that the tests measure primarily skills and knowledge that students could be expected to have mastered early in their high school careers. AIMS tests are offered beginning in the 10th grade (though students have multiple opportunities to retake them if they are unsuccessful at first). Consequently they measure material students could be expected to master at least by 10th grade. Moreover, students who successfully complete these

assessments have fulfilled a significant component of the requirements for graduation and can choose not to apply themselves further without much risk to their diploma.

2.3. ACT

Scores on the ACT are one indicator of students' preparedness for college. Students in Arizona who take the ACT score slightly above national averages. However, only 19 percent of Arizona high school students took the ACT in 2005, down from 27 percent in 2000.[x] ACT recommends that all students who aspire to college take a college-preparatory course load, and their assessments are linked to the recommended courses (this core program is described below). ACT data show that taking the recommended core coursework is strongly correlated with test scores, with those who have taken the core courses scoring more than two points higher on average (on a 36-point scale) than those who did not take them. This finding holds true for Arizona students as well. ACT reports that 67 percent of Arizona ACT-takers have taken the core courses, and that group scores two points higher than do non-core ACT-takers.

In other words, in Arizona, as across the nation, taking more rigorous coursework in high school leaves students better prepared for college work.

The two-point difference between core and non-core ACT-takers is evident for racial and ethnic subgroups as well, but there are also distinct gaps in performance by subgroup. Table 3 shows average composite ACT scores by race and ethnicity.

Table 3
Average AZ Composite ACT Scores by Ethnic Group (2005)

African American	American Indian/ Alaskan Native	Caucasian /White	Mexican-American/ Chicano	Asian American/ Pacific Islander	Puerto-Rican/ Hispanic
18.8	16.7	22.9	19.6	22.9	20.1

2.4. SAT AND ADVANCED PLACEMENT

Scores on and participation in SAT and AP exams provide additional evidence regarding Arizona students' readiness for college. Only 19.6 percent of Arizona students who take the SAT score slightly above the national average compared with 48 percent nationwide.[xi] As with the ACT, performance of Arizona students on the SAT is only an indirect measure of high school preparedness, because the small percentage of

students who take the exam are self selected and base their decision to participate on college plans.

Sixty-seven percent of Arizona high schools offer Advanced Placement classes, however only 6 percent of Arizona juniors and seniors take AP exams, versus 11 percent nationwide and 17 percent in the top five states. While Arizona schools may offer other ways to pursue advanced coursework, these numbers suggest that significant proportions of Arizona students are not pursuing rigorous college preparatory programs. The figure for both African American and Native American students is a two percent. Arizona has improved by 0.4 percent in AP participation rate since 1997, while the national improvement rate has been 3.7 percent. Top states have improved by approximately 7.4 percent.[xii]

Among Arizona students who take AP exams, 59.7 percent earn a score of three or above, on a five-point scale, the minimum for obtaining college credit. Here gaps among population subgroups are again evident: 56.7 percent of minority students receive a 3 or better, compared with 65.8 percent of white students. For African American students the percentage is 46.4, for American Indians it is 30.3, for Asian students it is 65.7, and for Hispanic students it is 54.1.[xiii]

3. RESEARCH AND POLICY ANALYSES REGARDING PREPARING STUDENTS FOR COLLEGE AND CAREERS

3.1. SCOPE OF THE PROBLEM

Arizona is by no means the only state in which high school preparation is an issue. Broad consensus exists regarding the crisis in American high schools, and national attention is increasingly focused on the importance of these last critical years of required schooling. It is important to set Arizona's circumstances in the larger national context for two reasons. First, because the problems that exist in Arizona can be found in many, if not all, other states, it is clear that an enumeration of Arizona's challenges is not designed to cast blame on the state's educators and policy leaders, but rather to improve understanding of the nature of the problem and possible routes to improvement. Second, the existing body of analysis produced by policy experts, researchers, and others can be of material benefit to Arizona leaders as they work to develop solutions that meet Arizona's needs. Specifically, the consensus that has developed regarding what constitutes successful preparation for high school graduates can serve as a baseline for Arizona's deliberations.

Educators, business leaders, elected officials, parents, and students have all pointed to the glaring mismatch between many students' high school preparation and the demands they face in college and the workplace. Forty percent of students in four-year institutions, and 63 percent of students in two-year institutions, need to enroll in remedial courses. Research supports the conclusion that significant numbers of students graduate from high school ill-prepared for college and career.[xiv] Taking

remedial courses is not just a duplication of cost and effort, but also an impediment to future success—while 56 percent of students who do not require remediation complete a two- or four-year degree, only 34 percent of those who need remediation do so.[xv]

Some high school students do leave secondary education well prepared for college and career, and some high schools and components of high schools perform well, as indicators such as TIMSS results for high-performing districts, and the growing numbers of students achieving top scores on AP exams, suggest. Nevertheless, a large proportion of American youth do not leave high school prepared to succeed in college.

Arizona is also not the only state that lacks structures and data collection processes that could support the bridge between high school and college. A study of the issue has found that few states collect data that would help them assess students' needs or the impact of policies and reforms.[xvi]

This problem exists in part because views of the purpose of high school have evolved over the past century, a period during which the percentage of young people graduating has increased from one in ten to roughly three in four.[xvii] A century ago, high school was largely seen as preparation for the select few destined for college. By the mid-twentieth century, as broader populations were served, expectations and graduation standards were lowered. In many jurisdictions, routes to the diploma proliferated, and academic rigor frequently took a back seat. Today, it is generally accepted that some post-secondary education is a prerequisite for high wage jobs and successful careers, and that a meaningful high school diploma, based in college preparatory academic content and career awareness and preparedness, is critical. The challenge in many states and districts has been to develop K-12 programming that successfully addresses these goals.

Problems besetting the American high school and concerns about the strength of the US workforce have persisted, and today a national conversation is underway about what is not right with high schools and how best to improve them. The scope of the problem is clear. Public opinion surveys have documented the widespread dissatisfaction of both employers and college faculty with the preparation of recent graduates.[xviii] Post-secondary institutions and others lament the cost in time and resources of providing substantial remedial coursework for new entrants.

All students are not affected equally. A significant and persistent gap between the achievement and opportunities of disadvantaged students and their more advantaged peers is also evident. For example, of high school graduates, those from high income families enter college at rates 25 percent higher than those of graduates from low income families. While dropout data varies by source, and the percentage of students dropping out of high school has been declining, there is widespread agreement that more students need to finish high school, and finish better prepared. According to the National Center for Education Statistics (NCES) data reported in Childtrends, 10.3 percent of students overall dropped out of high school in 2004, 23.8 percent of

Hispanics and 12.1 percent of African Americans. A similar gap is evident in Arizona. For example, in Arizona the Arizona Minority Education Policy Analysis Center reports that 2003 graduation rate for minorities was 64.1 percent, while that for white students was 81.9 percent.[xix]

Microsoft founder Bill Gates voiced the concern shared by many observers this way: "When I compare our high schools to what I see when I'm traveling abroad, I am terrified for our work force of tomorrow. In math and science, our fourth graders are among the top students in the world. By eighth grade, they're in the middle of the pack. By 12th grade, U.S. students are scoring near the bottom of all industrialized nations…In the international competition to have the biggest and best supply of knowledge workers, America is falling behind…"

3.2. THE NATIONAL HIGH SCHOOL IMPROVEMENT AGENDA

Over the past decade, many of those professionally concerned with the quality of public education have focused on improving high schools. Many reform efforts have already focused on younger children, and no one would argue that preparation for rigorous study can wait until the ninth grade. Nevertheless, the high school years are critical, and the Gates Foundation is one of many organizations funding projects to improve schools using a wide range of reform strategies. The National Governors Association (NGA) focused its recent summit on high school reform and student achievement, and has launched a sizeable program to provide funds to states that want to develop and implement high school improvement strategies.

Other national organizations concerned with education have weighed in on high school improvement as well. Drawing on research data as well as policy analysis, organizations such as the Alliance for Excellent Education, Achieve, the Education Trust, ACT, the College Board, Education Commission of the States, the National Commission on the Senior Year, the National High School Alliance, and others have studied the issue, and offer a variety of data, expertise, and strategies to assist states. Other endeavors, such as Standards for Success (University of Oregon), High Schools That Work (Southern Regional Education Board (SREB)), the Institute for Research and Reform in Education (IRRE) and the International Center for Leadership in Education, among many others, provide detailed frameworks states can use.

The high school conversation may seem to offer states a bewildering array of choices. However, a significant degree of consensus has emerged, both about the primary goals for high school, and about several elements that are critical for success, regardless of the specific approach to improvement a state takes. This consensus is based on independent reviews of the research regarding high school preparation and vertical alignment, and also reflects a noteworthy confluence of judgment about the objectives for U.S. high schools. Data can demonstrate achievement gaps and some of the problems that result when students are not well prepared. What is perhaps more significant is that so many researchers and policy analysts have focused on the same

issue--the achievement gap and inequity in students' preparation--and made the same judgment: that consigning some students to lesser expectations and opportunities is not the mission of public education in the United States.

Thus, consensus has clearly emerged that all students should graduate from high school with:

- Academic skills and knowledge sufficient to allow them to pursue further education or rewarding career opportunities;
- Life skills that prepare them to pursue goals in or out of school and to take on the role of a responsible citizen; and
- The capacity, background, and motivation to continue to educate themselves and to navigate post-secondary education and world of employment.

Second, key themes regarding rigor and relevance in particular emerge in virtually all of the reports and approaches advocated nationally that were reviewed in the preparation of this document.

3.3. HIGH SCHOOL PREPARATION THEMES

Four themes are stressed consistently by organizations such as Achieve and the American Diploma Project, the National Governors Association (NGA), the Education Trust, Education Commission of the States, High Schools That Work (SREB), ACT, the Center on Education Policy, the National Commission on the High School Senior Year and the National High School Alliance. These groups collectively have conducted and reviewed a substantial amount of research. Greater detail on the specific programs and initiatives of these and other groups is provided in the Attachment 2.

The four themes, discussed below, that might in part inform Arizona policy are:

- Setting high standards for all students, and holding all students accountable for meeting them.
- Supports for students at risk
- Making well crafted, ambitious standards the linchpin of an integrated system of curriculum, instruction, professional development, and assessments
- Providing for effective transitions to post-secondary education and work

3.3.1. Importance of setting high standards for all students, and holding all students accountable for meeting them

Extensive study of high school requirements and outcomes for graduates has demonstrated that many high schools simply do not adequately challenge their students academically or intellectually. Too often, graduation requirements, passing standards for graduation tests, and the content of courses are not rigorous and do not provide students with sufficient opportunity to grow and learn. Researchers and policy analysts are united in saying that all students need core—not basic or minimum competency—academic skills and knowledge to prepare themselves for both college and the workplace. A number of states (AL, AR, FL, IN, KS, MS, NY, NC, OK, OR, TX, VA, WA[xx]) have recently begun to require a college preparatory curriculum for graduation. These states have developed a variety of options for students who want an even more accelerated program, and for supporting students who will struggle with tougher requirements. These reforms have not been in place long enough for evaluation of their effects on student outcomes to be undertaken, but will undoubtedly be closely watched.[xxi] They also apply not only to core academic subjects, but to efforts to improve career and technical and related programs as well.

Tougher course requirements. The argument that more rigorous requirements are needed for all is not based on the premise that all students should go to college, but on updated goals for high school. First, the possibility of college should remain open to every student throughout high school, regardless of the path chosen post high school. No student should be taking coursework that will leave him or her ineligible for post-secondary study--or be discouraged from aspiring to college and encouraged to take "dead-end" classes. Second, every student needs grounding in the primary disciplines (e.g. mathematics, science, social studies, and English/Language Arts), which are a necessary preparation for college, career, and citizenship, and which also develop the capacity to continue learning and educating and adapting to the needs of the workplace throughout life. Almost any career offers more potential for advancement to workers who start out equipped with skills in math, reading, writing, speaking, and thinking, and many careers that do not require a college degree nevertheless demand fluency with these skills.

The Education Trust and others have noted that:

- There is significant variation state by state in graduation requirements, and
- There is very little consensus between the secondary and post-secondary communities about what should be required of high school graduates in terms of the actual course content.[xxii]

This lack of alignment is a significant problem for many students, who may in good faith complete high school graduation requirements, only to discover too late that

many post-secondary choices are already foreclosed for them. This is also a significant problem in Arizona, as is discussed below.

3.3.2. Supports for students at risk

Perhaps the biggest change that is called for in improving high schools is that of raising expectations. Each of the national groups in its own way stresses that by and large the problem lies not with students who are already excelling, but with those who have been consigned to slow-paced, undemanding coursework and have opted out of academic ambition. A number of strategies have been developed for supporting students who are at risk. Some focus on restructuring high schools so that students learn in a more personalized atmosphere and have the individualized attention of adults who are trained to recognize and address problems. Restructured highs schools can offer students the chance to pursue their own interests and strengths and to see how those interests can translate into college and workplace skills.

Other strategies include focusing attention on the pipeline through which students reach high school, ensuring that elementary and middle school students receive the grounding they need to succeed in high-level courses when they reach ninth grade. This pipeline begins with pre-school, and without a doubt high schools are faced with the stiff challenge of helping many students compensate for years of missed learning opportunities. K-12 systems are urged to consider vertical alignment for the entire P-20 trajectory, and to build systems that provide what is needed at every stage. At the same time, high schools must also focus on the students they are serving right now and will serve in the short-term future.

Apart from being the first opportunity for high school policies to have an impact, ninth grade is a critical year in students' educational careers. As the gateway year for access to more challenging work and the time to begin considering post-secondary plans, ninth grade is also the first year when significant numbers of students drop out or initiate a pattern of dropping in and out and gradually disengaging from school.[xxiii] Thus, focusing on ninth grade, a key transitional year for catching dropouts, has been identified by many observers as a critical opportunity to equip students to succeed with a more demanding program, and to develop interest-based academic and career pathways. The challenges vary from urban to rural districts, with the proportion of non-native English speakers in the population, the degree of transience, and other issues, so each state must develop strategies that suit the context in which its students are learning.

3.3.3. Importance of making well crafted, ambitious standards the linchpin of an integrated system of curriculum, instruction, professional development, and assessments

The premise of standards-based reform is that standards that clearly articulate what students need to know and be able to do in each subject, as well as the level of

performance that will be required, are the key to an aligned system.[xxiv] Well crafted standards not only define ambitious expectations for students, they also provide the basis for rigorous curricula, professional development, and assessments that work together to improve teaching and learning. (Review of curricula and professional development in Arizona were beyond the scope of this report but are certainly critical elements for the state to consider.)

Currently, state standards vary significantly, both in terms of the degree of rigor they call for and in terms of the clarity and detail with which they express goals for teaching and learning.[xxv] Moreover, states have been making significant changes to their standards in recent years – and indeed making regular revisions is part of the ongoing process of ensuring that standards are challenging and effective. Thus, making comparisons among states in terms of how successfully their standards are guiding improvements is difficult. Nevertheless, there is guidance and a number of models for states that are considering revisions to their standards.

It is important to note here that states face a dilemma as they set performance standards. Standards that are too high may yield unacceptably high failure rates, which is an especially troublesome issue when meeting the performance standards on an examination is an explicit requirement for graduation. On the other hand, if states set standards that are not sufficiently challenging the standards will not serve the purpose of ensuring that students are learning as they should and are prepared for the future. States respond to this dilemma in a variety of ways, but the consequences of relying on standards that are too low are clear from the analysis presented in this report.

Role of graduation tests. According to the Center on Education Policy, 26 states now employ high school exit exams.[xxvi] A few states, such as Alaska, Minnesota, and New Mexico, use minimum competency assessments. The majority, however, are moving toward standards-based or end-of-course exams. Very few, however, are linked to college requirements or readiness, and only one (Georgia's) was linked to workforce readiness at the time of this writing. Arizona has recently begun requiring passage of its AIMS assessment, which is tightly linked to the state's academic standards, for graduation.

Without a doubt, assessment is a key tool with which states can influence high school goals and achievement, however high stakes exit exams can be controversial and may have unintended negative consequences.[xxvii] Such tests are not fair if they are used without proper attention to the opportunities all students have to learn the tested material, an issue which has arisen in Arizona. They may not yield valid results if they are not closely linked to the achievement and performance standards they are designed to measure. They can also have the effect of narrowing the curriculum – and restricting learning – if schools and teachers feel undue pressure to focus on material that is to be tested, and neglect other, equally important material that is not as easy to assess.

Finally, if tests are not demanding, then relatively high pass rates may disguise a significant achievement deficit. Significant political pressure to increase both graduation

rates and test scores has resulted in lowered expectations in many states, as the definition of what constitutes proficiency is adjusted downward. A report for the American Diploma Project analyzed exit exams in a number of states and found that most are assessing skills and knowledge that are generally covered in middle school or very early in high school.[xxviii] Regardless of the quality and rigor of academic content standards a state may use, exit exams of this type cannot ensure that graduates are equipped to succeed in college and the workforce.

The AIMS is linked to Arizona's content standards, but those standards do not appear to describe a particularly demanding academic program for high school students, by comparison with other standards intended to set high expectations for students. At the same time, the performance levels required for passage of AIMS are not particularly high. Nevertheless, because the content standards for high school are not articulated by grade level, many students may not have mastered the coursework needed for success on AIMS by the time they are tested. Thus, Arizona students are not held to high academic expectations either by the standards that guide curricula or by the state assessment.

3.3.4. Providing for effective transitions to post-secondary education and work

The research examined for this study addressed both academic preparation and career exploration, and, for much of the field, integration of the two was an explicit focus. The effort to integrate academic and career objectives is long standing, but has had only limited success in many of the nation's high schools. Analysts argue that treating these two high school objectives as separate endeavors, relevant to two different sets of students, does a disservice to all. Linking academic preparation to career trajectories and themes that encompass a variety of options is the preferred approach to providing high school students with career exploration and technical education opportunities. The essence of this approach is both true integration and multiple pathways, in which all students are exposed to career awareness opportunities that link to their interests, and all are held to academic standards that will leave them qualified to pursue a range of options, as discussed elsewhere in this report. It also provides students who wish to pursue technical education opportunities in high school the opportunity to do so without sacrificing preparedness for postsecondary study.

We also note that secondary career and technical education can play an important role in preparing students for postsecondary education and career, and that many states are taking important steps to substantially redesign CTE programs to ensure they meet higher standards and expectations. In part, this requires the elimination of vocational courses and programs that are isolated and dead-end, and for the substantial restructuring of all career and technical education to include strong academic components as well. While review of AZ CTE was not an explicit focus of this study, it is important to note its importance to the future of the AZ high school endeavor.

4. ARIZONA GRADUATION REQUIREMENTS AND POST-SECONDARY ALIGNMENT

4.1. ARIZONA GRADUATION REQUIREMENTS

Arizona has defined the requirements for earning a high school diploma in terms of two measures: passage of the AIMS tests in reading, writing, and mathematics, and completion of the course requirements listed below.

The AIMS is a standards-based assessment in which students demonstrate mastery of defined strands within the three fields. Students have up to five opportunities to take each of the three assessments, beginning in the 10th grade, and must attain a score of "meets expectations" or "exceeds expectations" on each. The course requirements leave students – and districts – considerable flexibility: 20 credits are required, of which 8.5 are not specified. Thus, the state is not in a position to ensure that students who meet requirements are prepared for college intellectually, or that they meet eligibility requirements for post-secondary study.

As far as could be determined for this report, the Arizona Department of Education leaves the guidelines for fulfilling these 8.5 credits to the discretion of the districts in practice as well as on paper. No source of summative data on what the districts require, how they determine what they will require, or how outcomes for students might differ based on different requirements could be identified.

This section compares Arizona high school graduation requirements; Arizona requirements are compared to other national approaches in the next section.

Twenty Credits Required for Arizona High School Graduation:

- 4 credits of English or English as a Second Language, which will include but not be limited to the following: grammar, writing, and reading skills, advanced grammar, composition, American literature, advanced composition, research methods and skills and literature. One-half credit of the English requirement will include the principles of speech and debate but not be limited to those principles.

- 1.5 credits in instruction in the essentials, sources and history of the constitutions of the United States and Arizona and instruction in American institutions and ideals and in the history of Arizona.

- 1 credit of world history/geography.

- 2 credits of mathematics: the course content of the mathematics credits shall include Number Sense; Data Analysis and Probability;

Patterns, Algebra and Functions; Geometry; Measurement and Discrete Mathematics; and Mathematical Structure/Logic.

- 2 credits of science.
- 1 credit of fine arts or vocational education.
- 8.5 credits of additional courses prescribed by the local governing board, subject to the approval of the State Board.

In addition, Arizona has a number of career and technical education programs that offer students opportunities to explore different career trajectories and strategies for preparing themselves to enter various fields. The question is whether these options reflect an equally high standard as that required for postsecondary education, or are viewed as a lesser track for the "non college bound". Districts are authorized to allow students to meet some of the 8.5 unspecified requirements with Practical Arts credits, obtained through CTE study (as well as Fine Arts credits). Standards for CTE courses are linked to academic standards, though it could not be determined for this report how this linkage is accomplished. Multiple pathways to postsecondary and career preparation are essential to helping students succeed.

4.2. POST-SECONDARY SYSTEM CHARACTERISTICS

Arizona's post-secondary system consists of three public four-year institutions and ten multi-campus public community colleges, as well as 15 smaller independent schools and 53 nationally accredited career colleges or proprietary schools. While coordination of this system is complex, it is in many ways less so than in other states because the system is comparatively young and there are only three major four-year institutions.

4.2.1. University Admissions Requirements

The public university system in Arizona has defined basic admissions requirements for freshmen entering a BA program at any of three four-year institutions: Arizona State University, Northern Arizona University, and the University of Arizona. The Tri-University system asks students to meet thresholds for GPA and test scores, which vary for in-state and out-of-state students, admission to special programs, and other circumstances, and to have successfully completed the following course work:

- 4 units' English (Composition and Literature).
- 4 units' mathematics: Algebra I, Geometry, Algebra II, and a course for which Algebra II is a prerequisite.

- 3 units' laboratory science: One unit in at least three of the four major areas (Biology, Chemistry, Physics, Earth Science) is recommended.

- 2 units' Social Studies: One unit of American History and one additional unit of any combination of two semesters of social science such as: European/World History, Economics, Sociology, Geography, Government, Psychology, Anthropology, or Philosophy.

- 2 units of the same foreign language.

- 1 unit of fine arts or any combination of two semesters of fine arts

These basic requirements apply across the three institutions; additional requirements have been defined for some programs within these universities, such as the schools of engineering, journalism, and business at Arizona State University. Arizona residents who have met baseline requirements (have taken the required 16 courses, attend an Arizona high school, and rank in the top 25% of their classes) are ensured admission at one of the three universities. Applicants who do not meet the criteria for assured admission are evaluated on additional factors such as SAT scores.

The Community College systems all have completely open enrollment, and thus do not have specific course requirements for entering students. Because admissions requirements cannot act in part as a screen for preparedness, community colleges find themselves with a significant burden in terms of providing remediation in reading and math in particular. Both the four-year institutions and the community colleges provide extensive opportunities for remedial work for students who arrive unprepared for college-level coursework. For example, as stated above, in the Maricopa Community College System, of the 2004 graduates entering the system in 2005, 16 percent enrolled in developmental English (remedial level) and 40 percent enrolled in developmental math.

4.3. DISCREPANCIES BETWEEN HIGH SCHOOL GRADUATION AND COLLEGE ENTRANCE REQUIREMENTS

Students who complete only the current minimum requirements for graduation from Arizona high schools may not be eligible for admission to a four-year undergraduate program at the state's university system because of any of the possible discrepancies listed below. Only in English/Language Arts would Arizona high school graduates seem to automatically have sufficient credits; however, this comparison does not address the content of the required courses in detail. It is important to note that high school graduates must have completed 8.5 unspecified credits, which could be used to meet any or all of these deficiencies:

- Mathematics: High School graduates are required to take only two credits and the content is designated by strands that must be mastered if the student is to pass the AIMS test. The University system requires two additional years, and specifies that students advance past Algebra II.

- Science: High school graduates may be one credit short in science, and may not have a credit in any of the three required areas (of four options: Biology, Chemistry, Physics, Earth Science). The University system specifies laboratory science, while the graduation requirement does not.

- Social Studies: In addition to the American History requirement, which can be met with the required study of the U.S. and Arizona constitutions, the University system requires one unit, to include a combination of two semesters in two of several fields. High school graduates will have a credit in World History, but may not have a credit in any of the other areas.

- Foreign language: The University system requires two units; high school graduates may have none.

- Fine Arts: The University system requires one unit; high school graduates may have none.

It is also important to note that the Arizona University system is in the process of reevaluating admissions requirements, and decentralizing them by discipline to ensure that each faculty has the opportunity to set appropriate admissions standards. This change is likely to raise the requirements for college entrance, as well as further complicate the higher education preparation picture.

Arizona's basic requirements for graduation are not only inadequate to prepare students for admission to the state's university system; they are less stringent than those recommended by ACT, the American Diploma Project, the Education Trust, and High Schools That Work. The comparison is shown in Table 4.

Table 4
Goals for High School Graduation Compared

	AZ Diploma	AZ Tri-University Admissions	ACT	ADP	Education Trust	High Schools That Work
ENGLISH	4 years	4 years	4 years	4 years	4 years	4 years
MATHEMATICS	2 years	4 years	3 years	4 years	3 years	4 years
SCIENCE	2 years	3 years	3 years	3 years	3 years	3 years
SOCIAL STUDIES	2.5 yrs	2 years	3 years	3 years	3 years	3 years
FOREIGN LANGUAGE	none	2 years	1-2 yrs	none	2 years	none

Articulation between the community college system and the three state-funded four-year institutions has been the subject of considerable effort, and, according to state sources, the system has become a model for other states. First, a Post-secondary Articulation/Transfer Task Force (PATTF) has been charged by the Arizona Commission for Post-secondary Education with identifying potential areas for articulation and encouraging articulation possibilities among post-secondary institutions. Arizona has in place the Course Applicability System, which allows students at all community colleges to understand how the courses they are taking will be credited if they transfer to a four-year institution, and can plan ahead to meet requirements for transfer. Moreover, the system has defined the Arizona General Education Curriculum (AGEC), a thirty-five semester credit "block" that can be completed at any Arizona community college, and that is recognized by the four-year institutions.

A similar degree of articulation is not evident between the K-12 system and the higher education system. Definitions of what constitutes rigor, relevance, and comprehensiveness may vary, and a key starting point is the value of the credential Arizona high school graduates receive.

There is a significant gap between current requirements for high school graduation in Arizona and the admissions requirements of the state's university system. Because the requirements are not well articulated across different parts of the education system, students may proceed through Arizona high schools without taking required courses in a sequence that allows them to become eligible for admission to the four-

year institutions. Thus, students may arrive in the 10th or 11th grade in a position where meeting the requirements is virtually out of the question, and they may even arrive in 9th or 10th grade without having taken the course sequence that would adequately prepare them to succeed on the AIMS assessment.

4.4. SECONDARY AND POST-SECONDARY DATA COLLECTION

Like those in many states, the education system in Arizona collects a great deal of important data; however there is not a comprehensive system for determining which data are needed or for coordinating data collection efforts in different components of the system. There are also significant gaps in the data needed to fully assess the effectiveness of K-12 and higher education. For the purposes of reviewing articulation between high school and post-secondary study and careers, however, Arizona does have some data that shed light on the problem.

For example, the Board of Regents sponsored a 2002 study of Arizona High School Eligibility, in which the transcripts of a random sample of all graduates of Arizona high schools were reviewed to determine the sampled students' eligibility for admission to the three four-year institutions. The study found that 43.9 percent were eligible (met 14 of the 16 requirements, had a GPA of 2.5 or better, and fell in the top half of their class) and that 16.8 percent would meet the revised 2006 requirements for "assured" admission, meaning that they were in the top 25 percent of their class and had completed all 16 of the required competency courses.

Table 5
Arizona High School Graduates Meeting Basic University Eligibility Requirements

African American	American Indian	Asian American	Hispanic	White	Total
31.1	20.9	65.9	29.9	52.1	43.9

Source: Report to the Board of Regents. Executive Summary, Arizona High School Eligibility Study

The admissions requirements for the three four-year institutions were recently made more stringent by the Board of Regents partly in response to a Carnegie Institution report that provided data showing that high school preparation correlated strongly with university success. The Arizona universities are continuing their efforts to provide information to younger students and their parents about the eligibility requirements and to encourage enrollment in the necessary courses in other ways.

The Arizona Academic Scholars Program run by ABEC, a community based program designed to motivate the middle 50% of Arizona students to complete an

academically rigorous course of study, is one example of how the state is trying to encourage students to be ambitious and excel. This program is in its second year. The Arizona Department of Education has recently introduced the Regents Honors Endorsement as another way to encourage students to prepare for college entry. This program, not yet implemented, is intended to define the courses students who aspire to university entrance should take, and encourage early aspiration and commitment to college preparedness. The requirements will likely include at least: four credits of English, three credits of math (algebra I, geometry, algebra II), three credits of basic lab science (biology, chemistry, physics), 3.5 credits of social studies (chosen from US and world history, geography, economics and government) and two credits of the same foreign language. This course of study will be voluntary and measures to inform families about the suggested curriculum, and encourage students to enroll are part of the plan.

The discrepancies described above demonstrate that the K-12 system requirements are not yet aligned with the post-secondary requirements, though some students certainly do leave Arizona high schools well prepared for post-secondary education. Further indication of this misalignment is also provided by the High School Report Cards prepared for the Board of Regents. Each of the three four-year public higher education institutions collects data on Arizona high school graduates who have enrolled, and submits the data to the high schools from which the students graduated. Summary data for all Arizona high school graduates matriculating at any of the three institutions shows that the students who were admitted without academic deficiencies—that is, having completed all of the 16 required credits—earned a GPA of 2.9 in their first quarter of college study, while those who were admitted with deficiencies earned a GPA of 2.3. [xxix].

5. ARIZONA STANDARDS AND CURRICULA COMPARED

The requirements for graduation from Arizona high schools do not match the admissions requirements for Arizona's university system. This, however, is not the only indication that Arizona high schools are not sufficiently rigorous. As was discussed in the introduction, course requirements alone cannot ensure rigor. A curriculum that requires students to go deeply into the material, and performance expectations that are demanding, are critical to educating college- and work-ready graduates. This section explores more closely the academic demands of high school and ways in which academic programs vary.

The numeric requirements do not tell the whole story. First, because Arizona students may meet 8.5 of the graduation credit requirements in unspecified ways, the rigor of a significant portion of their coursework is left entirely to district and/or school discretion. Moreover, counselors, parents, and others tend to focus on attained grade point averages (GPAs), rather than on the content that must be mastered to attain them, particularly when scholarships and other recognition are based on these figures. Yet the GPA reflects only the success with which students complete required material; if

coursework is not demanding, a high GPA does not indicate a high degree of attainment or preparedness for further schooling or career.

A preliminary comparison of Arizona's standards and performance expectations with those of other groups reinforces the message suggested by the comparisons of numeric requirements shown in Table 4. Arizona's content and performance standards do not seem to set the bar as high as other standards do. A student who met only the minimum requirements put forth in Arizona would not be well prepared to matriculate at an Arizona university, to compete with peers educated according to higher expectations, or to perform optimally in the workplace.

The Department of Education's Standards Development and Implementation Unit is responsible for the development of the state's standards as well as for supporting and assisting schools in implementing them. Arizona has written standards in The Arts, Foreign and Native Language, Language Arts, Mathematics, Science, Social Studies, Technology, Workplace Skills, and Comprehensive Health/PE. The standards are specified by grade level (K-8) in Reading, Writing, Mathematics, and Science. They are not, however, specified by grade level for high school—a single set of standards is in place for grades 9 through 12.

Arizona's standards were revised in response to the passage of the 2001 No Child Left Behind Act because they had not previously been articulated by grade level. They were extensively reviewed at that time, and a process is in place for implementing them that includes professional development for teachers. Because AIMS is tightly linked to the standards, analysis of specific results can help teachers focus on areas in which their students are struggling.

For the purpose of this analysis, we compared one section of the mathematics standards for high school, Strand 3, which covers patterns, algebra, and functions, with similar standards from the America Diploma Project, Standards for Success and ACT. Based on this summary assessment, a marked contrast seems apparent between Arizona's standards and those of the other three groups examined in the degree of specificity and detail provided, as well as in the scope and difficulty of the required material. The Arizona strand, as well as excerpts from the American Diploma Project and Standards for Success standards, are included in Attachment 1. In both cases we have included only those related to high school algebra, for purposes of comparison. (The algebra benchmark developed by ACT is available at http://www.act.org/standard/planact/math/index.html; it is not included in this document because of its size.)

The brief excerpt below provides a hint of what a side-by-side comparison of these standards suggests, that Arizona's standards are not very detailed, which means that districts, schools, and individual teachers have considerable latitude to determine precisely what students will be taught. Moreover, based on informal comparison, the other sets of standards appear to describe more challenging conceptions of comparable material.

It is important to note that standards documents and other descriptions of specific performance and content expectations are conceived and organized in different ways for valid reasons. The comparison made here is not scientific; it is done for the purpose of identifying the possible need for further analysis by content experts. A thorough review could reveal how well Arizona's standards and performance expectations correspond to the kinds of standards that national experts have developed, including those discussed here as well as others. National discipline-based organizations, such as the National Council of Teachers of Mathematics and the National Academy of Sciences (National Science Education Standards) provide subject-specific content guidance.

Excerpt from the Arizona State Mathematics Standards, **Strand 3, Patterns, Algebra, and Functions, Concept 2 of 4, Functions and Relationships, items 1 and 2 of 9**
Describe and model functions and their relationships.
PO 1. Determine if a relationship is a function, given a graph, table, or set of ordered pairs.
PO 2. Describe a contextual situation that is depicted by a given graph.

Excerpt from Benchmark for Algebra, American Diploma Project, 1 of 6 sections, items 1 and 2 of 7
The high school graduate can:
J1. Perform basic operations on algebraic expressions fluently and accurately:
J1.1. Understand the properties of integer exponents and roots and apply these properties to simplify algebraic expressions.
Example:
Simplify the expression $\left(\frac{a}{b}\right)^m \cdot c^{2m}$ to obtain either $\frac{(ac^2)^m}{b^m}$ or $\left(\frac{ac^2}{b}\right)^m$.

J1.2. * Understand the properties of rational exponents and apply these properties to simplify algebraic expressions.
Example: Explain why $\sqrt[3]{x^2} \cdot \sqrt{x} = x^{\frac{2}{3}} \cdot x^{\frac{1}{2}} = x^{\frac{7}{6}} = \sqrt[6]{x^7} = x\sqrt[6]{x}$ for any non-negative number *x.*

From our preliminary comparison, the conclusion that Arizona's standards are less rigorous and detailed than most experts are recommending seems warranted.

The term *standards* encompasses two distinct concepts—academic content standards and performance standards—both of which are necessary for guiding teaching and learning. Academic content standards describe what concepts, skills, or other material students should be expected to master. Performance standards describe how well they should be able to do these things, or what it is they must be able to do to demonstrate mastery. Assessments are then a means of measuring the content standard (what) and the performance standard (how much). Arizona uses its required high school exit exam as a way of ensuring that graduating students perform to particular levels, and thus the performance level descriptors serve as supplements to the standards.

The AIMS assessment is scored on a four-point scale, according to which student responses are classified as exceeding, meeting, approaching, and falling far below particular standards. Examples of those descriptors are also included in Attachment 1 after the examples of the algebra standards. Students must meet or exceed the performance standard to graduate (with certain exceptions). The performance expectations for the graduation exam do not seem to alter the general conclusion that the state's expectations for students do not reach the levels advocated for college preparedness by the other groups.

6. PREPARING YOUTH FOR POST-SECONDARY EDUCATION AND CAREERS: KEY FINDINGS

Arizona, like many states, has what one study described as "unnecessary and detrimental barriers between high school and college….that are undermining student aspirations."[xxx] A significant number of the students who graduate from Arizona high schools are not adequately prepared for post-secondary study, and many also lack the basic skills and knowledge necessary to thrive in the workplace.

Some of the reasons for this lack of preparedness have been described in detail above, and we summarize the key conclusions here.

The secondary system in Arizona is not well aligned with the requirements for post-secondary study and the workplace.

Employers in Arizona and post-secondary institutions in Arizona are in accord with national researchers and policy analysts in defining ambitious expectations for high school graduates in terms of both hard and soft skills. While the skills and knowledge needed for work in various industries and for post-secondary study at different levels and in different fields vary somewhat, core skills are needed irrespective of students' specific goals. This set of skills and knowledge includes, but is not limited to:

- Mathematics (e.g. arithmetic, algebra, geometry, calculus, statistics, and their applications);
- Science and scientific thinking (e.g. computer science and engineering, applied technology, life sciences, etc.)
- English language skills (e.g. reading comprehension/reading for information, writing and oral communications skills); and
- Thinking and learning skills (e.g. critical thinking, listening and observation skills, and judgment and decision making).

Arizona students are not required to take, and in many cases not offered, curricula that would adequately prepare them for post-secondary study. They are not

well guided by the K-12 system as to what will be required of them if they pursue further schooling or careers, and the formal course and testing requirements are not sufficient to ensure adequate preparation. The system also does not take sufficient steps to monitor the progress of students, and to track the outcomes that result from preparation that varies in rigor.

The academic programming and graduation requirements in place in Arizona high schools are not sufficient to equip students with this set of necessary skills and knowledge.

There is a significant gap between current requirements for high school graduation in Arizona and the admissions requirements of the state's university system. Because the requirements are not well articulated across different parts of the education system, students may proceed through Arizona high schools without taking required courses in a sequence that allows them to become eligible for admission to the four-year institutions. Specifically:

- Graduation requirements are insufficient, both because 8.5 of the necessary credits left to the discretion of school districts may not result in adequately rigorous preparation, and because the required numbers of courses in several areas fall short of what is needed/recommended.

- The state standards do not appear to call on students to master sufficiently ambitious and rigorous course material and do not appear to be sufficiently detailed to provide clear instructional guidance.

- The state assessment, AIMS, used as a graduation requirement, does not appear to set a high bar for passage, and therefore does not ensure that graduates will have the level of skills needed.

- Arizona students are not performing well, even in terms of the state's current standards of proficiency and success, as demonstrated by scores on AIMS, dropout rates, and other indicators.

Students who do not perceive themselves as college bound at an early stage are at a particular disadvantage, because they may meet graduation requirements by taking a sequence of courses that neither meets basic four-year college entrance requirements not provides them with the necessary skills and knowledge for success in the workplace. Career and technical education options may not reflect the level of academic preparation required to meet this standard either.

The expectations of Arizona students embodied in the requirements for graduation, the state's academic standards, and the performance levels required

for passage of the state graduation assessment are not only poorly aligned, they also appear to be significantly less demanding than national experts recommend.

Arizona's academic standards for high school students are not articulated by grade and are fairly general, by comparison with other definitions of what high school students should be expected to know and be able to do. Similarly, the content assessed by AIMS, as well as the performance levels required for passage do not set as high a bar for Arizona students as may be desirable.

Significant numbers of Arizona high school students are not meeting Arizona requirements.

Finally, though Arizona does not appear to be setting particularly high expectations for its students, dropout rates, performance on AIMS, and other indicators suggest that significant numbers of students are not succeeding. Thus, Arizona's challenge is not only to bring its expectations and requirements inline with the demands of higher education and the workplace, but also to address the needs of students who are already struggling.

One way to summarize the issue facing Arizona is to ask why it is that businesses and colleges find that recent graduates – who have received passing grades in high school coursework and on the graduation exam – require remedial courses and training before they can undertake even the introductory challenges of college and the workplace. The AIMS assessment is not demanding and it is offered early enough (10th grade) that passage reflects accomplishments that fall short of what might be expected of a high school graduate. Passing early can also allow students to consider that they have met the requirement and need not apply themselves further.

However, AIMS is just one aspect of a system that is not well aligned with the demands of college and the workplace.

Arizona does not provide adequate oversight and management of the bridge from high school to further schooling and career.

Data that could be of significant value to the state in strengthening the bridge between high school and college (such as, for example, documentation of the need for remediation across Arizona colleges and universities, data regarding the ways in which high schools and districts direct their students to fill the 8.5 unspecified credits, and data regarding the educational and occupational outcomes of students who enroll in Arizona high schools) are not currently collected or publicly available. Individual institutions and entities within the state's educational system collect much data for themselves, but many kinds of summary data are not available.

This part of our report has examined several of the indicators of lack of preparedness of Arizona high school students, and potential misalignment among secondary and post-secondary education and the demands of the new, knowledge

economy. Raising the bar so that Arizona students leave high school ready for post-secondary education and careers is a significant challenge complicated by the complexity, diversity, and decentralized nature of the US education and workforce development systems. There is no simple, "one-size fits all" solution. Rather, a myriad of opportunities exist for Arizona policy makers and practitioners, and leaders in education, business, and communities to forge common purpose in building the well educated workforce the state requires to continue to grow and provide for its citizens. The next chapter examines specific education requirements of some of Arizona's targeted high growth occupations and industries.

SECTION II. INDUSTRIES AND OCCUPATIONS ANALYSIS

1. INDUSTRIES AND OCCUPATIONS KEY FINDINGS

The following key findings are drawn from our investigation.

1.1. THERE IS A GAP BETWEEN THE NEEDED EDUCATIONAL ATTAINMENT LEVEL IN DEMAND OCCUPATIONS COMPARED TO THE CURRENT WORKFORCE.

Thirty-nine percent of the livable wage jobs in 2013 will require at least a bachelor's degree while only 15 percent of Arizonan's age 25 or older have attained that level of educational attainment. Of Arizonan's age 25 and older in 2000, 26 percent had some post-secondary education but no degree, while only seven percent of Arizona's 'livable wage' job openings created between 2003 and 2013 will require some post-secondary education without a degree. The gap in the supply of and the demand for adequately educated workers to fill at least median wage job openings highlights the disconnect between job requirements and workforce availability. Most notably, there emerges an oversupply of individuals not finishing their degrees and an undersupply of individuals with a bachelor's degree.

1.2. WORKFORCE PREPARATION FOR GROWING OCCUPATIONS WILL REQUIRE AN UNDERSTANDING OF THE UNIQUENESS OF EACH INDUSTRY.

Each industry sector is unique in terms of total employment, wages, and education skill levels required by that sector's occupations. For example, the median wage for Transportation & Logistics was just over $29,000, while the median wage for Aerospace was just under $52,000.

Our analysis shows that 39 percent of Health Services jobs require at least an associate's degree, while only two percent of the Tourism & Travel jobs or five percent of Transportation & Logistics jobs require more than some vocational training and related work experience.

The 70 occupations in the final list of key occupations have a combined median wage of $46,938, ranging from $21,476 to $87,446. In terms of total employment growth between 2003 and 2013, across all industry sectors in the state, these occupations will account for 163,508 total openings by 2013. On average, these occupations will require at least an Associate's degree.

1.3. UNDERSTANDING OF SKILL LEVELS ACROSS INDUSTRIES REQUIRES ANALYSIS OF SEVERAL CLASSIFICATION SYSTEMS SINCE NO ONE SKILL DESCRIPTOR EXISTS TO PROVIDE A COMMON LANGUAGE ACROSS SECTORS.

There is no one set of skill descriptors common across the three sectors: secondary education, post-secondary education and the workplace. There is no single way to discuss skills much less a one-to-one connection between workplace "skills" and classes taken in high school.

The challenge in assessing the degree of alignment between high school requirements and success in the workplace and in post-secondary education is to translate these descriptions of applied skills to academic language. Such a translation requires detailed, exacting comparison of core curriculum (assuming that all Arizona high schools teach the exact same core curriculum) to the assessment elements used to determine the WorkKeys® competency level or the determination of O*NET Knowledges and Skills. This level of comparison requires a significant and substantial commitment of time and resources, which is far beyond the scope of this particular study.

The minimum level of education that will be needed to succeed in Arizona's key occupations is at least some post-secondary education. The average educational level across the 70 key occupations is an Associate degree (BLS Level 6).

The median Job Zone rating across the 70 key occupations is a three, meaning that most occupations in this zone require training in vocational schools, related on-the-job experience, or an associate's degree. Some may require a bachelor's degree. Previous work-related skill, knowledge, or experience is required for these occupations.

The profile of key occupations shows that the majority of jobs across industries will require at least a level four of seven levels in all eight of the WorkKeys® skills, with a level five required for Applied Math and Reading for Information.

1.4. ENGLISH, MATH, CUSTOMER SERVICE, AND READING, ACTIVE LISTENING AND CRITICAL THINKING ARE THE MOST FREQUENTLY LISTED KNOWLEDGES AND SKILLS REQUIRED FOR THE SEVENTY (70) KEY OCCUPATIONS INVESTIGATED IN THIS STUDY.

Our analysis shows that the three most frequent knowledges cited for the 70 key occupations are:

- English Language: Knowledge of the structure and content of the English language including the meaning and spelling of words, rules of composition, and grammar

- Mathematics: Knowledge of arithmetic, algebra, geometry, calculus, statistics, and their applications.

- Customer and Personal Service: Knowledge of principles and processes for providing customer and personal service. This includes customer service needs assessment, meeting quality standards for services, and evaluation of customer satisfaction.

The three most frequently cited skills are:

- Reading Comprehension: Understanding written sentences and paragraphs in work related documents.

- Active Listening: Giving full attention to what other people are saying, taking time to understand the points being made, asking questions as appropriate, and not interrupting at inappropriate times.

- Critical Thinking: Using logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions or approaches to problems.

1.5. ROUNDTABLE DISCUSSIONS HELD WITH BUSINESS LEADERS CORROBORATED FINDINGS FROM THE VARIOUS CLASSIFICATION SYSTEMS AND ENHANCED THE UNDERSTANDING OF SPECIFIC INDUSTRY NEEDS.

Roundtable participants highlighted the following issues:

- **Need for skilled workers.** Roundtable participants validated the findings in the Arizona Department of Commerce report on the Construction industry that the hard to fill positions are those that require technical skills. Participants noted that there is a supply of low skill workers, however, once a worker achieves a skilled craft they leave the construction industry for other opportunities.

- **Technical education opportunities are needed at an earlier stage.** Participants noted that many training programs require individuals to be 18 or even 21 years of age. Many believed that is too late, and if students were introduced to the skills and training needed at an early age, more would choose a career in transportation. Participants identified a critical need being vocational/technical education in the high schools that not only gives students the opportunity to gain the skills needed in the

industry, but also raise awareness about the opportunities available when a student graduates from high school. Participants added that these education opportunities allowed students to gain the soft skills, such as team work, that are important when entering the workforce.

- **Teachers and school counselors need to be better connected with the opportunities in the health services industry.** Many participants commented that teachers and counselors need to work with industry leaders on designing a curriculum that prepares students for knowledge and skills needed in the industry. Many noted that much has changed in the industry in the last five to ten years, and they did not believe teachers and counselors are aware of those changes. Examples included how to make labs in science classes more relevant and interesting.

- **High schools need to make students aware of opportunities in the Construction industry**. Participants believe that school counselors and teachers are not making students aware of the opportunities in the industry. Discussion focused on how students are told they can either go to college or "flip burgers." Participants noted that students are not aware of the career opportunities available, with good wages, in the Construction industry because teachers and counselors downplay the opportunities for non-college bound students. Similar to the comments from participants in the construction field, Transportation & Logistics industry participants think high schools are not making students aware of the opportunities in their industry.

- **Transportation & Logistics jobs offer high school graduates an opportunity for jobs that are in demand with good wages.** Several participants commented their industry is in high demand and high schools graduates that have math and reading skills can earn a better wage than in retail. Participants indicated they have job openings, and often must compete with those in the construction business for high school graduates willing to work outside.

- **Applied Math, Science and Reading Comprehension is critical.** Participants expressed concern that students who decided not to go to college do not apply themselves to math and science or reading skills because they are not told of the good jobs available in the Construction industry, for example. Participants believed that applied math and reading comprehension skills are the most important and are lacking from high school graduates. Their message was clear: high schools need to make non-college bound

students aware that if they take math, science and reading classes in high school there is a high demand for them in the Construction industry. Participants were universal in their belief that the current high school graduation requirements are inadequate. Specifically, the math and science requirements needed to be raised. High school seniors should be taking math, and courses that can combine math and science should be available. Several participants noted that math and science courses need to better engage students. Too many students exit out of opportunities in the health service field because math and science courses are not captivating.

- **Remediation is needed for nursing applicants.** Participants noted that many nursing applicants need to take college remediation courses before they are eligible to enter nursing programs.

- **Hard and soft skills are critically needed.** Several participants commented that a work ethic and ability to learn technical skills are the entry requirements for a well paying job for students coming out of high school. Several comments were made about how high school students need better employability skills; that is, awareness of the importance of such things as attendance and timeliness. Communication skills were identified as also extremely important. Participants from the life science industry noted that many of their employers required strong speaking and presentation skills. Vocational education, clubs, and other extra curricular activities need to be available so students can understand the value of having skills that make a good team.

- **The Health Services roundtable participants believed that overall the education level needed in the industry is higher than the national data indicates**. Most expressed that a college education is critical to career readiness in the health services field. In addition, the skill requirements for the key occupations needed to be higher for registered nurses and physician assistants. Participants also indicated nurse practitioners, pharmacy technicians, and phlebotomists were also key occupations.

In order to understand the education and training required for occupations critical to ongoing economic growth in Arizona, it is necessary to first establish some agreement about what those *occupations* are and in what *industries* the occupations are found. The goal of the occupational analysis for the Arizona Alignment Project is to provide a foundation for discussion of the demand for educational attainment levels and the state's ability to graduate students who can meet that demand. The ultimate focus is on the skills needed to fill occupations which are identified as being key to the growth

and health of targeted industry sectors in the state. The creation of a select list of targeted occupations requires careful and thoughtful construction, since the skills represented by the occupations will be used as the point of comparison to the skills of Arizona's high school graduates, and potentially form the foundation of changes in policy.

First, **Public Works** recognizes that Arizona state leaders have identified the state's most promising and most important *industry sectors*, and have funded analyses of six (6) industries to identify key occupations, and educational and training requirements for occupations within those industries. In addition, we reviewed key studies recently completed, received some preliminary data from studies currently being undertaken but not yet published, interviewed key informants, including members of the P-20 Council, conducted business roundtables, and analyzed national and state specific-data for the targeted industries.

This section of the report details the methodology **Public Works** used to arrive at the final list of industries and occupations and provides an analysis of those industries and occupations. Discussions with the Governor's office were important to ensure that both the methodology and the resulting roster of occupations addressed the unique characteristics of each industry sector, as well as addressed the educational attainment and wages that the state wishes to foster as it prepares its citizens for the jobs of the future.

Definitions

Industry: Economic units that are grouped together because they use like processes to produce goods or services. In order to receive its own 4-digit category, an industry must meet a certain level of economic significance based on the number of establishments, number of employees, payroll, value added and value of shipments.

Occupation: Classifications of work based upon work performed, skills, education, training, and credentials

The critical first step in the process involved identifying and defining the list of *targeted industries* from which the occupations would be drawn. **Public Works** was presented with the list of targeted industries that had been developed as part of Arizona's economic strategic plan. These industries have been identified as critical to the ongoing economic development of the state The list consisted of five industry sectors and eight sub-sectors identified as part of High Technology; covering 676 occupations. The industries identified included:

- Construction
- High Technology

    - Aerospace
    - Defense
    - Information Technology
    - Sustainable Systems
    - Semiconductor
    - Advanced Manufacturing
    - Engineering
    - Optics
- Life Science (Health and Bioscience)
- Tourism & Travel
- Transportation & Logistics

In order to identify and analyze *occupations* in Arizona with the potential to help grow and support the targeted *industries*, **Public Works** first needed to define the targeted *industries*, which would then yield a list of *occupations* within each industry. In order to do this, **Public Works** converted the original list of industries into the 4-digit North American Classification System (NAICS) categories. Using this classification system enabled a cross section analysis of industries and avoided any overlap in industry categories to prevent double-counting or overstating the relative significance of any single industry, and thus any occupations within an industry.

The result of the translation from the original list into NAICS categories is a list of eight industry sectors defined for this report. For ease of reference, a crosswalk of industry sectors is presented in Exhibit 1: *Industry Crosswalk* to identify the original industry and where it is addressed in the NAICS categories used for this report.

In other words, Arizona has identified a list of strategic industry sectors. **Public Works**, for the purposes of this report, converted the list into standardized categories so that we could use standardized data to analyze and compare sectors and occupations. Industry definitions and key occupations included in each industry are discussed in greater detail in Section 4: Industry Profiles in this chapter.

Exhibit 1
INDUSTRY CROSSWALK

Original List	NAICS
Construction	Construction
High Technology	Includes the following:
Aerospace	Aerospace
Defense	Aerospace
Information Technology	Advanced Communications & Information Technology
Sustainable Systems	Included across multiple industries:
Semiconductor	Advanced Communications & Information Technology
High Tech Manufacturing	Included across multiple industries:
Engineering	Architecture, Engineering & Related Services
Optics	Advanced Communications & Information Technology
Tourism & Travel	Tourism & Travel
Life Sciences (Health and Bioscience)	Life Sciences (Health Services)
Transportation & Logistics	Transportation

Once this list was finalized, we reviewed Arizona-specific studies available for some industry clusters. These included:

- Arizona Department of Commerce, *Building from a Position of Strength: Arizona Advanced Communications and Information Technology Roadmap*, prepared by the Battelle Technology Partnership Practice, March 2004;

- Arizona Department of Commerce, *A Workforce Needs Assessment of the Arizona Construction Trades Industry*, prepared by ACCRA (Arlington, VA), February 2005;

- Arizona Department of Commerce, *Positioning Arizona for the Next Big Technology Wave: Development and Investment Prospectus to Create a Sustainable Systems Industry in Arizona*, prepared by the Battelle Technology Partnership Practice, March 2004;

- *Arizona Bioscience Workforce Strategy: Preparing for the Future*, Technology Partnership Practice Battelle Memorial Institute, October 2003.

- *Competing with Talent: High Technology Manufacturing's Future in Greater Phoenix,* prepared by the Battelle Technology Partnership Practice, December 2005.

These studies provide comprehensive and thorough analyses of each particular industry covered. It became clear that the challenge for this current investigation was to not duplicate these studies, but to fill in the gaps for industries not covered by recent studies, and also to take a more global look and identify commonalities across industries.

2.1. SPECIAL CONSIDERATION OF HIGH TECHNOLOGY

"High Technology" is a catch-all term that can cover a wide range of activities. Ever since the 1980's, attempts have been made to define what is and is not "High Technology." Because "High Technology" can include everything from wireless telecommunications service to manufacturing computer components, it is too broad to be its own meaningful category. As a result, there is no NAICS category titled "High Technology." In Arizona, and for the scope of this study, "High Technology" is meant to include the eight industries, as shown in Exhibit 1.

Therefore, despite the difference in category labels, **Public Works** has captured information for all the industries identified as strategic to Arizona's ongoing economic development.

3. GENERAL PROFILE OF ARIZONA OCCUPATIONS

It is informative first to look at an analysis of Arizona's statewide Labor Market Information data. Exhibit 2: *High Wage Jobs Training Requirements* shows the training classification rating for the 270,218 high-wage jobs expected to be created in Arizona between 2003 and 2013. For purposes of this more general analysis of all Arizona occupations, high-wage is defined as paying above the median hourly rate of $13.10 per hour, a wage adequate to afford rent across the state. Just over 31.7 percent of the jobs will require no more than a high school education, while 39.9 percent of the jobs will require at least a bachelor's degree.

Exhibit 2
HIGH-WAGE JOBS TRAINING REQUIREMENTS

Training Requirements		High Wage
Code	Description	Percent of Jobs
1	First professional degree	2.6 percent
2	Doctoral degree	1.4 percent
3	Master's degree	3.4 percent
4	Bachelor's or higher degree, plus work experience	9.5 percent
5	Bachelor's degree	22.0 percent
6	Associate degree	9.7 percent
7	Post-secondary vocational training	6.7 percent
8	Work experience in a related occupation (may require some post-secondary education)	13.0 percent
9	Long-term on-the-job training (more than one year)	12.4 percent
10	Moderate-term on-the-job training (between one and twelve months)	17.3 percent
11	Short-term on-the-job training (less than one month)	2.1 percent
	TOTAL	**100.0 percent**

When an analysis of livable wage jobs – jobs which pay at or above the statewide median, which is adequate to afford rent across the state – is compared to a profile of Arizona's population, age 25 and older, it is clear that the educational attainment of Arizona's workforce needs to improve. Of Arizonan's age 25 and older, 26 percent had some post-secondary education but no degree, while only seven percent of Arizona's 'livable wage' job openings created between 2003 and 2013 will require some post-secondary education without any degree (Associates or bachelors). At the same time, 15 percent of Arizonan's age 25 or older had a bachelor's degree, but 38.9 percent of the 'livable wage' jobs in 2013 will require at least this level of educational attainment. There is a significant gap between the supply and the demand of workers adequately educated to fill the jobs that would pay at least the median wage in the state. Most notably, there will be an oversupply of individuals not finishing their degrees and an undersupply of individuals with a bachelor's degree.

Since, in some cases, on-the-job training does not preclude the need for some college, we used the BLS educational attainment clusters to further clarify the educational attainment needed for each occupation. Occupations paying the median required at least a bachelor's degree, for a total of 71.9 percent of openings requiring at least some college. This is compared to the fifty-seven (56.6) percent of the total

population who currently have some college. This means that 43 percent of the population with a high school diploma or less will be competing for twenty-eight (28) percent – just over one-fourth – of the openings that pay enough to afford rent in Arizona.

Any way you look at the data, Arizona is facing an undersupply of workers with post-secondary education.

4. METHODOLOGY FOR CREATING LIST OF KEY OCCUPATIONS

After defining the targeted industries, **Public Works** moved to identify strategic occupations. Arizona has already invested important time and resources to identify the industries that are expected to drive economic growth across the state over the next decades. Therefore, this list of industries became the starting point for identifying the list of demand occupations and the education and training individuals need to succeed in those occupations.

In the end, the purpose was to identify occupations that are increasing – or that Arizona wants to increase – in number in targeted industries, and that are at or above the median wage for that industry. The strategy is to identify occupations that, by having a critical mass, create an extremely attractive labor pool for the state's strategic industries.

This investigation is intended to provide the foundation data to answer the question: What skills are required for entering high wage occupations in targeted industries? Key occupations, therefore, need to be identified in the targeted industries and a database developed to catalogue the educational attainment requirements of the selected occupations. The list of occupations in Arizona's targeted industries was first taken from the Bureau of Labor Statistics matrix of occupations by industry as well as special industry reports prepared for the State. That list was matched against Arizona's Labor Market Information's projections of occupations for 2003-2013, which also included wage information and required education and training levels.

In terms of wage, the minimum threshold for selecting strategic occupations was set so that an individual employed in that occupation was earning a median wage that allowed them to afford to rent a home in Arizona. The list was also derived from the perspective of occupations that could enhance the demand for the industries which Arizona has targeted for development.

The federal government's Bureau of Labor Statistics (BLS) has conducted extensive research into the *occupational* profile of *industries*, i.e., what *occupations* can be found in what *industries* and in what concentrations. In order to develop the *occupational* profile, BLS uses the NAICS definition for each *industry*. Since wage and employment information by occupation, by industry, are already gathered according to

NAICS categories and definitions, the BLS matrix of occupations in each industry is based on NAICS categories.

The next phase required establishing criteria to choose key *occupations* in each *industry sector* for this current analysis. After initial review, it became apparent that each industry sector is unique in terms of total employment, wages, and education skill levels required by that sector's occupations. As a result, while these same elements were used to analyze each sector, each element was set at a different level best suited to that particular sector. For example, the average wage for Transportation was just over $29,000, while the average wage for Architecture and Engineering was just over $46,000. Setting a median wage threshold of $35,000 would have eliminated too many occupations in Transportation & Logistics and skewed the list towards the management tier, while it might not have eliminated enough occupations in the Architecture and Engineering sector.

4.1. REFINING LIST OF OCCUPATIONS FOR INDUSTRY ANALYSIS

Wage, employment, and employment growth information (2003 to 2013) for the initial list of 676 occupations used as the starting point for this study was downloaded from the Arizona Workforce Informer website, the source of Arizona's Labor Market Information. The data for the percent of *occupation* employment for each *industry* in 2002 and in 2012 was then taken from the national Occupational/Industry Matrix. While this is a composite picture from industries across the nation it does provide valuable information regarding the typical profile for a particular industry (for industry categories down to the 4-digit NAICS code level).

Public Works used 13 major data points to define occupations and estimate their potential for growth, and to narrow the original list of over 600 occupations to a manageable set for further study. Five data points were specific to the Arizona business environment and six were data points of national classifications, ratings, requirements and estimates of growth. Two of the data points involve calculations using both national and Arizona-specific data. The data points included:

2003 Estimated Employment (Arizona)

This data is compiled and analyzed by the Arizona Department of Economic Security, Research Administration in cooperation with the U.S. Department of Labor.

2013 Estimated Employment (Arizona)

This data is compiled and analyzed by the Arizona Department of Economic Security, Research Administration in cooperation with the U.S. Department of Labor.

Ten Year Employment Change (Arizona)

Number/Percent – increase in the number of new job openings
Separations – number leaving jobs due to retirement, other reasons
Total Openings – combination of new openings and separations

2003 Occupational Wage Estimates (Arizona)

While wage levels for each occupation are available by percentiles (10 percent, 25 percent and so on), the median wage is what is used most often. Wage information is available for hourly wages and/or for annual wages.

As noted previously, the wage cut-off point is different for each industry analyzed by **Public Works** for this report (Transportation & Logistics, Construction, Architecture & Engineering, Life Sciences – Health and Tourism & Travel). Generally, the threshold is the wage required to afford to own or rent a house in Arizona.

Education Requirements (Arizona/National)

The U.S. Department of Labor's Bureau of Labor Statistics assigned levels of 1 through 11, ranging from short-term On-The-Job Training (level 11) to First Professional Degree or Doctorate (level 1), to describe the education required by a majority of participants in each occupation.

Public Works' occupation analysis focused on those occupations that require obtaining an education and training threshold of at least some post-secondary education, i.e. level 8. (See Exhibit 3 for the full list of 11 levels). These ratings are used by Arizona's Labor Market Information System (Department of Economic Security, Research Administration.

Job Zone (National)

Assigns a rating of one (1 – little or no training; no more than high school diploma) to five (5 – extensive experience and education of bachelor's degree or beyond) to describe the combination of training and education for occupations.

WorkKeys® Skill Level (National)

Percent of Industry Employment by Occupation – 2002 (National)

This information identifies all of the employees in a particular industry, what percent comes from which occupations. For example, in the Construction industry, Carpenters account for 10 percent of all occupations employed in Construction.

Percent of occupation employment for each industry – 2002 (National)

This information provides, by industry, where individuals in each occupation are concentrated. Even though Carpenters account for 10 percent of the employment in Construction, 57 percent of all carpenters work in the Construction industry.

Percent of Industry Employment by Occupation – 2012 (National)

Percent of occupation employment for each industry – 2012 (National)

Estimates of Occupation Demand (Arizona & National)

This information predicts the ratio of total openings in 2013 to total 2003 employment. Total openings include both new jobs and jobs vacated by retiring workers or workers moving to other occupations.

Percent of all new jobs for an industry (Arizona & National)

This information identifies all of the new jobs being created within the defined industry and the percent that fall within a specific occupation.

4.2. SOURCES AND CRITERIA FOR IDENTIFYING TARGET OCCUPATIONS: EDUCATION AND SKILLS INDICATORS

The next challenge was to identify a common language or metric for discussing skills or education needed to succeed in the strategic occupations. While this is a straightforward concept, in fact no such universal language exists that speaks to high school courses, critical occupational skills, and college preparation. In other words, in an effort to answer the question, "In light of the occupations the state wants to grow, what skills are Arizona's high school graduates missing?", there is no single way to discuss skills much less a one-to-one connection between "skills" and classes taken in high school.

This required making some choices as we focused on the best way to present, describe, and categorize the occupations and skills that will be the focal point of discussion when answering the question of how well are high school graduates prepared for the workplace and post-secondary education.

In choosing a descriptor for required educational attainment and skills, we established some basic criteria.

1. The standard must be as universally available as possible, so that it is commonly used, widely accepted, and easy to understand.

2. The standard must be robust, and allow for testing in the "real world."

3. The standard must link the different pieces together as thoroughly as possible. For example, if it lists information by occupation, the occupations are coded according to one of the national databases (O*NET/SOC).

4. The standard must be understood and accepted outside the education community to the greatest extent possible, since the goal is to connect the education and workplace environments.

Public Works used four different descriptors, all of which meet these criteria: O*NET Job Zone, Bureau of Labor Statistics' Education Level, O*NET Knowledges and Skills, and WorkKeys® Skills. These descriptors are discussed in depth in Attachment 3.

5. INDUSTRY PROFILES

The following sections provide additional detail on each of the eight *industries* profiled by **Public Works** for this report. They include:

- Construction
- High Tech
  - Aerospace
  - Advanced Communications & Information Technology
  - Sustainable Systems
  - Architecture, Engineering & Related Services
  - High Tech Manufacturing
- Life Sciences
  - Bioscience
  - Health Services
- Transportation & Logistics
- Tourism & Travel

These industries were chosen as being most indicative of the industries that Arizona wishes to either target for growth or to nurture to assure continued or future growth. For five of these industries – Construction, Architecture, Engineering & Related Services, Health Services, Transportation & Logistics, and Tourism & Travel -- **Public Works** developed an overall industry profile by using the four classification systems described above: O*Net Job Zone, the BLS Educational and Training Levels, O*Net Knowledges and Skills and WorkKeys® for the *occupations* specific to the five targeted *industries.*

This proved to be an interesting and important analysis for when reviewing the next level of detail of occupational analysis, differences are observed from the profile for the state as a whole. This type of analysis showed, for example, that thirty-nine (39) percent of health services jobs require at least an associate's degree, while only two percent of the tourism and travel jobs or five percent of Transportation & Logistics jobs

require more than some vocational training and related work experience. At the same time, the state profile shows that the majority of jobs across industries will require at least a level four (4) of seven levels in all eight of the WorkKeys® skills (with the exception of Writing).

Attachment 4 provides a detailed listing of the final 70 occupations, including employment, wages, demand, Job Zone, BLS Educational Attainment Level and WorkKeys® skill levels.

Table 6: *Industry Summary* provides a summary comparison of all the occupations in each of the six industries profiled in greater detail specifically for this report (The remaining three industries have received significant coverage in previously released reports.)

The 70 occupations in the final list have a combined median wage of $46,938, ranging from $21,476 to $87,446. In terms of total employment growth between 2003 and 2013, across all industry sectors in the state, these occupations will account for 163,508 total openings by 2013. On average, these occupations will require at least an Associate degree.

Table 6
Industry Summary

Industry	Median Wage	Median Educational Attainment	Median Job Zone	Total 2003 Employment	Number of Occupations
Construction	$31,641	9	2	162,130	327
Aerospace	$51,858	7	3	11,677	69
Architecture, Engineering & Related Services	$46,084	6	3	21,140	240
Life Sciences -- Health Services	$33,739	8	3	171,056	293
Tourism & Travel	$17,443	10	N/A	211,876	257
Transportation & Logistics	$29,181	10	1	45,197	249

5.1. CONSTRUCTION

In February 2003, the Arizona Department of Commerce released a study, *A Workforce Needs Assessment of the Arizona Construction Trades Industry*, prepared by ACCRA. The study listed ten construction occupations, and stated that the "Greatest shortage [is] in 'core' skilled construction trades occupations," defined to include Carpenters, Laborers, Painters, Front-line supervisors (Foremen), and Electricians. However, the study went on to state that, according to survey respondents, the greatest *need* was for workers in positions that require experience and training. These include[xxxi]:

- Carpenters
- Concrete finishers
- Electricians
- Foremen
- Heavy equipment operators
- HVAC technicians
- Plumbers

While three of the occupations – carpenters, electricians, foreman – are seen as both "core" and "needed, " four others, viewed as needed by survey respondents – concrete finishers, heavy equipment operators, HVAC technicians, plumbers – are positions that require additional experience and training.

The report diagrams a career lattice, showing how construction occupations fall within four levels of experience and education, ranging from short-term on-the-job training to work experience in a related occupation. The lattice illustrates the various progressive relationships among occupations.

For the purposes of this study, **Public Works** reviewed the study to identify which occupations fall within the top two tiers of the career lattice and which were identified through the survey as being in greatest demand by employers. This resulted in a final list of five occupations:

- Carpenters
- Electricians
- First-line supervisors (Foremen)
- HVAC technicians.
- Plumbers

All five of these occupations earned a median wage of at least $31,641, 16 percent higher than the statewide median wage in 2004 and just slightly below the wage of $32,677 needed to afford rent in Arizona's urban areas.[xxxii]

The growth in demand for the five occupations ranged from 44 percent to 57 percent (total openings in 2013 compared to total employment in 2003).

Attachment 4 under *Construction Occupations* displays Job Zone training classifications and educational attainment comparisons.

5.1.1. Summary of Construction Roundtable

Over 20 industry representatives participated in a three-hour roundtable session conducted in December 2005. The roundtable resulted in the following findings:

Participants commented on and verified national data and its relevance to the industry in Arizona. They concluded:

- Jobs in Construction paid above the state median wage.
- Construction job growth in Arizona required an increase in knowledge, skills and training but did not demand a college degree.
- Skills needed in key occupations to the industry included:
  - **Active Listening** — Giving full attention to what other people are saying, taking time to understand the points being made, asking questions as appropriate, and not interrupting at inappropriate times.
  - **Troubleshooting** — Determining causes of operating errors and deciding what to do about it.
  - **Critical Thinking** — Using logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions or approaches to problems.
  - **Installation** — Installing equipment, machines, wiring, or programs to meet specifications.

The roundtable participants indicated that the education demands and skill levels on a national level were similar to Arizona.

Roundtable participants highlighted the following issues:

5.2. HIGH TECHNOLOGY

5.2.1. Aerospace

Aerospace consists of a single NAICS category – 3364, Aerospace product and parts manufacturing.

Using the national profile of occupations in the Aerospace sector, **Public Works** identified a total of 69 occupations, combining for a median wage of **$51,858** in 2003. The median educational attainment required in Aerospace overall in Arizona is **some post-secondary training (7).** The median **Job Zone** rating (combining experience and education) is **3, Medium Preparation Needed.** In other words, these occupations may require training in vocational schools, related on-the-job experience, or an associate's degree. Some may require a bachelor's degree.

Of the 69 occupations, 50 pay $26,374 or more, a median wage adequate to afford rent across the state.[xxxiii]

Twenty-one (21) Aerospace occupations had a concentration of three percent or higher in 2002. The occupations were ranked in order of employment to identify the top ten. The occupation "All Other Financial Services" was removed from the list since it is not specific to Aerospace and can be found across all industries. The resulting ten occupations with above median salaries, a significant concentration in the industry and which account for a significant portion of industry employment are listed in Attachment under *Aerospace Occupations*. Of these ten, four are found in the list of key occupations in other industries, namely:

- Avionic Technicians (Transportation & Logistics)
- Aircraft Mechanics and Service Technicians (Transportation & Logistics)
- First-Line Supervisors/Managers of Production and Operation (Biosciences)
- Engineering Managers (Architecture, Engineering & Related Services)

These ten occupations accounted for 59 percent of the Aerospace employment in 2003; and they earned a median salary ranging from $30,707 to $87,446.

The demand for the ten occupations ranges from 21 percent to 54 percent (total openings in 2013 compared to total employment in 2003).

5.2.2. Advanced Communications and Information Technology

Information Technology is defined as the development, installation, and implementation of computer systems and applications.[xxxiv] The definition used in the Battelle study commission by the Arizona Department of Commerce – *Building from a Position of Strength: Arizona Advanced Communications and Information Technology*

Roadmap – defines this sector using a list of forty-two 6-digit industries. Thirty-nine of the 42 industries are included in Exhibit 3: *Advanced Communications – Information Technology Categories*.[xxxv] The three that are not included in this analysis represent only a fraction of a NAICS 4-digit category. They are:

333295 Semiconductor Machinery Manufacturing
335921 Fiber Optic Cable Manufacturing
335929 Other Communication and Energy Wire Manufacturing

Exhibit 3
Advanced Communications – Information Technology Categories

NAICS Code	Description
5150	Broadcasting (except for Internet)
5170	Telecommunications (including Wired carriers, Wireless carriers, Telecommunications resellers, Satellite telecommunications, Cable and other program distribution, and Other telecommunications)
5180	Internet service providers, web search portals, and data processing services
5415	Computer Systems Design and Related Services
3341	Computer and Peripheral Equipment Manufacturing
3342	Communications Equipment Manufacturing.
3343	Audio and Video Equipment Manufacturing
3344	Semiconductor and Other Electronic Component Manufacturing
3346	Manufacturing and Reproducing Magnetic and Optical Media
5112	Software Publishers

The Battelle study identified 23 occupations for analysis. The focus of the Battelle study is, however, somewhat different and is not an analysis of occupations. Instead, it is an investigation of the industry sectors and firms which fall under the definition of Advanced Communications and Information Technology. Therefore, **Public Works** conducted additional analyses of the data relevant to the 23 occupations.

For four of the occupations identified in the Battelle study, there is no Arizona-specific employment, growth, or wage data.

In order to identify a final list of ten occupations to prioritize, we sorted the 23 occupations by total openings by 2013. The total IT sector employment for the top ten occupations in 2003 was 19,617. Concentration of these occupations within the IT sector ranged from 20 percent to 54 percent in 2003, expanding to 19 percent to 60 percent by 2013.

The ten occupations gleaned from the Battelle study, with high demand, high growth, and a significant concentration in the industry are cited in Attachment 4 under *Advanced Communications and Information Technology Occupations.*

In terms of education and experience, eight of the ten occupations require at least a Bachelor's degree, one requires an Associate's degree, and one requires a Bachelor's or higher plus work experience. Compared to other sectors, this selection of occupations demands a high level of education. In addition, eight of the ten occupations are in the top two Job Zones.

5.2.3. Sustainable Systems

An April 2003 study by Battelle – *Positioning Arizona and Its Research Universities: Science and Technologies Core Competencies Assessments* – identified Sustainable Systems as an important market niche for Arizona given the state's existing research strengths.

Like IT, Defense, and High Tech, there is no NAICS category, or sub-category titled "Sustainable Systems." However, information is available from the Battelle Technology Partnership Practice, *Positioning Arizona for the Next Big Technology Wave: Development and Investment Prospectus to Create a Sustainable Systems Industry in Arizona* study commissioned by the Arizona Department of Commerce and released in March 2004. Looking at workforce issues, the study concluded that "A key finding was the lack of cross-disciplinary academic programs that would produce trained graduates for a sustainable systems industry. Even in today's market, demand exists for engineers trained in renewable energy, energy efficiency, water management, and environmental remediation; and this trend will grow."[xxxvi] The study recommended that Arizona increase the number of people graduating with degrees in energy, environment, materials, and water engineering.[xxxvii]

The study identifies the following as falling under the umbrella of Sustainable Systems:

- Energy Efficiency and Renewable Energy
- Environmental Services and Equipment (water management)
- Sustainable Manufacturing and Pollution Prevention and Recycling
- Green Construction Materials and High-Value Bio-products
- Sustainable Agriculture
- Sustainable Forest Products

None of these, however, constitutes an industry category or even sub-category. Instead, firms engaged in supporting, creating, and/or maintaining sustainable systems are embedded in more traditional categories of manufacturing and agriculture. Many of

the occupations involved in Sustainable Systems are captured and analyzed in other industry sectors in this report.

So as not to duplicate the work of the Battelle study, which adequately covers Sustainable Systems, this investigation does not identify specific occupations associated with this industry.

5.2.4. Architecture, Engineering and Related Services

All Engineering industries are contained within the single category of **Architectural, Engineering, and Related Services** (5413). Engineering Services alone is a 5-digit category, and therefore cannot be used on its own to evaluate the occupational profile of Engineering as an industry. **Public Works**' has chosen to include the catch-all category of Architectural, Engineering and Related Services because it includes occupations that most likely are a part of Sustainable Systems and Advanced Manufacturing sectors but are not necessarily captured in the 4-digit categories assigned to those sectors. Using this category as an exclusive sector prevents double-counting occupations elsewhere.

NAICS defines this category as including the following:[xxxviii]

Architectural Services

Architectural Services comprises establishments primarily engaged in planning and designing residential, institutional, leisure, commercial, and industrial buildings and structures by applying knowledge of design, construction procedures, zoning regulations, building codes, and building materials.

Engineering Services

Engineering Services comprises establishments primarily engaged in applying physical laws and principles of engineering in the design, development, and utilization of machines, materials, instruments, structures, processes, and systems. The assignments undertaken by these establishments may involve any of the following activities: provision of advice, preparation of feasibility studies, preparation of preliminary and final plans and designs, provision of technical services during the construction or installation phase, inspection and evaluation of engineering projects, and related services.

Drafting Services

Drafting Services comprises establishments primarily engaged in drawing detailed layouts, plans, and illustrations of buildings, structures, systems, or components from engineering and architectural specifications.

Building Inspection Services

This industry comprises establishments primarily engaged in providing building inspection services. These establishments typically evaluate all aspects of the building structure and component systems and prepare a report on the physical condition of the property, generally for buyers or others involved in real estate transactions. Building inspection bureaus and establishments providing home inspection services are included in this industry.

Surveying and Mapping (except Geophysical) Services

This industry comprises establishments primarily engaged in performing surveying and mapping services of the surface of the earth, including the sea floor. These services may include surveying and mapping of areas above or below the surface of the earth, such as the creation of view easements or segregating rights in parcels of land by creating underground utility easements.

Testing Laboratories

This industry comprises establishments primarily engaged in performing physical, chemical, and other analytical testing services, such as acoustics or vibration testing, assaying, biological testing (except medical and veterinary), calibration testing, electrical and electronic testing, geotechnical testing, mechanical testing, nondestructive testing, or thermal testing. The testing may occur in a laboratory or on-site.

Using the national profile of occupations in the Architecture and Engineering sector, **Public Works** identified a total of 240 occupations, combining for a median wage of **$46,084** in 2003. The median educational attainment required in Architecture and Engineering overall in Arizona is an **Associate's degree (6).** The median **Job Zone** rating (combining experience and education) is **3, Medium Preparation Needed.** In other words, these occupations may require training in vocational schools, related on-the-job experience, or an associate's degree. Some may require a bachelor's degree.

Of the 240 occupations, 131 pay $34,060 or more, a median wage 25 percent above Arizona's statewide median wage. At an hourly wage of $16.38, it is an adequate wage to cover rent in an urban area in Arizona.[xxxix]

National data shows that 45 Architecture & Engineering occupations had a concentration of three percent or higher in 2002. Of these, 43 occupations require educational attainment of at least some post-secondary vocational training. When screening for occupations which account for at least two percent of Architecture & Engineering employment and a 33 percent demand, eight occupations remained on the list. The eight occupations with above median salaries, high demand, high growth, a significant concentration in the industry and which account for a significant portion of

industry employment are listed in Attachment 4 under *Architecture, Engineering and Related Services Occupations*.

Of the eight occupations, six are growing at a rate in Arizona that significantly exceeds the growth rate nationally. The two which are growing more slowly are Mechanical Engineers and Electronics Engineers (except computer). **Public Works** chose to retain these two occupations, however, because of their importance to other high technology sectors.

These eight occupations accounted for 38 percent of the Architecture & Engineering employment in 2003; and they earned a median salary ranging from $36,679 to $87,446.

The demand for the eight occupations ranges from 35 percent to 54 percent (total openings in 2013 compared to total employment in 2003).

5.2.5. High Technology Manufacturing

Public Works completed an analysis of the recently released Battelle study, *Competing with Talent: High Technology Manufacturing's Future in Greater Phoenix* (December 2005).

The focus of the report is on technician occupations, namely production, electrical/electronic engineering, manufacturing software/applications, and electromechanical technicians.

The Battelle research included an in-depth analysis of firms and their needs as compared to what Maricopa County Community College District offers in its training and education programs. The report attempts to address the question of where and how technicians will receive the training in the skills considered important by the high technology manufacturing firms.

The researchers found that, "Some overarching themes emerged from these data, including the following:

- *High-tech manufacturing employers almost uniformly require what might be viewed as a basic or "core" set of academic skills from their technicians. Skills such as basic problem solving, reading, arithmetic, logical reasoning, the ability to work in teams, and overall learning skills are almost always required.*

- *The ability to work well in teams is almost universally reported as a higher-priority requirement. It is clear that employers in Greater Phoenix also value workers with critical thinking and problem-*

solving skills and those who can communicate effectively and work together." (pp. xix-xx)

In fact, **Public Works'** analysis using the WorkKeys® skill levels shows that the skill levels for these occupations require at least level 4 proficiency, with the exception of Listening and Writing, which require a level 3. In other words, the skill levels needed for this sector are just one level lower (on a scale of 7) for Applied Math, Reading for Information, Listening, and Writing, when compared to the list of 70 key occupations across industries, despite the fact that, in most cases, these are technician-level occupations.

In addition, the report concluded that, "For high-technology manufacturing to continue to grow and remain competitive as the base of Greater Phoenix's knowledge economy, the various stakeholders—industry, higher education and the community colleges, the K-12 system, and the community—must simultaneously address a range of challenges and opportunities to build and strengthen the talent pipeline." (p. xxii)

The Battelle study provides a detailed list of occupations included in the study. However they use a different system of titles and codes based on the Classification of Instructional Programs (CIP) used by the US Department of Education, rather than the O*NET system used by the US Department of Labor. Therefore, in order to compare High Tech Manufacturing to the other sectors in the Alignment report, **Public Works** translated Battelle's list into O*NET titles. The results are as follows:

The 55 CIP titles used in the Battelle study translate into a list of list of 77 different O*NET occupations. Of those 77, 15 are found on **Public Works'** final list of 70 key occupations. The 15 break out by industry as follows:

- 6 in Advanced Communications and Information Technology
- 4 in Life Sciences - Biosciences
- 3 in Transportation & Logistics
- 1 in Construction
- 1 in Architecture, Engineering & Related Services

In other words, critical High Tech Manufacturing occupations are embedded in the other industries analyzed for this report, and 20 percent are already included in the list of key occupations.

The 15 High Tech Manufacturing occupations included in the list of key occupations are listed in Attachment 4.

The remaining 62 occupations in the Battelle study not included in the final list of 70 key occupations in our study break down as follows:

- Seven occupations do not appear in Arizona's Labor Market Information list of occupations, projections and wages for 2003-2013

even though the first two especially are prominent in the Battelle study, namely,

- Electrical and Electronic Engineering Technicians (17-3023)
- Engineering Technicians, Except Drafters, All Other (17-3029)

The other five occupations are:

- Coil Winders, Tapers, and Finishers
- Textile Winding, Twisting, and Drawing Out Machine Setters, Operators, and Tenders
- Semiconductor Processors
- Refractory Materials Repairers, Except Brickmasons
- Logisticians

- Eleven occupations pay below $12.38 per hour, the minimum wage used that targets a person's ability to afford rent across the state.

- Thirty-three occupations pay above $12.38 per hour, can be found in Arizona's LMI data and are not already included in the list of 70 key occupations.

Public Works' list of occupations used to construct a High Tech Manufacturing industry analysis comparable to the other analyses in this report encompasses all the occupations used in the Battelle study for which there is data (i.e., 70 total), including those paying below a 'livable' wage and those already included in our list of 70 key occupations. For this sector, we found that the median educational attainment is **some post-secondary vocational training (7)**, and the median Job Zone rating of 3 means that most occupations in this zone require **training in vocational schools, related on-the-job experience, or an associate's degree. Some may require a bachelor's degree.**

The median wage for this sector of **just below $37,000** is the second highest median wage of all the sectors analyzed for this report, and is well above the statewide median wage of just over $27,000.

Total 2003 employment of 165,000 across all industries accounts for 7 percent of employment in Arizona in 2003, while the increase in demand (new jobs plus openings created from retirements) for these occupations averages 42 percent for the 2003 to 2013 timeframe.

5.3. LIFE SCIENCES

5.3.1. Biosciences

The Battelle study on Arizona's Bioscience workforce strategy explains its purpose as follows: "This detailed strategic assessment of Arizona's position in

bioscience workforce development offers tangible strategies and actions based on an integrated analysis of demand and supply factors and informed by best practices found in other states."[xl]

The study methodology included:

- Assessing the demand for bioscience workers in Arizona – including survey, data analysis, interviews and focus groups.
- Inventorying educational activities
- Preparing a situational analysis – SWOT assessment of Arizona regarding bioscience workforce development.
- Conducting a best practice and benchmarking analysis.
- Developing a strategic framework and initiatives for Arizona to develop a demand-driven bioscience workforce system.

The 12 occupations identified in the Battelle study on Arizona's bioscience workforce are[xli]:

- Biomedical Engineers
- Electro-Mechanical Technicians
- Environmental Engineering Technicians
- Industrial Engineering Technicians
- Mechanical Engineering Technicians
- Biochemists & Biophysicists
- Biological Technicians
- Medical Scientists, Except Epidemiologists
- Medical & Clinical Laboratory Technologists
- Assemblers & Fabricators, All Other
- Medical & Clinical Laboratory Technicians
- First-Line Supervisors/Managers of Production & Operating

Total employment across all industry sectors for these occupations in 2003 was 22,993, with projected employment in 2013 to be 29,127. When the number of new jobs is combined with openings created by retirements or individuals leaving the occupations, the total number of openings will grow by 11,489, an increase in demand of 50 percent.

One of the recommendations made by the study's author is to "focus on developing industry-driven skill standards translated into core curricula to ensure comprehensive, high-quality, and responsive program efforts."[xlii] The study recommended that the first two primary skill development areas should be:

1. Laboratory sciences spanning health care and research lab environments; and

2. Biomedical production involving line production through quality assurance and regulatory compliance.

According to the study, biomedical engineers and medical and clinical laboratory technicians "stand out as key occupational specializations for Arizona compared with the nation…".[xliii]

5.3.2. Health Services

Bioscience occupations are identified through the Battelle study;[xliv] therefore, it is not necessary to include a separate analysis of the Life Science Research and Manufacturing industry sectors in this report.

To create a complete view of the life sciences in Arizona, however, as they relate to health services, **Public Works** included the following categories:

NAICS Code	Description
6211	Offices of physicians
6212	Offices of dentists
6213	Offices of other health practitioners
6214	Outpatient care centers
6215	Medical and diagnostic laboratories
6216	Home health care services
6219	Other ambulatory health care services
6220	Hospitals, private
6231	Nursing care facilities
6232	Residential mental retardation, mental health and substance abuse facilities
6233	Community care facilities for the elderly
6239	Other residential care facilities

Using the national profile of occupations in these sectors, **Public Works** identified a total of 293 occupations, with a median wage of **$33,739** in 2003. The median educational attainment required in Health Services overall in Arizona is **moderate on-the-job training (8).** The median Job Zone rating (combining experience and education) is **3, Medium Preparation Needed.** In other words, these occupations may require training in vocational schools, related on-the-job experience, or an associate's degree. Some may require a bachelor's degree.

Of the 293 occupations, 235 pay $27,248 or more which is the statewide median wage across all occupations. The wage was set at this level to capture a wide range of health services occupations, not only doctors and nurses. At an hourly wage of $13.10, this wage is still adequate to cover rent at the state level in Arizona.[xlv]

National data shows that 33 Health Services occupations had a concentration of 3 percent or higher in 2002. Of those, only 14 occupations require educational attainment of moderate on-the-job training. When looking for occupations that account for at least one percent of Health Services employment, and are growing at a rate in Arizona that significantly exceeds the growth rate nationally, seven occupations remain.

These seven occupations accounted for 26 percent of Health Services employment in 2003; and they earned a median wage ranging from $27,651 to $61,014.

The demand for the seven occupations ranges from 61 percent to 94 percent (total openings in 2013 compared to total employment in 2003), which represents the highest rate of demand of all the sectors analyzed.

The seven occupations with above median salaries, high demand, high growth, a significant concentration in the industry and which account for a significant portion of industry employment are shown in Attachment 4 under *Health Services Occupations*.

5.3.3. Summary of Health Services Roundtable

Over 20 participants representing various aspects of the health services industry attended a three-hour roundtable session in December 2005.

Participants commented on and verified national data and its relevance to the industry in Arizona. They concluded:

- Jobs in Health Services paid above the state median wage.
- Health Services job growth in Arizona required 2 years of college education and work experience or a college degree.

Skills needed in key occupations to the industry included:

- **Active Listening** — Giving full attention to what other people are saying, taking time to understand the points being made, asking questions as appropriate, and not interrupting at inappropriate times.
- **Reading Comprehension** — Understanding written sentences and paragraphs in work related documents.

- **Critical Thinking** — Using logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions or approaches to problems.

- **Speaking** — Talking to others to convey information effectively.

- **Time Management** — Managing one's own time and the time of others.

The roundtable participants believed that overall the education level needed in the industry is higher than the national data indicates. Though not specific about the level of college education, most expressed that a college education is critical to career readiness in the health services field. In addition, the skill requirements for the key occupations needed to be higher for registered nurses and physician assistants. Participants also indicated nurse practitioners, pharmacy technicians, and phlebotomists were also key occupations.

Other issues raised by participants included:

- **Remediation is needed for nursing applicants.** Participants noted that many nursing applicants need to take college remediation courses before they are eligible to enter nursing programs.

- **High school graduation requirements, especially in math and science are inadequate.** Participants were universal in their belief that the current high school graduation requirements are inadequate. Specifically, the math and science requirements needed to be raised. High school seniors should be taking math, and courses that can combine math and science should be available.

- **Math and science courses need to be more rigorous and relevant.** Several participants noted that math and science courses need to better engage students. Too many students exit out of opportunities in the health service field because math and science courses are not captivating.

- **Teachers and school counselors need to be better connected with the opportunities in the health services industry.** Many participants commented that teachers and counselors need to work with industry leaders on designing a curriculum that prepares students for knowledge and skills needed in the industry. Many noted that much has changed in the industry in the last five to ten years, and they did not believe teachers and counselors are aware

of those changes. Examples included how to make labs in science classes more relevant and interesting.

- **Hard and soft skills are needed.** Having strong math and reading skills is important in the health services industry. However, communication and time management skills were identified as also extremely important. Participants from the life science industry noted that many of their employers required strong speaking and presentation skills.

5.4. TOURISM & TRAVEL

To create a complete view of the tourism and travel industry in Arizona, **Public Works** included the following categories:

NAICS Code	Description
4853	Taxi and limousine service
4870	Scenic and sightseeing transportation
7130	Amusement, gambling, and recreation industries
7120	Museums, historical sites, and similar institutions
7200	Accommodation and food services.

Using the national profile of occupations in these sectors, **Public Works** identified a total of 257 occupations, with a median wage of **$17,443** in 2003. The median educational attainment required in Tourism & Travel overall in Arizona is **moderate on-the-job training (10).** There were not enough Tourism & Travel occupations assigned a Job Zone rating (combining experience and education) to draw valid conclusions regarding a median rating of combined experience and education.

National data shows that 93 Tourism & Travel occupations had a concentration of three percent or higher in 2002. Of those, 35 pay $25,750 or more which, at an hourly rate of $12.38 is the minimum wage required to afford rent in Arizona. The wage was set at this level to capture a wide range of Tourism & Travel occupations.[xlvi]

Of those, 23 occupations require educational attainment of some work experience in a related occupation (Level 8). Of those 23, only 15 employed 150 or more workers in 2003.

These 15 occupations accounted for 33 percent of Tourism & Travel employment in 2003; and they earned a median wage ranging from $26,215 to $71,114.

The demand for the 15 occupations ranges from 19 percent to 57 percent (total openings in 2013 compared to total employment in 2003).

The 15 occupations with above median salaries, high demand, high growth, a significant concentration in the industry and which account for a significant portion of industry employment are shown in Attachment 4 under *Tourism & Travel Occupations*.

The *Arizona Tourism Workforce Assessment Initiative*, completed July 2005, found that the skills gap for Tourism & Travel occupations, as assessed through the series of forums conducted for the study include:[xlvii]

- Workplace readiness – attitude, dress, work ethic, discipline, ability to work with others
- Technology literacy
- Knowing about local attractions and communicating them
- Customer service.

With regards to customer service, Public Works found that it appeared in the skills list for the 18 key Tourism & Travel occupations 14 times.

5.5. TRANSPORTATION & LOGISTICS

Transportation & Logistics, for the purposes of this study, includes 12 categories.

NAICS Code	Description
4811	Scheduled air transportation
4812	Nonscheduled air transportation
4821	Rail transportation
4841	General freight trucking
4842	Specialized freight trucking
4855	Charter bus industry
4881	Support activities for air transportation
4884	Support activities for road transportation
4885	Freight transportation arrangement
4921	Couriers
4931	Warehousing and storage
4851	Urban transit systems

Not included are categories relating to water-based transportation or pipeline transportation. Sightseeing transportation, as well as taxis and limos are included under the Tourism & Travel sector.

Using the national profile of occupations in these transportation sectors, **Public Works** identified a total of 277 occupations. Combined, the Transportation & Logistics occupations median wage in Arizona was **$29,181** in 2003. This is probably due in significant part because the median educational attainment required in the Transportation & Logistics industry overall in Arizona is **moderate on-the-job training (8)**. The median Job Zone rating (combining experience and education) is **1, Little or No Preparation Needed.** In other words, these occupations may require a high school diploma or GED certificate. Some may require a formal training course to obtain a license, however, on average no previous work-related skill, knowledge, or experience is needed.

Of the 277 occupations, national data shows that 40 had a concentration of three percent or higher in Transportation & Logistics. Of those 40, eight occupations required at least work experience in a related occupation, or more than long-term on-the-job experience but less than post-secondary vocational training. These eight occupations accounted for 9.5 percent of the Transportation & Logistics employment in 2003; and they earned a median salary ranging from $33,781 to $56,976.

The demand for the eight occupations ranged from 36 percent to 54 percent (total openings in 2013 compared to total employment in 2003).

The eight occupations with above median salaries, high demand, high growth, a significant concentration in the industry and which account for a significant portion of industry employment are identified in Attachment 4 under *Transportation & Logistics Occupations*.

5.5.1. Summary of Transportation & Logistics Roundtable

Over 20 Transportation & Logistics industry participants (primarily from transportation construction) attended a one-hour roundtable session held in December 2005. The roundtable resulted in the following findings:

Participants commented on and verified national data and its relevance to the industry in Arizona. They concluded:

- Jobs in Transportation & Logistics paid above the state median wage.
- Transportation & Logistics job growth in Arizona required increased knowledge in skills and training but did not demand a college degree.

Skills needed in key occupations to the industry included:

- **Equipment Maintenance** — Performing routine maintenance on equipment and determining when and what kind of maintenance is needed.

- **Troubleshooting** — Determining causes of operating errors and deciding what to do about it.

- **Repairing** — Repairing machines or systems using the needed tools.

- **Equipment Selection** — Determining the kind of tools and equipment needed to do a job.

The roundtables participants indicated that the education demands and skill levels on a national level were similar to Arizona.

Issues discussed included:

- **Transportation & Logistics jobs offer high school graduates an opportunity for jobs that are in demand with good wages.** Several participants commented their industry is in high demand and high schools graduates that have math and reading skills can earn a better wage than in retail. Participants indicated they have job openings, and often must compete with those in the construction business for high school graduates willing to work outside.

- **Work skills and training critical for career opportunities.** Several participants commented that a work ethic and ability to learn technical skills are the entry requirements for a well paying job for students coming out of high school.

- **High schools need to make students aware of the opportunities in the industry.** Similar to the comments from participants in the construction field, Transportation & Logistics industry participants think high schools are not making students aware of the opportunities in their industry.

- **Technical education opportunities are needed at an earlier stage.** Participants noted that many training programs require individuals to be 18 or even 21 years of age. Many believed that is too late, and if students were introduced to the skills and training needed at an early age, more would choose a career in transportation.

SECTION III. CONCLUSION

Aligning high schools to college and career readiness is a challenge for many states. Arizona is not unique in that regard; however the circumstances facing Arizona's need for an aligned system is different, largely driven by the current and projected job growth facing the State. Arizona has consistently ranked among the top five states in job creation for the last several years. Many states are working to create a business environment that will bring job growth to a level that Arizona is currently experiencing. At the same time, Arizona's challenge is to create an environment to sustain current job growth and to ensure those jobs are good paying jobs.

High schools play a critical role in preparing a workforce to meet the anticipated job market. If a workforce is not educated and trained for current jobs, as well as anticipated job growth, Arizona businesses will either import skilled workers from outside the State or look to expand or locate elsewhere. In assessing this key element, this report leads to the most central conclusion:

Arizona's secondary system in not well aligned with the requirements for post-secondary study and the workplace.

We believe it is important that members of the P-20 council act with a sense of urgency as the alignment issues will only become greater as the education and skill levels become even more demanding in future years.

1. SUMMARY OF MAJOR FINDINGS

College readiness needs to be the minimum requirement for high school graduates. While every high school student will not go on to college, every high school student who wants a high wage/high demand occupation will need some post-secondary coursework.

Arizona high school graduates need to be prepared for both college and career. The labor market for high wage occupations requires both post-secondary education and work experience. High school students can no longer be differentiated between college bound and non-college bound. All high school students need to be both college and career ready.

High school rigor in applied math and reading comprehension is critical. The skills and knowledge needed for career preparation require the ability to apply mathematical formulas and problem-solving techniques to work related problems and the ability to understand the meaning and purpose of written text.

Relevance in high school is critical. High schools need to be better connected with the skills needed in growing industries and aware of the career opportunities available by pursuing post-secondary coursework.

Insufficient data can hinder efforts to improve high school, postsecondary and workforce alignment. Data driven decision-making is critical to designing programs that effectively link high schools to postsecondary and career preparedness. Greater emphasis is needed on identifying the common measures and metrics needed to better evaluate the degree of alignment gaps that exist within Arizona's high schools.

2. SUMMARY OF MAJOR GAPS

Graduation requirements are insufficient. The state graduation requirements for high school are insufficient in preparing students for college and career. Math and science requirements are particularly inadequate.

There is a lack of identified college/career course curriculum. No specific high school course curriculum has been identified for students, parents, and teachers as to the scope and sequence of courses needed during high school to start college or be prepared for a career that pays good wages.

AIMS testing is not aligned to college or career readiness. The AIMS test is insufficient in providing rigor or relevance to quantify a student's readiness for college or career readiness. AIMS was not designed as a college or career ready assessment but rather a 10th grade proficiency assessment. Therefore, Arizona does not have a standard assessment tool aligned to college and career readiness.

Data gaps prevent Arizona from pinpointing alignment gaps. Arizona is by no means unique in lacking data to identify specific gaps regarding high school alignment. The biggest challenge is linking a common language and metric that identifies the skills needed across secondary, post-secondary and workplace sectors. In addition, data does not exist to identify the level of remediation occurring by college or university, nor does data exist on which high schools are sending students onto college that need remediation.

3. NEXT STEPS

This report was not intended to make recommendations for how to design a better aligned system. It does, however, attempt to identify findings to describe the status of the current system and to assist policy makers to identify the next steps needed to achieve the goal of alignment. Our conclusion is that Arizona policymakers need to raise the graduation requirements, identify a college/career ready course curriculum, and re-examine the purpose and intent of the AIMS test at the high school level.

ATTACHMENT 1: ARIZONA, ADP AND SUCCESS FOR ALL ALGEBRA STANDARDS EXAMPLES COMPARED

From the Arizona State Mathematics Standards:

Strand 3: Patterns, Algebra, and Functions

Every student should understand and use all concepts and skills from the previous grade levels. The standards are designed so that new learning builds on preceding skills and are needed to learn new skills. Communication, Problem-solving, Reasoning & Proof, Connections, and Representation are the process standards that are embedded throughout the teaching and learning of mathematical strands.

Concept 1: Patterns Identify patterns and apply pattern recognition to reason mathematically.
PO 1. Communicate a grade-level appropriate iterative or recursive pattern, using symbols or numbers. PO 2. Find the n^{th} term of an iterative or recursive pattern. PO 3. Evaluate problems using basic recursion formulas.

Concept 2: Functions and Relationships Describe and model functions and their relationships.
PO 1. Determine if a relationship is a function, given a graph, table, or set of ordered pairs. PO 2. Describe a contextual situation that is depicted by a given graph. PO 3. Identify a graph that models a given real-world situation. PO 4. Sketch a graph that models a given contextual situation. PO 5. Determine domain and range for a function. PO 6. Determine the solution to a contextual maximum/minimum problem, given the graphical representation. PO 7. Express the relationship between two variables using tables/matrices, equations, or graphs. PO 8. Interpret the relationship between data suggested by tables/matrices, equations, or graphs. PO 9. Determine from two linear equations whether the lines are parallel, perpendicular, coincident, or intersecting but not perpendicular.

Concept 3: Algebraic Representations
Represent and analyze mathematical situations and structures using algebraic representations.
PO 1. Evaluate algebraic expressions, including absolute value and square roots. PO 2. Simplify algebraic expressions. PO 3. Multiply and divide monomial expressions with integral exponents. PO 4. Translate a written expression or sentence into a mathematical expression or sentence. PO 5. Translate a sentence written in context into an algebraic equation involving multiple operations. PO 6. Write a linear equation for a table of values. PO 7. Write a linear algebraic sentence that represents a data set that models a contextual situation. PO 8. Solve linear (first degree) equations in one variable (may include absolute value). PO 9. Solve linear inequalities in one variable. PO 10. Write an equation of the line given: two points on the line, the slope and a point on the line, or the graph of the line. PO 11. Solve an algebraic proportion. PO 12. Solve systems of linear equations in two variables (integral coefficients and rational solutions). PO 13. Add, subtract, and perform scalar multiplication with matrices. PO 14. Calculate powers and roots of real numbers, both rational and irrational, using technology when appropriate. PO 15. Simplify square roots and cube roots with monomial radicands (including those with variables) that are perfect squares or perfect cubes. PO 16. Solve square root radical equations involving only one radical. PO 17. Solve quadratic equations. PO 18. Identify the sine, cosine, and tangent ratios of the acute angles of a right triangle.

Concept 4: Analysis of Change
Analyze change in a variable over time and in various contexts.
PO 1. Determine slope, x-, and y-intercepts of a linear equation. PO 2. Solve formulas for specified variables.

Benchmark for Algebra, American Diploma Project:

J. Algebra
Because major areas of study at post-secondary institutions have different prerequisites, certain mathematics benchmarks are marked with an asterisk (*). These asterisked benchmarks represent content that is recommended for all students, but is required for those students who plan to take calculus in college, a requisite for mathematics and many mathematics-intensive majors.

The high school graduate can:

J1. Perform basic operations on algebraic expressions fluently and accurately:

J1.1. Understand the properties of integer exponents and roots and apply these properties to simplify algebraic expressions.

Example:

Simplify the expression $\left(\frac{a}{b}\right)^m \cdot c^{2m}$ to obtain either $\frac{(ac^2)^m}{b^m}$ or $\left(\frac{ac^2}{b}\right)^m$.

J1.2. * Understand the properties of rational exponents and apply these properties to simplify algebraic expressions.

Example: Explain why $\sqrt[3]{x^2} \cdot \sqrt{x} = x^{\frac{2}{3}} \cdot x^{\frac{1}{2}} = x^{\frac{7}{6}} = \sqrt[6]{x^7} = x\sqrt[6]{x}$ for any non-negative number *x.*

J1.3. Add, subtract and multiply polynomials; divide a polynomial by a low-degree polynomial.

Example: Divide $x^3 - 8$ by $x - 2$ to obtain $x^2 + 2x + 4$;

divide $x^4 - 5x^3 - 2x$ by x^2 to obtain $x^2 - 5x - \frac{2}{x}$.

Example: Divide $x^3 - x^2 + x - 2$ by $x^2 + 1$ to obtain $x - 1 + \frac{-1}{x^2+1}$ and understand that also means that $(x^2 + 1)(x - 1) - 1 = x^3 - x^2 + x - 2$.

J1.4. Factor polynomials by removing the greatest common factor; factor quadratic polynomials.

Example: Remove the greatest common factor $3x^3y$ from $12x^3y^2 + 9x^4y + 6x^5y^3$ to obtain the factorization $3x^3y(4y + 3x + 2x^2y^2)$.

Example: Factor $x^2 - 36$, $4x^2 + 12xy + 9y^2$ and $x^2 - 5x - 6$ to obtain $(x + 6)(x - 6)$, $(2x + 3y)^2$ and $(x - 6)(x + 1)$ respectively.

J1.5. Add, subtract, multiply, divide and simplify rational expressions.
(Associated Workplace Task: #1)
(Associated Post-secondary Assignments: #1 and 2)

Example: Express $\frac{1}{x} + \frac{1}{y}$ as a single fraction to obtain $\frac{x+y}{xy}$.

Example: Simplify $\frac{a^2 - b^2}{2b} \cdot \frac{6ab}{a+b}$ to obtain $3a(a - b)$.

J1.6. Evaluate polynomial and rational expressions and expressions containing radicals and absolute values at specified values of their variables.

J1.7. * Derive and use the formulas for the general term and summation of finite arithmetic and geometric series; find the sum of an infinite geometric series whose common ratio, *r,* is in the interval (-1, 1).

Example: Derive the formula for the sum *S* of the first *N* terms of a geometric series whose first term is 1 and common ratio is *r* to obtain $S = 1 + r + r^2 + r^3 + \ldots + r^{N-1} = \frac{1 - r^N}{1 - r}$.

Example: Determine the 126th term of the arithmetic sequence whose third term is 5 and seventh term is 29.

J2. Understand functions, their representations and their properties:

J2.1. Recognize whether a relationship given in symbolic or graphical form is a function.

J2.2. * Determine the domain of a function represented in either symbolic or graphical form.

Example: Determine that the domain of the function $f(x) = \sqrt{x - 2}$ can be written in interval form as $[2, \infty)$ and the domain of the function $g(x) = \frac{1}{x^2 - 9}$ contains all real numbers except 3 and -3.

J2.3. Understand functional notation and evaluate a function at a specified point in its domain. (Associated Post-secondary Assignment: #1)

J2.4. * Combine functions by composition, as well as by addition, subtraction, multiplication and division.

J2.5. * Identify whether a function has an inverse and when functions are inverses of each other; explain why the graph of a function and its inverse are reflections of one another over the line *y = x.*

J2.6. * Know that the inverse of an exponential function is a logarithm, prove basic properties of a logarithm using properties of its inverse and apply those properties to solve problems.

J3. Apply basic algebraic operations to solve equations and inequalities:

J3.1. Solve linear equations and inequalities in one variable including those involving the absolute value of a linear function.

Example: The length *L* of a spring in centimeters is given by $L = \frac{4}{7}F + 9$, where *F* is the applied force in dynes. What force *F* will produce a spring length of 14 centimeters?

Example: A pipe is to be cut to a length of 5 meters accurate to within a tenth of a centimeter. Recognize that an acceptable length x (in meters) of the pipe satisfies the inequality $|x - 5| \leq 0.001$.

J3.2. Solve an equation involving several variables for one variable in terms of the others. (Associated Post-secondary Assignment: #2)

Example: If *C* represents the temperature in degrees Celsius and *F* represents the temperature in degrees Fahrenheit, then $C = \frac{5}{9}(F - 32)$. Solve this equation for F to obtain $F = \frac{9}{5}C + 32$.

Example: Newton's law of gravitation says that the force F exerted by a body of mass *m* on a body of mass M is $F = \frac{GmM}{r^2}$, where *G* is the gravitational constant and r is the distance between the bodies. Solve this equation for r to obtain $r = \sqrt{\frac{GmM}{F}}$.

J3.3. Solve systems of two linear equations in two variables.

J3.4. * Solve systems of three linear equations in three variables.
(Associated Post-secondary Assignment: #1)

J3.5. Solve quadratic equations in one variable.
(Associated Post-secondary Assignment: #1)

Example: Solve $x^2 - x - 6 = 0$ by recognizing that $x^2 - x - 6 = (x - 3)(x + 2)$ can be factored to obtain the two solutions $x = 3$ and $x = -2$.

Example: Solve $x^2 + 4x + 2 = 0$ by using the quadratic formula or by completing the square.

J4. Graph a variety of equations and inequalities in two variables, demonstrate understanding of the relationships between the algebraic properties of an equation and the geometric properties of its graph, and interpret a graph:

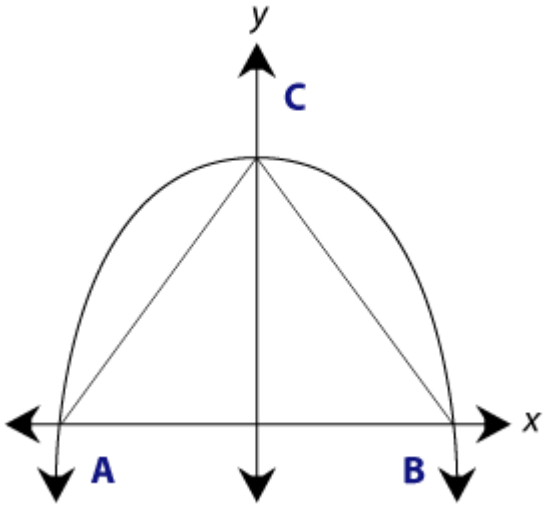
J4.1. Graph a linear equation and demonstrate that it has a constant rate of change.
(Associated Post-secondary Assignment: #1)

J4.2. Understand the relationship between the coefficients of a linear equation and the slope and x- and y-intercepts of its graph.
(Associated Post-secondary Assignment: #3)
J4.3. Understand the relationship between a solution of a system of two linear equations in two variables and the graphs of the corresponding lines.

J4.4. Graph the solution set of a linear inequality and identify whether the solution set is an open or a closed half-plane; graph the solution set of a system of two or three linear inequalities.

Example: Graph the solution set of the system of linear inequalities:
$2x + y \leq 4$
$x \geq 1$.

J4.5. Graph a quadratic function and understand the relationship between its real zeros and the x-intercepts of its graph. (Associated Post-secondary Assignment: #1)
Example: The parabola shown below has equation $y = -x^2 + 2$ and passes through the points A, B and C. What is the area of the triangle ABC, rounded to two decimal places?



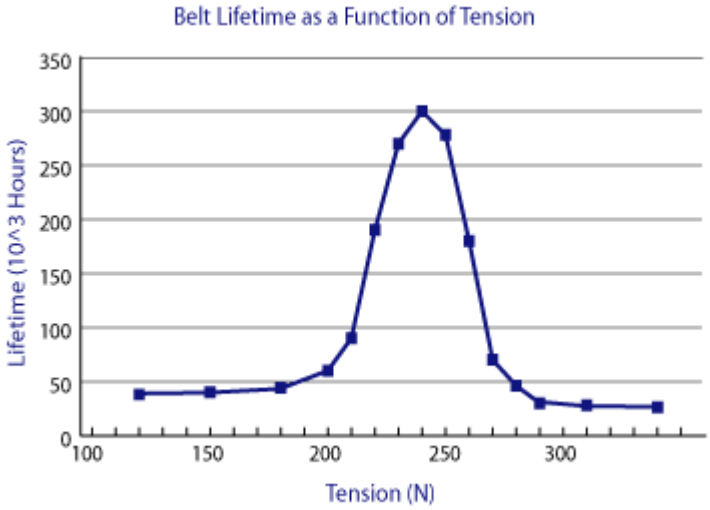
J4.6. * Graph ellipses and hyperbolas whose axes are parallel to the *x* and *y* axes and demonstrate understanding of the relationship between their standard algebraic form and their graphical characteristics.

J.4.7. Graph exponential functions and identify their key characteristics.

Example: Graph the exponential function $y(x) = 2^x$. Recognize that *y*(*x*+1) is twice as large as *y*(*x*) since $y(x+1) = 2^{x+1} = 2 \cdot 2^x = 2 \cdot y(x)$.

Example: How much money must be invested at 6 percent annual interest if you want to have $40,000 in 20 years?

J4.8. Read information and draw conclusions from graphs; identify properties of a graph that provide useful information about the original problem. (Associated Post-secondary Assignment: #3)
Example: The lifetime of the timing belt in your car depends on the tensioning of the belt. The manufacturer specifies 240 N as the proper tension, but the mechanic working on your car can be off by as much as 10 percent. Use the following graph to estimate the reduction in the life of the belt that can occur with this error in tensioning.



J5. Solve problems by converting the verbal information given into an appropriate mathematical model involving equations or systems of equations; apply appropriate mathematical techniques to analyze these mathematical models; and interpret the solution obtained in written form using appropriate units of measurement:

J5.1. Recognize and solve problems that can be modeled using a linear equation in one variable, such as time/rate/distance problems, percentage increase or decrease problems, and ratio and proportion problems. (Associated Workplace Tasks: #1 and 2)
(Associated Post-secondary Assignment: #2)

J5.2. Recognize and solve problems that can be modeled using a system of two equations in two variables, such as mixture problems.
(Associated Post-secondary Assignment: #2)

Example: A chemist has available two solutions of acid. The first solution contains 12 percent acid, and the second solution contains 20 percent acid. He wants to mix the two solutions to obtain a 500-milliliter mixture containing 15 percent acid. How many milliliters of each solution should he mix?

J5.3. Recognize and solve problems that can be modeled using a quadratic equation, such as the motion of an object under the force of gravity. (Associated Post-secondary Assignment: #1)
Example: A stone is dropped off a cliff 660 feet above ground. When will the stone hit the ground if its height in feet at time t seconds after it is dropped is given by $h(t) = 660 - 16 \cdot t^2$?

J5.4. Recognize and solve problems that can be modeled using an exponential function, such as compound interest problems.

J5.5. * Recognize and solve problems that can be modeled using an exponential function but whose solution requires facility with logarithms, such as exponential growth and decay problems. (Associated Post-secondary Assignments: #1 and 2)
Example: How long will it take the balance in your savings account to double if you earn 1.5 percent compounded annually?

J5.6. Recognize and solve problems that can be modeled using a finite geometric series, such as home mortgage problems and other compound interest problems. (Associated Workplace Task: #3)
(Associated Post-secondary Assignment: #1)
Example: How much money will you have in a retirement fund if you deposit $1,000 each year for 20 years and the interest rate remains constant at 4 percent?

J6. * Understand the binomial theorem and its connections to combinatorics, Pascal's triangle and probability.

From Standards for Success:

Algebra (1 of 6 strands of the mathematics standards)

A. Successful students know and apply basic algebraic concepts. They:
A.1. use the distributive property to multiply polynomials.
A.2. know how to compose and decompose functions and how to find inverses of basic functions.
A.3. simplify and perform basic operations on rational expressions, including finding common denominators (e.g., add, subtract, multiply and divide).
A.4. understand exponents, roots and their properties [e.g., (x2)(x3)=x5 and (√x)3 = x3/2)]. Mathematics 33
A.5. know basic theorems of exponents and roots.
A.6.* understand logarithms (to bases 2, 10 and e) and their properties.
A.7.* divide low degree polynomials (e.g., long division).
A.8.* know basic theorems of logarithms.
A.9.* factor polynomials (e.g., difference of squares, perfect square trinomials, difference of two cubes and trinomials such as x2 + 3x + 2).

B. Successful students use various appropriate techniques to solve basic equations and inequalities. They:
B.1. solve linear equations and absolute value equations. B.2. solve linear inequalities and absolute value inequalities.
B.3. solve systems of linear equations and inequalities using algebraic and graphical methods (e.g., substitution, elimination, addition and graphing).
B.4. solve quadratic equations using various appropriate methods while recognizing real solutions. This includes: B.4a. factoring. B.4b. completing the square. B.4c. the quadratic formula.

C. Successful students distinguish between and among expressions, formulas, equations and functions. They:
C.1. know when it is possible to simplify, solve, substitute or evaluate equations and expressions and when it is not possible. For example, expand, but do not solve, the expression (x+3)(x+1); substitute a = 3, b =4 into the formula a2 + b2 = c2; solve the equation 0 = (x+3)(x+1); or evaluate the function f(x) = (x+3)(x+1) at x = -1.
C.2. understand that the concept of a function has a specific definition beyond being a type of algebraic expression.
C.3. represent functions, patterns and relationships in different ways (e.g., statements, formulas and graphs).
C.4. understand the algebraic language and notation for functions (e.g., domain and range).
C.5. understand a variety of functions (e.g., polynomial, rational, exponential, logarithmic and trigonometric) and properties of each.

D. Successful students understand the relationship between equations and graphs. They:
D.1. understand basic forms of the equation of a straight line and how to graph the line without the aid of a calculator.
D.2. understand the basic shape of a quadratic function and the relationships between the roots of the quadratic and zeroes of the function.
D.3. know the basic shape of the graph of exponential and log functions, including exponential decay.

E. Successful students understand algebra well enough to apply it procedurally and conceptually to a range of common problems. They:
E.1. recognize which type of expression best fits the context of a basic application (e.g., linear equation to solve distance/time problems; quadratic equation to explain the motion of a falling object; or compound interest as an exponential function).

F. Successful students demonstrate the ability to work with formulas and symbols algebraically. They:

F.1.* know formal notation (e.g., sigma notation and factorial notation).
F.2.* know arithmetic and geometric progressions and series.

Arizona Mathematics Standard Performance Level Descriptors for High School

Students at the "Exceeds the Standard" level generally know the skills required at the "Meets" and "Approaches" levels and are able to:	**Students at the "Meets the Standard" level generally know the skills required at the "Approaches" level and are able to:**	**Students at the "Approaches the Standard" level generally know and are able to:**
• Identify and apply properties of real numbers. • Use combinations and permutations to solve problems. • Distinguish between independent and dependent events • Determine the relationship between lines. • Solve formulas for specified variables. • Solve contextual problems using angle and side lengths of triangles. • Calculate surface area of 3-dimensional objects. • Determine whether a given procedure for solving an inequality is valid.	• Determine whether the solution to a problem is reasonable. • Differentiate among subsets of the real numbers. • Find probability in contextual situations. • Apply the counting principle. • Solve a system of linear equations algebraically. • Determine the slope, x-intercept and y-intercept of a linear equation. • Write the equation of a line using points, slope or the graph of the line. • Solve a linear inequality in one variable. • Perform transactions on a plane figure. • Determine elements of line segments (midpoint, distance). • Calculate volume of 3-dimensional objects. • Identify a valid conjecture. • Write an appropriate conjecture in a contextual situation.	• Solve word problems. • Simplify numerical expressions. • Find probability using visual clues. • Construct and interpret graphic displays. • Make simple predictions from data. • Determine possible outcomes. • Simplify algebraic expressions. • Translate a contextual problem into algebraic terms. • Write the equation of a line, given a table of values. • Solve linear equations. • Recognize and apply a simple iterative or recursive pattern. • Perform simple matrix operations. • Determine the solution of a system of equations from a graph. • Identify attributes of 2- and 3-dimensional objects. • Solve problems involving similar figures and proportionality. • Use properties of angles to solve problems. • Identify simple transformations. • Determine the purpose of a simple mathematical algorithm. • Apply basic rules of logic to arguments.

ATTACHMENT 2: SELECTED HIGH SCHOOL RESEARCH AND POLICY ORGANIZATION PROFILES

ACT

ACT focuses on the preparation of high school students for college and the workplace. ACT monitors course-taking and outcomes for high school graduates. ACT has developed college readiness benchmarks (for college-level biology, algebra, and English composition) that provide specific guidance regarding critical coursework for college success. These are linked to the company's assessment system and are designed to help students, their families, and educators better understand the meaning of the assessment score ranges. They are also intended to highlight connections among the test scores and the skills needed for success in high school and beyond, and to help students pinpoint areas in which they need to improve prior to graduation. They also provide a useful snapshot of the readiness of thousands of high school students.

ACT has contributed to the research base on the deficiencies in high school graduates' preparation for post-secondary study and the workplace, noting in particular high dropout rates among first-year college students and their significant need for remedial courses once in college. ACT has long recommended a core course load (4 yrs English, 3 yrs each of math, science, and social studies), and it has found that students who take this core consistently score higher on their assessments than do students who fall short of the core course load. However, only slightly more than half of students nationwide take at least the recommended core.

ACT has found that only 22 percent of the 1.2 million students who took the ACT exams in 2004 met their college readiness benchmarks in all three subject areas, and that Native American, Hispanic American, and African American students are behind their White and Asian peers in this regard. Moreover, ACT has recently concluded that the core curriculum—defined in terms of credit hours or numbers of courses--is not adequate to ensure that all students receive the preparation they need. ACT has identified a strong positive relationship between the amount and kind of high school coursework students take and their readiness for college. Specifically, the more courses a student takes, and the greater the challenge level of those courses, the more likely that student is to enter college and complete a degree. ACT emphasizes that the benefits of taking more challenging coursework accrue equally to students at all achievement levels—they have found, for example, that students' scores increase an average of 2.6 score points for science and 6 points for math when they take difficult courses beyond the core recommendations, regardless of their initial level of achievement.

Based on those findings, ACT has identified specific "courses for success," that are closely linked with college success. They recommend that every student take these courses: one or more advanced math course beyond algebra II (e.g. trigonometry); Biology, Chemistry, and Physics; and one to two years of a foreign language. They argue that improving the quality and rigor of the core courses, and also requiring all

students, regardless of their achievement level or post-secondary plans, to take the "courses for success" would yield improved achievement and preparation for schooling and work for students at all levels.

Achieve/American Diploma Project

Achieve has taken the lead in developing the American Diploma Project (ADP), in collaboration with the Education Trust, and the Thomas B. Fordham Foundation. The ADP is an initiative to help states address the challenges of making high schools more rigorous and better preparing their students for post-secondary schooling and the workplace—specifically of making the high school diploma more valuable. These groups have collected research on the gaps between high school requirements and college and workplace expectations and other aspects of the issue. They have also developed reports and tools to guide states in their reform efforts.

The ADP has found that "no state requires its graduates to take courses that reflect the real-world demands of work and post-secondary education" (2004). While Arkansas, Indiana, and Texas have recently made a college-preparatory curriculum the norm, no state yet has adopted all of the ADP recommended requirements for all students.

To guide states, ADP has defined benchmark skills for English and math, and workplace tasks that demonstrate applications of the benchmark knowledge and skills. The academic benchmarks are organized by strands that fill out the picture of what students need to know and be able to do—specific requirements are listed in Table 4, above.

ADP also worked with companies in participating states to develop workplace tasks that make concrete the links between the benchmarks and the skills needed in the workplace. Thus, for each of ten jobs, such as machine operator, licensed nurse, actuary, events manager, forester, and others (they are in the process of developing more), information is provided about the career path, salary structures, and the like. Tasks that are part of the job are described and links to specific strands in the benchmarks are identified.

Standards for Success

Standards for Success is an initiative developed at the University of Oregon to help develop explicit links between high school goals and the skills and knowledge students need to succeed in entry-level university courses.

Understanding University Success describes foundational skills and content standards, also referred to as Knowledge and Skills for University Success in English, mathematics, natural sciences, social sciences, second languages, and the arts. An 80-page booklet addresses each discipline in a separate chapter. The foundations--skills, behaviors, and attitudes expected of incoming students—are described and

standards describe the content knowledge that helps maximize the probability of success in entry-level university courses.

Career Clusters

The U.S. Department of Education Office of Vocational and Adult Education (OVAE) has developed 16 career clusters, descriptions of pathways from secondary school to post-secondary schooling school and the workplace that are designed to help students link what they can learn in school with what they can do in the future. They are administered by the National Association of State Directors for Career and Technical Education Consortium; personnel from states collaborated with representatives from business and industry to develop the individual clusters. The project consists of curriculum frameworks and supporting materials. High schools could use these to organize curricula; guidance counselors can use them to advise students; etc. www.careerclusters.org

The sixteen clusters are:
Agriculture, Food, & Natural Resources ; Architecture & Construction ; Arts, A/V Technology & Communications; Business, Management & Administration; Education & Training; Finance; Government & Public Administration; Health Science; Hospitality & Tourism; Human Services; Information Technology; Law, Public Safety & Security; Manufacturing; Marketing, Sales & Service; Science, Technology, Engineering & Mathematics; Transportation, Distribution & Logistics

Center on Education Policy

CEP is an independent advocate for public education whose mission is to disseminate information to help citizens and policymakers. A recent report (4th in an annual series) examines the status, characteristics, and impacts of high school exit exams. It is based on surveys of states with exit exams, as well as review of research and review by an expert panel.

26 states now have exit exams. Majority of these are standards-based or end-of-course type exams, rather than minimum-competency—others are considering this change. Very few are specifically linked to college requirements or college readiness. Only one (Georgia) is linked to workforce readiness. CEP notes recent progress states have made in developing more innovative ways of using exit exams and more alternative means of meeting requirements (the most frequent result is making them easier to pass, but some are making them more difficult), but little change in pass rates or narrowing of achievement gaps. Through case studies they note positive effects, particularly greater alignment of tests with standards, but also negative effects, particularly a de-emphasis on higher-order thinking skills and on subjects not tested.

Education Trust

The Education Trust is a non-profit group that advocates for policies that will boost academic achievement for all students and eliminate achievement gaps. They produce research reports, expert testimony, and assistance to districts, schools, and other groups. They strongly advocate that states and districts consider the K-16 educational trajectory and offer academic benchmarks, based on ADP's and others' findings.

The Education Trust has found that there is too much variation state by state in what is required for graduation, and there is very little consensus between secondary and post-secondary communities about what should be required, especially in terms of content, as opposed to number of courses, etc. They present evidence of the importance of knowledge and skills to workplace and economic success. They strongly advocate viewing goals for high school in terms of the requirements of both post-secondary study and the workplace.

Education Trust advocates a college-prep curriculum for all students:

- English--4 years
- Math—3 years, including Algebra I and II, Geometry, and, preferably 1-2 additional years (trigonometry and calculus)
- Natural Science—3 years, including lab sciences (biology, chemistry, and physics)
- Social Studies—3 years
- Second Language—2 years

Jobs for the Future

Jobs for the Future provides research, analysis, and policy development to states and communities. As part of its initiative to increase the number of low-income students who enter and complete post-secondary education, , they produced a report in collaboration with the Aspen Institute to explore the role of career and technical education in U.S. high schools.

Called Double the Numbers: Increasing Post-secondary Credentials for Underrepresented Youth, his report argues that career and technical education has been shrinking but remains a significant component of high school in the U.S. As it currently functions, it seems to help at-risk students remain in school and graduate but does not necessarily prepare them for college-level work or the workplace. Overall, rigor has been improving but has a long way to go. Vocational education needs to change and adapt—the report argues for increased rigor, relevance, and relationships—in alignment with general reform goals for high schools. Career and technical education needs to become a pathway that is more academically rigorous and equips students to make desirable choices about post-secondary schooling and the workplace—or jurisdictions will shift resources in other directions.

MDRC

MDRC is a social policy research organization focused on the economic and social well being of low-income people. MDRC has evaluated the Talent Development High School program, a comprehensive school reform initiative designed to target the high proportions of students who drop out of high school or do not succeed academically.

MDRC found that the Talent Development model produced substantial gains in attendance, academic course credits earned, and promotion rates among ninth-graders, and that these gains tended to be sustained as students progressed through school.

The principal goals of Talent Development were to raise the expectations of teachers and students, and to prepare all students for post-secondary education and employment. The five main strategies are small learning communities, organized around interdisciplinary teacher teams that share the same students and have common daily planning time; curricula leading to advanced English and mathematics coursework; academic extra-help sessions; staff professional development strategies; and parent and community involvement. Other strategies include a focus on ninth-grade transition courses that prepare students for higher-level study, freshman seminars to help students develop solid study skills, and curriculum strands built around career themes.

National Commission on the High School Senior Year

The National Commission on the High School Senior Year is a public/private partnership between The Woodrow Wilson National Fellowship Foundation, the Charles Stewart Mott Foundation, the U.S. Department of Education, and the Carnegie Corporation of New York. It developed a report on how to improve the senior year as a transition to post-secondary education and the work force.

The commission identifies as primary goals “graduating students who are ready and eager to learn more, capable of thinking critically, and comfortable with the ambiguities of the problem-solving process.” Students should graduate knowing how to use their learning and how to connect key ideas within and among different disciplines. They argue that schools serve not only economic ends but also social and democratic purposes. Using extensive data about economic and other outcomes, they argue that all students need a minimum of two years of post-secondary education, defined broadly to include adult education and vocational training.

The Commission recommended that states establish rigorous course requirements, such as those defined in the High Schools That Work program—and that the college-preparatory program be the default choice for all students. They recommended that all seniors complete a capstone or research project, do an internship, participate in community service, take college-level classes, or in some other way be required to explore the world of work and other enterprises beyond high school. They also

recommended that every state establish a P-16 council to establish links from preschool through post-secondary education.

National Governors Association

The National Governors Association (NGA) provides a means by which the nation's governors can work collectively to develop and influence national policy. The organization collects and disseminates research in many areas, including education. The NGA held a summit in February, 2005 that focused on high school reform, and has served as a catalyst for reform efforts in a number of states. They are tracking states' responses to the specific goals they identified. The "Action Agenda" they outlined is linked to the goals for the American Diploma Project, described above; Achieve and the NGA have collaborated in defining key goals—the action agenda--for high school reform:

- Restore Value to the High School Diploma: align high school academic standards with college and workplace expectations, upgrade high school coursework, and create college- and work-ready tests.
- Redesign High Schools: reorganize low-performing high schools first, expanding high school options in all communities and providing support to low-performing students.
- Give High School Students the Excellent Teachers and Principals They Need: improve teacher knowledge and skills, provide incentives to recruit and keep teachers where they are needed most, and develop and support strong principal leadership.
- Set Goals, Measure Progress, and Hold High Schools and Colleges Accountable: set goals and measure progress, strengthen high school and post-secondary accountability, and intervene in low-performing schools.
- Streamline and Improve Education Governance: creating a common K–12 and post-secondary agenda and improve coordination across the two sectors.

The NGA has also initiated the Honor States Grant Program, through which states can apply for Gates Foundation funds to support specific high school reform efforts. The program is set up in two phases, with the first focused on data collection systems, coordination between secondary and post-secondary schooling, and other objectives. In the second phase states will focus on one or more of seven goals:

- Increasing course rigor,
- Expanding AP participation,
- Using virtual learning to advance high school improvement,
- Turning around low-performing high schools,
- Improving teacher knowledge and skills and/or recruitment and retention,
- Developing a statewide longitudinal K-16 data system, and
- Streamlining education governance.

Many states have initiatives underway to improve high schools. The NGA has identified three means by which states are attempting to restore value to the high school diploma: giving college and work readiness assessments in high school; defining a statewide college-prep curriculum as a requirement for high school graduation; and providing financial incentives for disadvantaged students to meet rigorous standards. They are monitoring states' progress in these and other areas related to high school improvement. They have also coordinated with Achieve to develop overarching goals (described above) and are committed to working to keep this on the front burner of states' policy agendas.

SREB/High Schools That Work

The Southern Regional Education Board (SREB) is a consortium of 16 states that work together to achieve goals for improving education. High Schools That Work (HSTW) is an initiative developed by SREB that provides goals and key practices for states and others to use in improving middle and high school achievement. It is in use in 31 states.

HSTW takes the approach that most students can master rigorous academic and career/technical studies if high expectations are conveyed and if they are well supported. The model provides for gradual strengthening of academic requirements and expanding opportunities for college-prep curriculum to all students. It also includes access to "intellectually challenging career/technical studies in high-demand fields that emphasize the higher-level mathematics, science, literacy, and problem-solving skills needed in the workplace and in further education."

HSTW recommended curriculum:

- English—minimum 4 years of college-prep English that emphasize reading, writing, and presentation skills.
- Math—minimum 4 years, including Algebra I and II, geometry, and a higher-level course. If the 4 years are completed by 11th grade students still take math in 12th grade.
- Science—minimum of 3 college-prep courses: biology, chemistry, physics or applied physics, or anatomy/physiology. Laboratory experiments and investigative studies should be part of curriculum. Schools using block schedules should require 4 years.
- Social Studies—minimum 3 years college-prep courses emphasizing reading and writing to learn
- Computer—minimum 1 course or demonstrated proficiency beyond keyboarding
- Concentration—minimum 4 credits in chosen pathway, from among at least 4 options that include career/technical as well as academic (to include at least 2 AP/IB courses).

HSTW has identified additional goals that significantly raise student achievement: reading 25+ books per year across curriculum; writing weekly in all classes; using

writing and reading strategies to enhance learning in all classes; writing research papers in all classes; and completing rigorous English/language arts curriculum (honors/college prep level)

ATTACHMENT 3: EDUCATION AND SKILL DESCRIPTORS

BLS Education and Training Levels

US DOL Bureau of Labor Statistics Occupations are classified into 1 of 11 categories based on analyses of the occupation's usual education and training requirements. The rating is based on the level of educational attainment of a preponderance of the participants in that occupation (over 50 percent). These ratings speak almost exclusively to the level of training or educational attainment and not to experience. The lower the number, the higher the level of education. Applying this rating system allowed **Public Works** to create an educational-level profile for all occupations paying above the median wage, as well as for each of the strategic industries and the final list of key occupations. This profile is important because it defines the minimum level of education – which happens to be at least some post-secondary education – that will be needed to succeed in Arizona's key occupations. Clarifying the educational level threshold can then inform what sort of preparation is needed in high school to succeed in meeting the skills demands of strategic occupations. In other words, our analysis shows that, for the sake of growing Arizona's strategic industries, Arizona's students must graduate prepared to continue their education in a formal setting.

As indicated in the Sections 2.2 and 3.2 and Attachment 2 many national organizations describe what preparation is desirable in order to enter and succeed in post-secondary courses of study or degree programs. Exhibit 4: *BLS Education and Training* Levels identifies the 11 classifications.

BLS EDUCATION AND TRAINING LEVELS

1:	**First professional degree.**
2:	**Doctoral degree.**
3:	**Master's degree.**
4:	**Work experience, plus a bachelor's or higher degree.** Most occupations in this category are managerial occupations that require experience in a related non-managerial position.
5:	**Bachelor's degree.**
6:	**Associate degree.**
7:	**Post-secondary vocational training.** Ranges from programs lasting only a few weeks to more than a year. In some occupations, a license is needed that requires passing an examination after completion of the training.
8:	**Work experience in a related occupation.** Some occupations requiring work experience are supervisory or managerial occupations. (May possibly require some post-secondary education.)
9:	**Long-term on-the-job training.** More than 12 months of on-the-job training or combined work experience and formal classroom training.(Does not require post-secondary education.)
10:	**Moderate-term on-the-job training.** 1 to 12 months of combined on-the-job experience and informal training. (Does not require post-secondary education.)
11:	**Short-term on-the-job training.** Short demonstration or up to one month of on-the-job experience or instruction. (Does not require post-secondary education.)

The median educational level across the 70 key occupations is an Associate's Degree (Level 6).

O* Net Job Zone

The Job Zone classification (another data set available for most occupations in the O*NET database), is also assigned a numeric value on a scale of 1 to 5 for the combination of education and experience recommended to succeed in the occupation. However, the ranking is the reverse of the BLS system. The *higher* the number the more education and experience required. While the Job Zone rating does not speak to

specific skills, it does indicate the degree to which job holders in Arizona's targeted occupations will need to be able to succeed in post-secondary education, the level of post-secondary education, and the ability to gain experience, all in order to foster Arizona's strategic industries.

The Job Zone numeric value allows for an easy reference and comparison across occupations and industries. In order to review over 600 occupations across eight industries to identify the key occupations in each industry, **Public Works** used the Job Zone ratings as screening criteria to narrow down the list to the most key occupations. (See Attachment 6:,*Job Zone Classification* for definitions of the combined education and training levels.) This criteria speaks to the issue of the length of the preparation 'pipeline' through which a high school graduate must travel in order to succeed in Arizona's key occupations. It is assumed that the longer the pipeline, the stronger the foundation of preparation needs to be so that the individual can succeed each step of the way, and not drop out prematurely.

The median Job Zone rating across the 70 key occupations is a three, meaning that most occupations in this zone require training in vocational schools, related on-the-job experience, or an associate's degree. Some may require a bachelor's degree.

More detailed information regarding Job Zones is available in Attachment 6.

WorkKeys®

As mentioned earlier, there is no one set of skill descriptors common to secondary education, post-secondary education and the workplace. As a result, Public Works is using a variety of indicators to describe what is needed to ultimately succeed in occupations critical to Arizona's strategic industries. While Job Zone and BLS education levels describe the overall 'bar' – the educational attainment and amount of experience required for success in each occupation – O*NET Knowledges and Skills and WorkKeys® skills speak to more specific workplace skills.

ACT, the college testing company, developed the WorkKeys® system of classification which includes eight skill types and the level of that skill generally required to succeed in each of the occupations profiled.

The WorkKeys® system of eight skills allows for cross-industry comparison and analysis of skills requirements. The common set of skills also allows for comparison of proficiency levels across experience, training, and education levels. There is no universal or standard set of skill labels used by high schools, colleges, occupational trainers, and employers. WorkKeys®, however, can be used across most educational levels and industries because it identifies skills and proficiencies by occupation.

The following Exhibit *5: WorkKeys* quantifies the median level of competency needed for each skill level as identified for the set of 70 key occupations, and includes a description of that level.

WorkKeys[xlviii]

Element	Level	Characteristics of Items on WorkKeys Assessment	Skills for Level Indicated
Applied Math	**5**	• Problems require several steps of logic and calculation (e.g., problem may involve completing an order form by totaling the order and then computing tax)	• Decide what information, calculations, or unit conversions to use to solve the problem • Look up a formula and perform single-step conversions within or between systems of measurement • Calculate using mixed units (e.g., 3.5 hours and 4 hours 30 minutes) • Divide negative numbers • Find the best deal using one- and two-step calculations and then comparing results • Calculate perimeters and areas of basic shapes (rectangles and circles) • Calculate percent discounts or markups

Element	Level	Characteristics of Items on WorkKeys Assessment	Skills for Level Indicated
Reading for Information	**4**	• Reading materials include company policies, procedures, and notices • Reading materials are straightforward, but have longer sentences and contain a number of details • Reading materials use common words, but do have some harder words, too • Reading materials describe procedures that include several steps • When following the procedures, individuals must think about changing conditions that affect what they should do • Questions and answers are often paraphrased from the passage	• Identify important details that may not be clearly stated • Use the reading material to figure out the meaning of words that are not defined • Apply instructions with several steps to a situation that is the same as the situation in the reading materials • Choose what to do when changing conditions call for a different action (follow directions that include "if-then" statements)
Writing	**3**	• Messages are clear • The majority of the sentences are complete • Writing has few mechanical, grammatical, and word usage errors so the message is adequately conveyed • The language may be more casual than standard business English but never contains slang or is rude • Some organization is evident, but the writing may have inappropriate transitions and/or some information out of logical order	

Element	Level	Characteristics of Items on WorkKeys Assessment	Skills for Level Indicated
Applied Technology	**4**	• Moderately complex because they can involve two or more simple systems that work together or one moderately complex system • Systems may have up to ten components • Situation can have one or two variables • All needed information is present • Extraneous information may be included • Less common technical terms are defined	• Understand the operation of moderately complex tools and diagnostic equipment • Understand the operation of moderately complex machines and systems • Apply less obvious basic principles to solve problems within physical systems • Solve moderate problems • Eliminate physical symptoms that do not point to the source of a problem, disregarding extraneous information • Identify the best solution after eliminating other unsuitable possibilities
Listening	**4**	Note: Level 4 performance requires: • All primary information is given and it is correct • Supporting information is included that is either correct or, if incorrect, does not interfere with the central message • Correctly show the relationships among the pieces of primary information	
Locating Information	**4**	• Straightforward workplace graphics such as basic order forms, diagrams, line graphs, tables, flowcharts, instrument gauges, or maps • One or two graphics are used at a time	• Find several pieces of information in one or two graphics • Understand how graphics are related to each other • Summarize information from one or two straightforward graphics • Identify trends shown in one or two straightforward graphics • Compare information and trends shown in one or two straightforward graphics

Element	Level	Characteristics of Items on WorkKeys Assessment	Skills for Level Indicated
Observation	**4**	• Straightforward procedure involving more than one component • A few extra details and distractions are present • Procedure is direct, clearly explained, and easy to follow • Attention is directed toward important details	• Select and pay attention to the components of a straightforward procedure with some details that are hard to notice • Remember a few important details that are reinforced • Remain focused on relevant details when there are some extra details or distractions
Team Work	**4**	• Work situations involve several problems or sources of difficulty • Team goals and consequences are not altogether clear • Resources may be limited • Team members have competing concerns	• Use prioritization and time management skills to effectively and efficiently accomplish tasks • Exhibit creative thinking when solving problems or accomplishing tasks • Show a commitment to quality • Show sensitivity to customer needs • Practice followership by taking direction and responding appropriately to negative feedback • Demonstrate respect for other team members • Show an appreciation for diversity among team members

O*NET Knowledges and Skills

Categories and descriptions of knowledge and skills are similar across occupations in the U.S. Bureau of Labor Statistics' O*NET-defined occupations; however, the various knowledges and skills are not assigned a numeric level to correspond to a level of high school competency, such as first year Algebra, or third year Language Arts. Instead, they are described in general terms in narrative form. The descriptions are valuable for a detailed analysis of specific occupations, and we in fact analyze the knowledges and skills for each of the targeted occupations to determine the frequency with which each one appears. We use the frequency as an indicator of the importance of that particular knowledge or skill. For example, our analysis shows that the three most frequent *knowledges* cited for the 70 key occupations are:

- English Language: Knowledge of the structure and content of the English language including the meaning and spelling of words, rules of composition, and grammar

- Mathematics: Knowledge of arithmetic, algebra, geometry, calculus, statistics, and their applications.

- Customer and Personal Service: Knowledge of principles and processes for providing customer and personal service. This includes customer service needs assessment, meeting quality standards for services, and evaluation of customer satisfaction.

The three most frequently cited *skills* are:

- Reading Comprehension: Understanding written sentences and paragraphs in work related documents.

- Active Listening: Giving full attention to what other people are saying, taking time to understand the points being made, asking questions as appropriate, and not interrupting at inappropriate times.

- Critical Thinking: Using logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions or approaches to problems.

A complete list of the knowledges and skills and a tally of their frequency appears in Attachment 4 and 5.

Again, the challenge is to translate these descriptions of applied skills to academic language. Such a translation requires detailed, exacting comparison of core curriculum (assuming that all Arizona high schools teach the exact same core

curriculum) to the assessment elements used to determine the WorkKeys competency level or the determination of O*NET Knowledges and Skills. This level of comparison requires a significant and substantial commitment of time and resources, which is far beyond the scope of this particular study. However, there is still much to be gleaned from the analysis of knowledge and skills, even at this general level.

ATTACHMENT 4: OCCUPATIONAL EMPLOYMENT PROJECTIONS, WAGE ESTIMATES, AND TRAINING REQUIREMENTS FOR ARIZONA

SOC Code	SOC Title	2003 Est.	2013 Projected	Total Openings	Demand	Median Wage	Code	Description	Job Zone	Description	WORK-KEYS	Applied Math	Applied Tech	Listening	Locating Info	Observation	Reading for Info	Team Work	Writing
Industry: Construction																			
47-2031	**Carpenters**	33,809	43,240	14,934	44.2 percent	$31,641	9	Long-term on-the-job training	3	Medium		4	3	3	4	4	3	4	4
47-2111	**Electricians**	10,648	14,595	6,052	56.8 percent	$37,280	9	Long-term on-the-job training	3	Medium		5	4	3	5	4	5	4	3
47-1011	**First-Line Supervisors/ Managers of Construction Trades and Extraction Workers**	15,611	20,546	7,590	48.6 percent	$44,735	8	Work experience in a related occupation	4	Considerable		5	5	4	5	5	5	4	3
49-9021	**Heating, Air Conditioning, and Refrigeration Mechanics and Installers**	4,598	6,540	2,553	55.5 percent	$35,102	9	Long-term on-the-job training	3	Medium		4	4	2	5	4	4	4	3
47-2152	**Plumbers, Pipe fitters, and Steamfitters**	8,581	11,449	4,841	56.4 percent	$36,128	9	Long-term on-the-job training	3	Medium		4	4	3	4	4	4	3	3

SOC Code	SOC Title	2003 Est.	2013 Projected	Total Openings	Demand	Median Wage	Code	Description	Job Zone	Description	WORKKEYS	Applied Math	Applied Tech	Listening	Locating Info	Observation	Reading for Info	Team Work	Writing
Industry: Aerospace																			
11-9041	**Engineering Managers**	4,812	5,535	1,681	34.9%	$87,446	4	Bachelor's or higher degree, plus work experience	5	Extensive	N/A								
17-2011	**Aerospace Engineers**	3,967	4,315	1,330	33.5%	$74,073	5	Bachelor's degree	5	Extensive	N/A								
17-3099	**All other drafters, engineering, and mapping technicians**	2,055	2,393	833	40.5%	$48,202	6	Associate degree	**n/a**		N/A								
49-2091	**Avionics Technicians**	591	701	253	42.8%	$48,397	7	Postsecondary vocational training	4	Considerable	N/A								
49-3011	**Aircraft Mechanics and Service Technicians**	3,035	3,942	1,623	53.5%	$42,575	7	Postsecondary vocational training	4	Considerable	N/A								
51-1011	**First-Line Supervisors/ Managers of Production and Operating**	8,126	9,659	3,237	39.8%	$41,118	8	Work experience in a related occupation	3	Medium		4	4	4	4	4	4	4	3
51-2011	**Aircraft Structure, Surfaces, Rigging, and Systems Assembler**	645	705	237	36.7%	$41,547	9	Long-term on-the-job training	3	Medium		3	5		5	5	5	3	
51-2023	**Electro-mechanical Equipment Assemblers**	685	681	162	23.6%	$30,707	11	Short-term on-the-job training	3	Medium									

51-4034	**Lathe and Turning Machine Tool Setters, Operators, and Tenders**	576	589	123	21.4%	$35,453	10	Moderate-term on-the-job training	3	Medium		3	4	3	4	3	3	3	3
51-4041	**Machinists**	4,154	4,726	1,540	37.1%	$32,088	9	Long-term on-the-job training	3	Medium		5	4	4	4	4	4	4	2

SOC Code	SOC Title	2003 Estimated	2013 Projected	Total Openings	Demand	Median Wage	Code	Description	Job Zone	Description	WORKKEYS	Applied Math	Applied Tech	Listening	Locating Info	Observation	Reading for Info	Team Work	Writing
Industry: Information Technology																			
11-3021	**Computer and Information Systems Managers**	4,914	6,446	2,424	49.3 percent	$83,887	4	Bachelor's or higher degree, plus work experience	5	Extensive		4		3	4	5	5	4	4
15-1021	**Computer Programmers**	7,200	7,685	2,185	30.3 percent	$56,042	5	Bachelor's degree	4	Considerable		5		4	5	6	5	4	4
15-1031	**Computer Software Engineers, Applications**	5,210	6,791	2,096	40.2 percent	$66,482	5	Bachelor's degree	4	Considerable		6	0	4	5	4	5	4	4
15-1032	**Computer Software Engineers, Systems Software**	4,496	5,800	1,749	38.9 percent	$72,217	5	Bachelor's degree	4	Considerable		6		4	5	4	5	4	4
15-1041	**Computer Support Specialists**	12,570	15,483	4,459	35.5 percent	$39,936	6	Associate degree	3	Medium		4	4	4	4	4	5	4	4
15-1051	**Computer Systems Analysts**	7,356	9,678	3,154	42.9 percent	$64,117	5	Bachelor's degree	4	Considerable		4	3	4	4	4	5	4	3
17-2071	**Electrical Engineers**	3,346	3,637	949	28.4 percent	$71,543	5	Bachelor's degree	4	Considerable		4	5	4	4	6	5	4	4
15-1071	**Network and Computer Systems Administrators**	4,092	5,393	1,755	42.9 percent	$52,639	5	Bachelor's degree	4	Considerable	N/A								
15-1081	**Network Systems and Data Com Analysts**	2,596	3,819	1,529	58.9 percent	$56,489	5	Bachelor's degree	3	Medium		6		5	5	5	5	5	4

SOC Code	SOC Title	2003 Estimated	2013 Projected	Total Openings	Demand	Median Wage	Code	Description	Job Zone	Description	WORKKEYS	Applied Math	Applied Tech	Listening	Locating Info	Observation	Reading for Info	Team Work	Writing
Industry: Engineering																			
17-1011	**Architects, Except Landscape and Naval**	2,361	3,198	1,107	46.9 percent	$54,729	5	Bachelor's degree	5	Extensive	N/A								
17-3022	**Civil Engineering Technicians**	1,671	2,069	748	44.8 percent	$36,679	6	Associate degree	3	Medium		5	5		5	5	6	5	
17-2051	**Civil Engineers**	4,981	6,098	1,911	38.4 percent	$49,923	5	Bachelor's degree	4	Considerable	N/A								
17-3012	**Electrical and Electronics Drafters**	2,006	2,283	841	41.9 percent	$38,778	7	Post-secondary vocational training	3	Medium		5	4		5	5	5	5	
17-2072	**Electronics Engineers, Except Computer**	5,332	6,147	1,863	34.9 percent	$66,021	5	Bachelor's degree	5	Extensive		4			4		5		
11-9041	**Engineering Managers**	4,812	5,535	1,681	34.9 percent	$87,446	4	Bachelor's or higher degree, plus work experience	5	Extensive	N/A								
17-2141	**Mechanical Engineers**	3,897	4,198	1,367	35.1 percent	$59,861	5	Bachelor's degree	4	Considerable	N/A								
17-1022	**Surveyors**	1,565	1,879	849	54.2 percent	$39,709	5	Bachelor's degree	3	Medium		5	3	3	4	4	4	4	3

SOC Code	SOC Title	2003 Estimated	2013 Projected	Total Openings	Demand	Median Wage	Code	Description	Job Zone	Description	WORKKEYS	Applied Math	Applied Tech	Listening	Locating Info	Observation	Reading for Info	Team Work	Writing
Industry: Bioscience																			
51-2099	**Assemblers and Fabricators, All Other**	3,075	3,325	1,045	34.0 percent	$21,476	10	Moderate-term on-the-job training	n/a		N/A								
19-1021	**Biochemists and Biophysicists**	97	133	66	68.0 percent	$76,225	2	Doctoral degree	5	Extensive	N/A								
19-4021	**Biological Technicians**	278	336	105	37.8 percent	$26,911	6	Associate degree	n/a		N/A								
17-2031	**Biomedical Engineers**	130	171	63	48.5 percent	$60,006	5	Bachelor's degree	n/a		N/A								
17-3024	**Electro-Mechanical Technicians**	431	514	173	40.1 percent	$50,020	6	Associate degree	4	Considerable		5	5	4	5	4	5	4	3
17-3025	**Environmental Engineering Technicians**	358	496	213	59.5 percent	$33,940	6	Associate degree	3	Medium		5	3	3	4	4	4	3	3
51-1011	**First-Line Supervisors/Managers of Production and Operating**	8,126	9,659	3,237	39.8 percent	$41,118	8	Work experience in a related occupation	3	Medium		4	4	4	4	4	4	4	3
17-3026	**Industrial Engineering Technicians**	2,005	2,169	584	29.1 percent	$41,440	6	Associate degree	3	Medium		4	4	3	4	4	4	4	3
17-3027	**Mechanical Engineering Technicians**	917	1,046	321	35.0 percent	$38,614	6	Associate degree	3	Medium		5	4		5	5	5	4	3
29-2011	**Medical and Clinical Laboratory Technologists**	2,076	3,090	1,573	75.8 percent	$44,716	5	Bachelor's degree	4	Considerable		5			5	5	5	5	4
19-1042	**Medical Scientists, Except Epidemiologists**	649	1,020	485	74.7 percent	$42,816	2	Doctoral degree	4	Considerable	N/A								

SOC Code	SOC Title	2003 Estimated	2013 Projected	Total Openings	Demand	Median Wage	Code	Description	Job Zone	Description	WORKKEYS	Applied Math	Applied Tech	Listening	Locating Info	Observation	Reading for Info	Team Work	Writing
Industry: Health																			
29-2061	**Licensed Practical and Licensed Vocational Nurses**	9,001	12,507	5,468	60.7 percent	$34,253	7	Post-secondary vocational training	3	Medium		5		4	4	4	5	4	3
29-2012	**Medical and Clinical Laboratory Technicians***	4,851	7,168	3,624	74.7 percent	$27,651	6	Associate degree	2	Some		5	4	4	4	5	5	3	3
11-9111	**Medical and Health Services Managers**	4,193	6,354	2,978	71.0 percent	$61,014	4	Bachelor's or higher degree, plus work experience	5	Extensive		5	4	4	4	4	4	4	4
29-1123	**Physical Therapists**	2,341	3,636	1,525	65.1 percent	$60,075	3	Master's degree	5	Extensive		4	3	4	4	5	5	4	4
29-1071	**Physician Assistants****	2,341	4,178	2,197	93.8 percent	$57,020	5	Bachelor's degree	4	Considerable		4			4	4	4	3	4
29-2034	**Radiological Technologists and Technicians**	4,059	6,119	2,818	69.4 percent	$40,464	6	Associate degree	3	Medium		3	3	3	4	4	5	3	3
29-1111	**Registered Nurses**	34,123	53,901	26,918	78.9 percent	$49,667	6	Associate degree	3	Medium		5	3	4	4	4	5	4	3

**This occupation includes Phlebotomists.*
***This occupation includes Nurse Practitioners.*

SOC Code	SOC Title	2003 Estimated	2013 Projected	Total Openings	Demand	Median Wage	Code	Description	Job Zone	Description	WORKKEYS	Applied Math	Applied Tech	Listening	Locating Info	Observation	Reading for Info	Team Work	Writing
Industry: Transportation & Logistics																			
53-1011	**Aircraft Cargo Handling Supervisors**	215	242	78	36.3 percent	$33,781	8	Work experience in a related occupation	n/a		N/A								
49-3011	**Aircraft Mechanics and Service Technicians**	3,035	3,942	1,623	53.5 percent	$42,575	7	Post-secondary vocational training	4	Considerable	N/A								
49-2091	**Avionics Technicians**	591	701	253	42.8 percent	$48,397	7	Post-secondary vocational training	4	Considerable	N/A								
49-3031	**Bus and Truck Mechanics and Diesel Engine Specialists**	4,915	5,942	2,291	46.6 percent	$35,143	7	Post-secondary vocational training	3	Medium		5	5	3	4	5	5	4	3
53-2012	**Commercial Pilots**	792	998	418	52.8 percent	$45,386	7	Post-secondary vocational training	4	Considerable	N/A								
49-2093	**Electrical and Electronics Installers and Repairers, Transportation Equipment**	461	557	209	45.3 percent	$45,720	7	Post-secondary vocational training	3	Medium		3	3		4	5	4		
53-6051	**Transportation Inspectors**	476	548	185	38.9 percent	$56,254	8	Work experience in a related occupation	?		N/A								
11-3071	**Transportation, Storage, and Distribution Managers**	1,676	1,980	631	37.6 percent	$56,976	8	Work experience in a related occupation	3	Medium		4	5	3	4	5	4	4	3

SOC Code	SOC Title	2003 Estimated	2013 Projected	Total Openings	Demand	Median Wage	Code	Description	Job Zone	Description	WORKKEYS	Applied Math	Applied Tech	Listening	Locating Info	Observation	Reading for Info	Team Work	Writing
Industry: Tourism & Travel																			
11-2021	**Marketing Managers**	4,382	5,361	1,788	40.8 percent	$66,678	4	Bachelor's or higher degree, plus work experience	4	Considerable		5	4	4	5	4	5	4	4
11-9051	**Food Service Managers**	11,537	13,296	3,640	31.6 percent	$34,476	8	Work experience in a related occupation	3			5	4	3	4	4	4	5	
11-1021	**General and Operations Managers**	25,249	31,962	11,475	45.4 percent	$71,114	4	Bachelor's or higher degree, plus work experience	4	Considerable		4			4	4	4	4	
35-1011	**Chefs and Head Cooks**	1,616	1,901	764	47.3 percent	$36,496	8	Work experience in a related occupation	4	Considerable		4		4	4	4	4	6	5
39-1011	**Gaming Supervisors**	1,648	1,897	594	36.0 percent	$38,727	8	Work experience in a related occupation	2		N/A								
11-9081	**Lodging Managers**	1,757	1,849	384	21.9 percent	$32,818	8	Work experience in a related occupation	3	Medium		4			4	4	4	3	4
37-1011	**First-line supervisors/managers of housekeeping and janitorial workers**	4,233	5,125	1,892	44.7 percent	$26,215	8	Work experience in a related occupation	?										
25-4010	**Archivists, Curators, and Museum Technicians**	1,056	1,188	364	34.5 percent	$39,080	3	Master's degree	?		N/A								

SOC Code	SOC Title	2003 Estimated	2013 Projected	Total Openings	Demand	Median Wage	Code	Description	Job Zone	Description	WORKKEYS	Applied Math	Applied Tech	Listening	Locating Info	Observation	Reading for Info	Team Work	Writing
37-1012	**First-line supervisors/ managers of landscaping, lawn service, and grounds keeping workers**	4,242	5,328	1,479	34.9 percent	$29,639	8	Work experience in a related occupation	4	Considerable	N/A								
11-2022	**Sales Managers**	7,661	10,621	4,374	57.1 percent	$64,341	4	Bachelor's or higher degree, plus work experience	4	Considerable		5	4	4	5	5	5	5	4
39-1021	**First-Line Supervisors/ Managers of Personal Service Workers**	3,183	3,228	844	26.5 percent	$30,916	8	Work experience in a related occupation	3	Medium	N/A								
11-9071	**Gaming Managers**	567	566	107	18.9 percent	$50,771	8	Work experience in a related occupation	3	Medium									
25-3021	**Self-Enrichment Education Teachers**	4,478	6,250	2,323	51.9 percent	$26,835	8	Work experience in a related occupation	4	Considerable									
11-3011	**Administrative Services Managers**	5,491	6,763	2,340	42.6 percent	$52,713	4	Bachelor's or higher degree, plus work experience	4	Considerable		3		4	4	4	4	4	4
31-9011	**Massage Therapists**	2,142	2,639	912	42.6 percent	$30,125	7	Postsecondary vocational training	n/a		N/A								
13-1121	**Meeting and Convention Planners (aka Special Events Mgr. or Director)**	755	876	285	37.7 percent	$39,617	5	Bachelor's degree	4	Considerable	N/A								

SOC Code	SOC Title	2003 Estimated	2013 Projected	Total Openings	Demand	Median Wage	Code	Description	Job Zone	Description	WORKKEYS	Applied Math	Applied Tech	Listening	Locating Info	Observation-	Reading for Info	Team Work	Writing
	TOTAL	**334,943**	**435,500**	**163,508**	**48.8%**	**$3,285,673**													
	NUMBER	**70**	**70**	**70**		**70**						**43**	**30**	**33**	**43**	**42**	**43**	**41**	**36**
	AVERAGE					**$ 46,938**	**6**	Associate degree	**4**	Considerable		**4**	**4**	**4**	**4**	**4**	**5**	**4**	**3**

*Notes on Tourism & Travel Occupations: While the O*NET system divides General and Operations Managers into two separate occupations, the Arizona LMI combines them into a single occupation. The same is true for Chefs and Head Cooks, and for Archivists, Curators, and Museum Technicians. "Self-Enrichment Education Teachers" include Dance Instructor, Dance Teacher, Martial Arts Instructor (Judo, Karate), Flight Instructor, Teacher, Gymnastics Instructor, Language Instructor, Swimming Instructor, Art Instructor, Art Teacher, all or some of which can be found at resorts or other Tourism destinations. "Massage Therapists" can be found at hotels, resorts, and spas, all of which are part of the Tourism & Travel industry.*

ATTACHMENT 5: FREQUENCY OF KNOWLEDGES FOR TARGETED OCCUPATIONS

Frequency	Knowledge	Knowledge Description
58	English Language	Knowledge of the structure and content of the English language including the meaning and spelling of words, rules of composition, and grammar.
50	Mathematics	Knowledge of arithmetic, algebra, geometry, calculus, statistics, and their applications.
45	Customer and Personal Service	Knowledge of principles and processes for providing customer and personal services. This includes customer needs assessment, meeting quality standards for services, and evaluation of customer satisfaction.
42	Administration and Management	Knowledge of business and management principles involved in strategic planning, resource allocation, human resources modeling, leadership technique, production methods, and coordination of people and resources.
39	Computers and Electronics	Knowledge of circuit boards, processors, chips, electronic equipment, and computer hardware and software, including applications and programming.
36	Engineering and Technology	Knowledge of the practical application of engineering science and technology. This includes applying principles, techniques, procedures, and equipment to the design and production of various goods and services.
31	Design	Knowledge of design techniques, tools, and principles involved in production of precision technical plans, blueprints, drawings, and models.
30	Education and Training	Knowledge of principles and methods for curriculum and training design, teaching and instruction for individuals and groups, and the measurement of training effects.
28	Mechanical	Knowledge of machines and tools, including their designs, uses, repair, and maintenance.
24	Production and Processing	Knowledge of raw materials, production processes, quality control, costs, and other techniques for maximizing the effective manufacture and distribution of goods.
24	Public Safety and Security	Knowledge of relevant equipment, policies, procedures, and strategies to promote effective local, state, or national security operations for the protection of people, data, property, and institutions.
23	Personnel and Human Resources	Knowledge of principles and procedures for personnel recruitment, selection, training, compensation and benefits, labor relations and negotiation, and personnel information systems.
20	Building and Construction	Knowledge of materials, methods, and the tools involved in the construction or repair of houses, buildings, or other structures such as highways and roads.

Frequency	Knowledge	Knowledge Description
19	Clerical	Knowledge of administrative and clerical procedures and systems such as word processing, managing files and records, stenography and transcription, designing forms, and other office procedures and terminology.
18	Physics	Knowledge and prediction of physical principles, laws, their interrelationships, and applications to understanding fluid, material, and atmospheric dynamics, and mechanical, electrical, atomic and sub-atomic structures and processes.
14	Psychology	Knowledge of human behavior and performance; individual differences in ability, personality, and interests; learning and motivation; psychological research methods; and the assessment and treatment of behavioral and affective disorders.
13	Telecommunications	Knowledge of transmission, broadcasting, switching, control, and operation of telecommunications systems.
12	Chemistry	Knowledge of the chemical composition, structure, and properties of substances and of the chemical processes and transformations that they undergo. This includes uses of chemicals and their interactions, danger signs, production techniques, and disposal methods.
12	Law and Government	Knowledge of laws, legal codes, court procedures, precedents, government regulations, executive orders, agency rules, and the democratic political process.
12	Sales and Marketing	Knowledge of principles and methods for showing, promoting, and selling products or services. This includes marketing strategy and tactics, product demonstration, sales techniques, and sales control systems.
11	Economics and Accounting	Knowledge of economic and accounting principles and practices, the financial markets, banking and the analysis and reporting of financial data.
11	Medicine and Dentistry	Knowledge of the information and techniques needed to diagnose and treat human injuries, diseases, and deformities. This includes symptoms, treatment alternatives, drug properties and interactions, and preventive health-care measures.
11	Transportation	Knowledge of principles and methods for moving people or goods by air, rail, sea, or road, including the relative costs and benefits.
10	Biology	Knowledge of plant and animal organisms, their tissues, cells, functions, interdependencies, and interactions with each other and the environment.
9	Communications and Media	Knowledge of media production, communication, and dissemination techniques and methods. This includes alternative ways to inform and entertain via written, oral, and visual media.
7	Therapy and Counseling	Knowledge of principles, methods, and procedures for diagnosis, treatment, and rehabilitation of physical and mental dysfunctions, and for career counseling and guidance.

Frequency	Knowledge	Knowledge Description
6	History and Archeology	Knowledge of historical events and their causes, indicators, and effects on civilizations and cultures.
5	Geography	Knowledge of principles and methods for describing the features of land, sea, and air masses, including their physical characteristics, locations, interrelationships, and distribution of plant, animal, and human life.
5	Sociology and Anthropology	Knowledge of group behavior and dynamics, societal trends and influences, human migrations, ethnicity, cultures and their history and origins.
3	Fine Arts	Knowledge of the theory and techniques required to compose, produce, and perform works of music, dance, visual arts, drama, and sculpture.
2	Food Production	Knowledge of techniques and equipment for planting, growing, and harvesting food products (both plant and animal) for consumption, including storage/handling techniques.
2	Foreign Language	Knowledge of the structure and content of a foreign (non-English) language including the meaning and spelling of words, rules of composition and grammar, and pronunciation.
2	Philosophy and Theology	Knowledge of different philosophical systems and religions. This includes their basic principles, values, ethics, ways of thinking, customs, practices, and their impact on human culture.

ATTACHMENT 6: FREQUENCY OF SKILLS FOR 48 TARGETED OCCUPATIONS

Frequency	Skill	Skill Description
64	Reading Comprehension	Understanding written sentences and paragraphs in work related documents.
55	Active Listening	Giving full attention to what other people are saying, taking time to understand the points being made, asking questions as appropriate, and not interrupting at inappropriate times.
53	Critical Thinking	Using logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions or approaches to problems.
47	Active Learning	Understanding the implications of new information for both current and future problem-solving and decision-making.
46	Time Management	Managing one's own time and the time of others.
42	Speaking	Talking to others to convey information effectively.
41	Judgment and Decision Making	Considering the relative costs and benefits of potential actions to choose the most appropriate one.
34	Coordination	Adjusting actions in relation to others' actions.
31	Writing	Communicating effectively in writing as appropriate for the needs of the audience.
29	Mathematics	Using mathematics to solve problems.
28	Complex Problem Solving	Identifying complex problems and reviewing related information to develop and evaluate options and implement solutions.
27	Instructing	Teaching others how to do something.
26	Monitoring	Monitoring/Assessing performance of yourself, other individuals, or organizations to make improvements or take corrective action.
23	Troubleshooting	Determining causes of operating errors and deciding what to do about it.
21	Equipment Selection	Determining the kind of tools and equipment needed to do a job.
17	Management of Material Resources	Obtaining and seeing to the appropriate use of equipment, facilities, and materials needed to do certain work.
16	Science	Using scientific rules and methods to solve problems.
16	Service Orientation	Actively looking for ways to help people.
14	Social Perceptiveness	Being aware of others' reactions and understanding why they react as they do.
13	Installation	Installing equipment, machines, wiring, or programs to meet specifications.

Frequency	Skill	Skill Description
13	Quality Control Analysis	Conducting tests and inspections of products, services, or processes to evaluate quality or performance.
12	Learning Strategies	Selecting and using training/instructional methods and procedures appropriate for the situation when learning or teaching new things.
11	Equipment Maintenance	Performing routine maintenance on equipment and determining when and what kind of maintenance is needed.
11	Management of Personnel Resources	Motivating, developing, and directing people as they work, identifying the best people for the job.
11	Repairing	Repairing machines or systems using the needed tools.
10	Operation Monitoring	Watching gauges, dials, or other indicators to make sure a machine is working properly.
9	Operation and Control	Controlling operations of equipment or systems.
9	Operations Analysis	Analyzing needs and product requirements to create a design.
7	Management of Financial Resources	Determining how money will be spent to get the work done, and accounting for these expenditures.
7	Systems Analysis	Determining how a system should work and how changes in conditions, operations, and the environment will affect outcomes.
7	Systems Evaluation	Identifying measures or indicators of system performance and the actions needed to improve or correct performance, relative to the goals of the system.
7	Technology Design	Generating or adapting equipment and technology to serve user needs.
6	Negotiation	Bringing others together and trying to reconcile differences.
6	Persuasion	Persuading others to change their minds or behavior.
4	Programming	Writing computer programs for various purposes.

ATTACHMENT 7: JOB ZONE CLASSIFICATION

Code	Job Zone	Education/Training	
1	**Little or No Preparation Needed**	These occupations may require a high school diploma or GED certificate. Some may require a formal training course to obtain a license.	No previous work-related skill, knowledge, or experience is needed for these occupations.
2	**Some Preparation**	These occupations usually require a high school diploma and may require some vocational training or job-related course work. In some cases, an associate's or bachelor's degree could be needed.	Some previous work-related skill, knowledge, or experience may be helpful in these occupations, but usually is not needed.
3	**Medium Preparation Needed**	Most occupations in this zone require training in vocational schools, related on-the-job experience, or an associate's degree. Some may require a bachelor's degree.	Previous work-related skill, knowledge, or experience is required for these occupations.
4	**Considerable Preparation Needed**	Most of these occupations require a four-year bachelor's degree, though not all occupations.	A minimum of two to four years of work-related skill, knowledge, or experience is needed for these occupations.
5	**Extensive Preparation Needed**	Bachelor's degree is the minimum formal education required for these occupations; however, many also require graduate school.	Extensive skill, knowledge, and experience are needed for these occupations. Many require more than five years of experience.

Using the Job Zone classification system, eighty-five (85) percent of new jobs will require medium to extensive preparation, ranging from training in vocational schools, and related on-the-job experience, to an associate's degree or a bachelor’s degree.

JOB ZONE RATING OF NEW HIGH-GROWTH, HIGH-WAGE JOBS

Job Zone	Number of Occupations in Category	Percent of Occupations	Number of Jobs	Percent of Jobs
1 Little or No Preparation Needed	10	2.9 percent	1,748	1.6 percent
2 Some Preparation	45	13.2 percent	38,140	14.2 percent
3 Medium Preparation Needed	104	30.4 percent	109,820	40.0 percent
4 Considerable Preparation Needed	118	34.5 percent	89,812	33.1 percent
5 Extensive Preparation Needed	65	19.0 percent	30,698	11.0 percent
Total	342	100 percent	270,218	100 percent

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[xvi] Kirst and Venezia, 2004.
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[xix] Arizona Minority Education Policy Analysis Center, 2005
[xx] Source: National Governors Association
[xxi] See also Education Commission of the States (2005); and National Center for Public Policy and Higher Education (2005).
[xxii] Education Trust, ACT, 2005
[xxiii] Rumberger, 2001; Natriello, 1987.
[xxiv] Briars and Resnick, 2000; Smith and O'Day, 1990
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[xxix] Source: Report to the Board of Regents. Executive Summary, 2004-05 High School Report Card.
[xxx] Venezia and Kirst, 2001.
[xxxi] Arizona Department of Commerce, *A Workforce Needs Assessment of the Arizona Construction Trades Industry*, prepared by ACCRA (Arlington, VA), February 2005, p. 19.
[xxxii] According to *2004-2005 Arizona's Housing Market…a glance*, a report prepared by the Arizona Housing Finance Authority, Housing Commission, and Department of Housing, a worker must earn $15.71, or $32,677, to afford rent in urban areas of the state. (p. 1).
[xxxiii] According to *2004-2005 Arizona's Housing Market…a glance*, a report prepared by the Arizona Housing Finance Authority, Housing Commission, and Department of Housing, a worker must earn $12.68 to rent in any area of the state. (p. 1).
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[xxxvi] Arizona Department of Commerce, Positioning Arizona for the Next Big Technology Wave: Development and Investment Prospectus to Create a Sustainable Systems Industry in Arizona, March 2004, p. xxvi.

[xxxvii] Arizona Department of Commerce, Positioning Arizona for the Next Big Technology Wave: Development and Investment Prospectus to Create a Sustainable Systems Industry in Arizona, March 2004, p.117.
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[xxxix] According to *2004-2005 Arizona's Housing Market…a glance*, a report prepared by the Arizona Housing Finance Authority, Housing Commission, and Department of Housing, a worker must earn $15.71 to rent in an urban area of the state. (p. 1).
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[xli] Battelle Memorial Institute, *Arizona Bioscience Workforce Strategy: Preparing for the Future*, October 2003, p.A-1. Note, the report lists 13 occupations, but two are combined into a single SOC occupation in Arizona's Labor Market Information System:
[xlii] Battelle Memorial Institute, Arizona Bioscience Workforce Strategy: Preparing for the Future, October 2003, p.77.
[xliii] Battelle Memorial Institute, Arizona Bioscience Workforce Strategy: Preparing for the Future, October 2003, p.6.
[xliv] Maricopa Community College, *Arizona Bioscience Workforce Strategy: Preparing for the Future*, prepared by Battelle Memorial Institute, October 2003.

[xlv] According to *2004-2005 Arizona's Housing Market…a glance*, a report prepared by the Arizona Housing Finance Authority, Housing Commission, and Department of Housing, a worker must earn $12.38 to rent in the state. (p. 1).
[xlvi] According to *2004-2005 Arizona's Housing Market…a glance*, a report prepared by the Arizona Housing Finance Authority, Housing Commission, and Department of Housing, a worker must earn $12.38 to rent in the state. (p. 1).
[xlvii] Power Point presentation provided by Bernie Ronan, Maricopa Community College. *Arizona Tourism Workforce Assessment Initiative* (July 2005) was sponsored by the Arizona Community College Association, the Arizona Office of Tourism, the Arizona Tourism Alliance, the Arizona Restaurant & Hospital Association, and the Arizona Hotel & Lodging Association.
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