Evaluation of the Illinois Network for Advanced Manufacturing: Final Report

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Executive Summary

Following is a brief summary of the INAM project, the evaluation, the findings, and the recommendations. For those wishing to examine the full report, chapter and section references are provided to help the reader find the relevant sections.

INAM Description and Activities (section 2.1)

The Illinois Network for Advanced Manufacturing (INAM) is a consortium of 21 two-year colleges from across Illinois that sought to prepare TAA-eligible and other workers for employment in high-wage, high-skill advanced manufacturing occupations within six areas: certified production technicians, mechatronics, precision machining (CNC or computer numerical control), industrial maintenance, and welding/metalworking. Originally, INAM also was intended to offer courses in green manufacturing but that plan was dropped due to a lack of common certificate offerings at any of the colleges.

Following are the key components of the INAM programs:

- Use educational plans to provide students with a clear path for success;
- Strengthen the curricula and support the earning of industry-recognized credentials;
- Purchase equipment that aligns with the needs of local industries;
- Develop online and technology-enabled learning by strategically aligning INAM programs with technology purchased by the Illinois Green Economy Network (IGEN);
- Provide the opportunity for prior learning assessments to accelerate students' progress through the program and recognize past experience;
- Develop internships and on-the-job training opportunities;
- Provide placement services; and
- Develop articulation agreements with four-year colleges and universities.

The project specifically targeted TAA workers, veterans, incumbent workers, unemployed, and others who sought additional training to secure and/or maintain employment. However, the INAM colleges accepted all students who applied.

Evaluation Design Summary (sections 1.5; 2.3; and Appendix A)

The evaluation was designed to answer the following research questions:

Implementation study

- How was the particular curriculum selected, used, or created?

- How were programs and program design improved or expanded using grant funds? What delivery methods were offered? What was the program administrative structure? What support services and other services were offered?
- Did the grantees conduct an in-depth assessment of participants' abilities, skills and interests to select participants into the grant program? What assessment tools and process were used? Who conducted the assessment? How were the assessment results used? Were the assessment results useful in determining the appropriate program and course sequence for participants? Was career guidance provided, and if so, through what methods?
- What contributions did each of the partners (employers, workforce system, other training providers and educators, philanthropic organizations, and others as applicable) make in terms of: 1) program design, 2) curriculum development, 3) recruitment, 4) training, 5) placement, 6) program management, 7) leveraging of resources, and 8) commitment to program sustainability? What factors contributed to partners' involvement or lack of involvement in the program? Which contributions from partners were most critical to the success of the grant program? Which contributions from partners had less of an impact?

Outcomes study

- How do academic outcomes of participants and nonparticipants compare?
- How do employment outcomes of participants and nonparticipants compare?
- Do impacts vary by program or student characteristics?
- How will differences in treatment and comparison groups be adjusted?

To guide the evaluation, the logic model below outlines the process of developing and implementing the TAA grant and INAM consortium. The model presents two distinct pipelines: a pipeline of the planning activities to be carried out by the consortium and a pipeline of program implementation activities to be carried out by the consortium and its constituent institutions. The program outputs roll out in two time periods, short-term outputs (the aligned curricula, credentials, and coursework from INAM; the access to new equipment and tools acquired by needs identified in the curricula modifications; and new internship opportunities and job search aid) and intermediate outputs (the programmatic mix of credentials formed by the combination of the three short-term outputs). The contextual factors influence both entry into the participant pipeline, generating the social needs the program aims to fill, and the degree of program success in realizing intended outcomes. The outcomes indicated by the model contain the higher education institutional changes brought about by the consortium itself and the employment and student effects generated by the program's output.

The evaluation study used a mixed-methods approach, collecting qualitative data from interviews and focus groups, qualitative and quantitative data from surveys, and quantitative data from college administrative records and job and wage data from state unemployment insurance data. More specifically, the data collections included surveys of INAM student participants upon entrance and exit; surveys of project directors, faculty, data stewards, education planners, and other college personnel; interviews of project directors at each INAM college; focus groups of students and faculty at each INAM college; surveys of project directors at the end of the implementation period, and interviews and focus groups of employers. In addition, content experts in each of the five INAM areas reviewed the syllabi for each INAM program and each college, and provided detailed critiques.

The evaluation study also included comparison groups to help in estimating what outcomes students might have been achieved if the consortium had not been in place. The primary comparison

group consisted of students who attended the same institutions prior to the implementation of INAM, though for some types of analyses it was possible to also use some INAM students as a comparison group, using their employment records prior to their participation in INAM as a measure of employment outcomes for nonparticipants.

There were a few known biases in selecting the comparison group of prior attenders that could be adjusted for in the analysis: one college improperly provided no students who had received certificates, and six colleges provided only students who had received certificates. These biases do not affect all analyses in the same way; for example, the data from colleges providing only certificates can be used when estimating the average length of time it takes to earn a certificate, but not to estimate the likelihood of earning a certificate. In those cases where the selection bias might affect the analysis, the biased data were dropped from the analysis. Except for these biases at the seven colleges using inappropriate selection criteria, it seems likely that the comparison group was highly similar to the INAM participants: (1) the same general selection criteria were used, selecting all students who appeared to be enrolling in a complete advanced manufacturing program (i.e., omitting those who appeared to be taking only a single course [such as a hobbyist] and those selecting a course to fill a requirement for a different certificate); (2) since community colleges largely draw students from within a specified geographic area, the use of prior attendees means that the comparison students and INAM participants were drawn from the same general pools (except that a few colleges had no comparable programs prior to INAM and thus could not provide comparison students); and (3) the time periods for the student enrollments were not greatly different between the comparison students and INAM participants. If there is a bias in the selection process, it is likely to be in the direction that the comparison students were more likely to be persistent course-takers than the INAM participants; the reason is that one can retrospectively determine that a comparison student was not serious about a program (e.g., because the student took only a single course), while making the same determination for INAM participants at the time of enrollment is more difficult. Thus, there may be a small tendency for the comparison students to show better educational outcomes. Unfortunately, data on the comparison students were too limited to measure the degree of similarity with INAM participants or to adjust for differences; the colleges provided insufficient data about the students to support modeling, and the response rate to a survey of the comparison students was so low that the survey data effectively were not usable..

Implementation Findings

Building of institutional capacity

- Colleges strengthened their academic programs, with some that can be viewed as exemplary. (chapter 6)
- Colleges purchased new equipment that will provide a lasting resource for continued instruction. (page 4-3)
- The colleges indicate that they plan to continue most of the changes they made and to strengthen their programs further. (chapter 7)

Partnerships

- College faculty have developed relationships with faculty at other colleges that they expect to continue. (page 4-3)

- The colleges established articulation agreements with four four-year colleges, making it easier for graduates to earn four-year degrees.(page 2-11)

- Partnering with local businesses has increased at some of the colleges. (section 2.15)

Fidelity to original design

- INAM largely followed its original plan, but two components were dropped: plans for a program in green manufacturing (because the colleges' offerings were too dissimilar to address as a consortium), and plans to use technology purchased by IGEN (because the system did not seem readily usable). (page 2-25)

- Three other INAM strategies were used in a more limited manner than planned: internships (because of a lack of positions due to the local economy, combined with legal liability issues), the educational planning process (which varied from little more than data collection to persistent advising and followup, depending on the college), and prior learning credits (because faculty often were unwilling to trust that students were properly prepared).

- Some of the equipment was purchased relatively late in the grant period, and thus was not available to all students.

The main impact of dropping the green manufacturing program is that INAM enrollments otherwise might have been larger. Since the technology purchased by IGEN did not appear readily usable, dropping its use probably was not significant.

The limited use of some of the planned INAM strategies may have reduced INAM's opportunities to maximize retention by failing to provide personalized followup in advising, and failing to provide shortened paths to program completion. The limited use of internships may possibly have lowered employment prospects for program participants. The potential impact of increasing access to credits for prior learning is arguable: they have the potential to shorten program completion time, but faculty often did not trust that affected students would have had sufficient training.

The delayed purchase of equipment may have lessened students' opportunities to make use of the equipment, potentially also affecting students' retention and employment prospects.

Participant Impacts and Outcomes

- INAM exceeded its projections in terms of enrollment (2,655 vs. 2,487), retention (1,402 vs. 1,132), the number of students earning credit hours (2,362 vs. 2,054)), and the number receiving a wage increase after enrollment (760 vs. 565). (p. 3-11)

- Students frequently earned credentials, which should be helpful in finding employment. Overall, 16 percent earned one or more INAM certificates without earning an outside credential, 7 percent earned both an INAM certificate and an outside credential, and 6 percent earned only an outside credential. (p. 3-4)

- The rate of certificate completion was lower than projected, but improved relative to the rate found for the comparison group (37 percent versus 18 percent, looking at completion over 2.3

years). However, it is still premature to estimate ultimate completion rates; those in the comparison group took an average of 2.7 years, which is more than was available to any of the INAM students. (p. 3-5)

- Employment rates were higher among INAM students who enrolled prior to a given quarter, compared with those who had not yet enrolled as of that same quarter. Depending on the employment quarter, the employment rate was between 1 and 9 percentage points higher, with an average of 5 percentage points higher. (p. 3-7)

- Findings on wages were more complicated. Since employment rates were higher after participating in INAM, some INAM participants received wages who otherwise probably would not have received them. There also was a general trend of increasing wages. However, participants' wages were not significantly different than those of nonparticipants or the comparison group, and were often worse. (pp. 3-8 – 3-10)

- Students showed a wide diversity of outcomes, and DOL's original performance measures are too limited to fully reflect them. In particular, students often attained employment at times not captured by the performance measures, such as prior to exiting the college, after the first quarter after exiting the college, or after completing one or a few courses without completing the program and receiving a certificate.[1] A substantial number also received outside credentials without receiving a college certificate, and such credentials may be sufficient to help the students with their employment.

These data on outcomes are not definitive for two reasons. First, the time period available for the project and the evaluation was too short for many students to complete the program, and for the employment outcomes to be fully measured. Second, there are not sufficient data to adequately describe whether or how the comparison group differed from the INAM participants, or to statistically adjust for any such differences. However, the selection procedures that were used should have produced roughly equivalent groups, and the use of information on INAM participants prior to their enrollment provided another source of comparison data.

[1] Students were counted in the DOL performance measure if they started their job in either the quarter of exiting or the quarter after exiting. If they started a term (or more) before that time or after that time, they may still represent employment resulting from INAM participation, but do not get counted in the DOL measure.

Employment and education outcomes among INAM participants (Tables 3-1, 3-2, and 3-4)

Outcome measure	Number	Percent
Enrollment and retention measures		
Unique participants served/enrollees (B1)	2,655	100
Total number who have completed a grant-funded program of study (B2)	600	23
Total number of grant-funded program of study completers who are incumbent workers (B2a)	333	13
Total number still retained in their programs of study (or other grant-funded programs) (B3)	1,402	53
Total number retained in other education program(s) (B4)	7	0
Total number of credit hours completed (aggregate across all enrollees) (B5)	26,077	NA
Total number of students completing credit hours (B5a)	2,362	89
Total number of earned credentials (aggregate across all enrollees) (B6)	773	NA
Total number of students earning certificates - less than one year (aggregate across all enrollees) (B6a)	600	23
Total number of students earning certificates - more than one year (aggregate across all enrollees) (B6b)	0	0
Total number of students earning degrees (aggregate across all enrollees) (B6c)	35	1
Total number pursuing further education after program of study completion (B7)	180	7
Employment and education status*		
Students who earned a certificate		
Total employed after program of study completion (not incumbent worker, not employed in quarter before exit, and employed in quarter after exit) (APR B8)	41	2
Not incumbent worker, employed in quarter before exit, and employed in quarter after exit	20	1
Incumbent worker and employed in quarter after exit with higher wages	112	5
Incumbent worker and employed in quarter after exit	49	2
Earned certificate and employed in last quarter with available data	215	9
Earned certificate and still enrolled in fall 2015	37	1
Earned certificate and not employed in last quarter with available data	101	4
Students not earning a certificate		
Not incumbent worker, did not earn certificate, and employed in last quarter with data with higher salary	445	18
Incumbent worker, did not earn certificate, and employed in last quarter with available data with higher wages	533	22
Incumbent worker, did not earn certificate, and employed in last quarter with available data	305	12
Still attending college in fall 2015	246	10
Not employed in last quarter with available data	371	15
Total retained in employment after program of study completion (not incumbent worker, not employed in quarter of exit, and employed in 3 quarters after exit) (B9)	18	1
Wages*		
Total employed at enrollment who received a wage increase post-enrollment (incumbent worker with wage increase) *(B10)*	760	31
Incumbent worker with no wage increase	461	19
Non-incumbent worker with zero wages prior to INAM and positive wages after entering INAM	146	6
Non-incumbent worker with nonzero wages prior to INAM and higher wages after entering INAM	111	4
Non-incumbent worker with zero wages both prior to and after entering INAM	304	12
Started INAM too late to measure wage increases	459	19
Other person who is not an incumbent worker	234	9

* Percentages are based on INAM participants with wage/employment data

Conclusions

INAM had many successes, including a strengthening and expansion of the academic programs, the acquiring of useful equipment, the encouragement of cooperation across colleges, improvements in enrollment, improvements in retention, and improvements in job attainment. The colleges also anticipate that most of the changes made will be persisting changes.

INAM may have not reached its full potential by not fully implementing some of the original plans, such as providing more personalized and persistent advising, more extensive use of internships, and greater availability of credits for prior learning. Students also might have benefited more from earlier purchases of equipment.

INAM may possibly have overestimated the economic potential for advanced manufacturing; the programs appear to help participants to find employment, but not necessarily with higher wages. However, possibly it is too early to measure the full economic potential for participants, partly because they often have not had adequate time to complete the program, and because the entry-level positions they attain after participating in INAM may not reflect their full potential for improved wages.

Colleges that wish to replicate the project have substantial data available that can be useful, such as the course syllabi that are posted on the web, along with the comments of the content experts who reviewed the syllabi. They should understand that substantial planning is required to implement the program successfully. INAM colleges were not always ready to implement their programs or purchase equipment, and the creation of new programs can take substantial time in terms of having the curricula reviewed and approved.

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Table

Introduction 1

This report discusses the final status of the Illinois Network for Advanced Manufacturing (INAM) as of the conclusion of the program implementation following the last term in fall 2015.

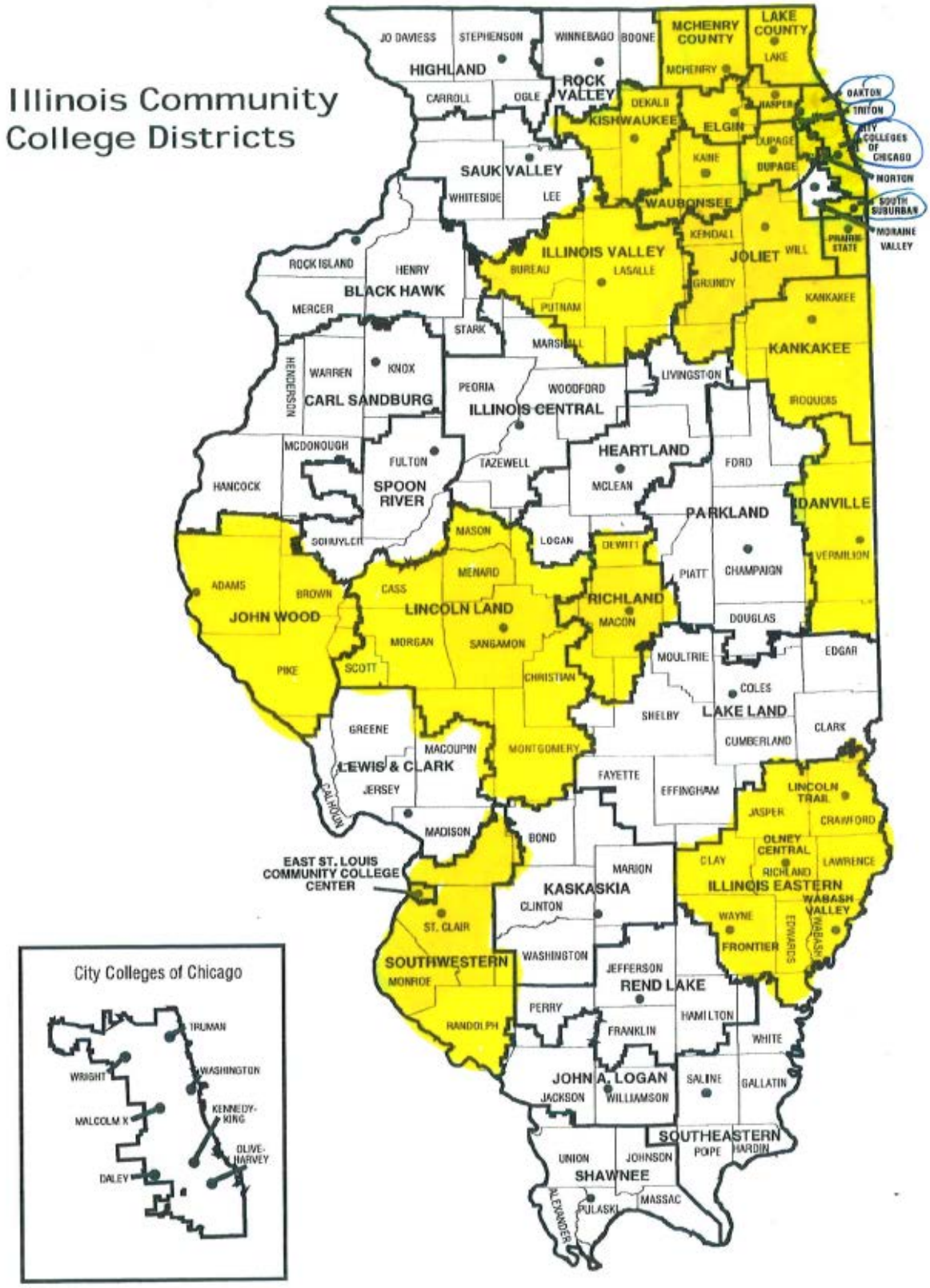
1.1 History and Purpose of INAM

In 2009, the American Recovery and Reinvestment Act amended the Trade Act of 1974 to authorize the Trade Adjustment Assistance Community College and Career Training (TAACCCT) Grant Program. On March 30, 2010, President Barack Obama signed the Health Care and Education Reconciliation Act, which included $2 billion over four years to fund the TAACCCT program. TAACCCT provided community colleges and other eligible institutions of higher education with funds to expand and improve their ability to deliver education and career training programs that could be completed in two years or less and were suited for workers eligible for training under the TAA for Workers program as well as veterans and other workers. TAACCCT focused on ensuring that the nation's institutions of higher education could help adults succeed in acquiring the skills, degrees, and credentials needed for high-wage, high-skill employment while also meeting the needs of employers for skilled workers.

In response to the authorization of TAACCCT, the Illinois Network for Advanced Manufacturing (INAM) was formed. INAM's membership included 21 two-year colleges from across the state that came together to apply for TAACCCT funds to promote and provide training in advanced manufacturing throughout Illinois (see Figure 1-1). The stated purpose of INAM is "To expand and improve the network's ability to deliver education and career training programs leading to industry-recognized certificates or associate degrees that can be completed in two years or less and prepare TAA-eligible and other workers for employment in high-wage, high-skill advanced manufacturing occupations that meet employer needs. The pathways that are being created provide access to highly paid jobs within advanced manufacturing through a myriad of entrance points that match the skill sets and educational attainment of the prospective students."

INAM has focused on different areas in advanced manufacturing: certified production technicians, mechatronics, precision machining (CNC or computer numerical control), industrial maintenance, and welding/metalworking. Originally, INAM also was intended to offer courses in green manufacturing, but that plan was dropped due to a lack of common certificate offerings at any of the colleges.

Figure 1-1. INAM member colleges



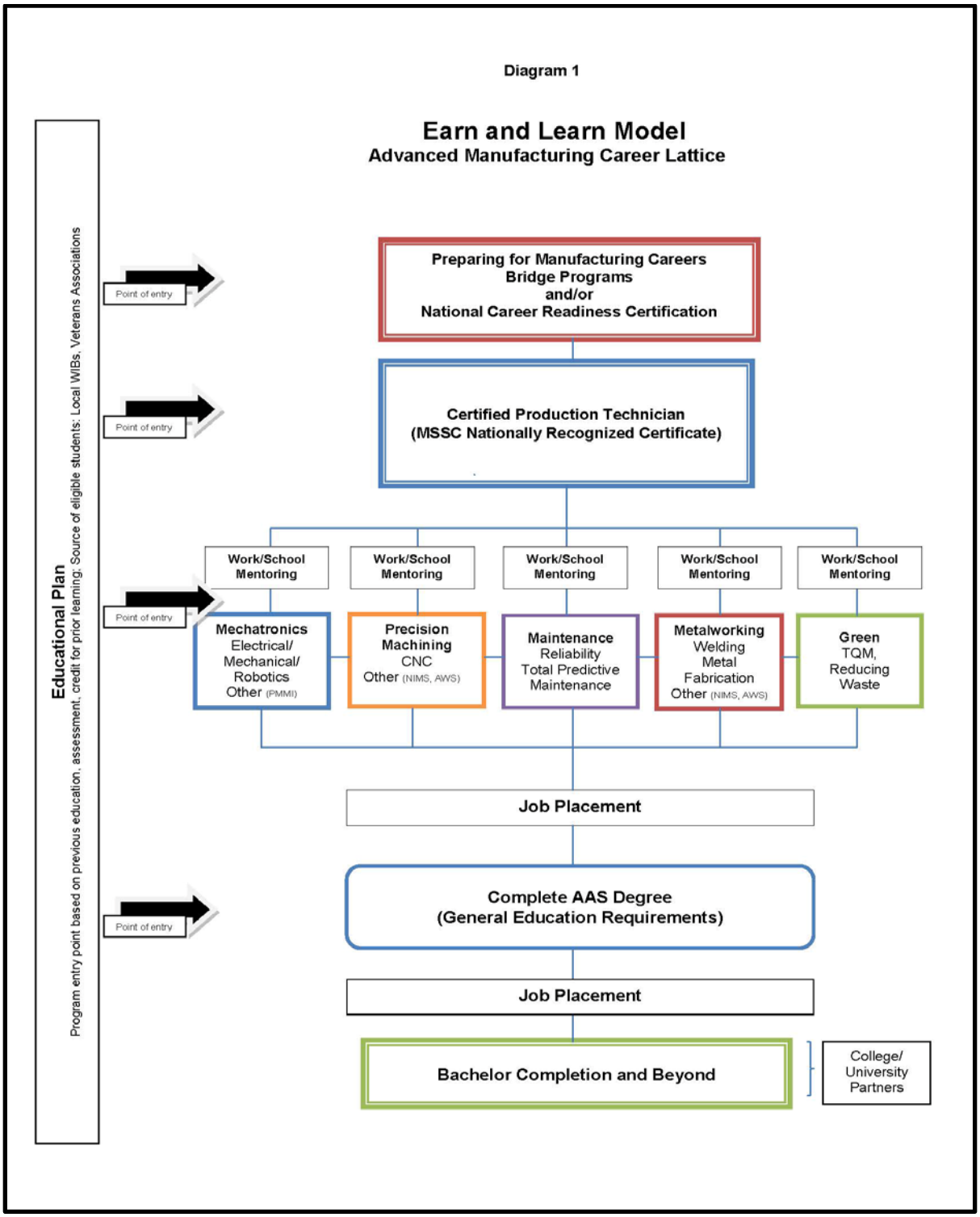
1.2 Overview of the INAM Model

INAM was created to achieve six objectives:

- To create educational plans for participants that provide a clear pathway and lattice to industry-recognized credentials in advanced manufacturing;
- To build and offer programs along the career pathway and lattice that meet advanced manufacturing industry needs and result in industry-recognized credentials and/or associate degrees;
- To develop online and technology-enabled learning by strategically aligning INAM programs with technology purchased by the Illinois Green Economy Network (IGEN), a first-round TAA awardee;
- To develop partnerships that include internships and on-the-job training opportunities in advanced manufacturing;
- To provide placement services that connect students to available jobs in advanced manufacturing;
- To develop articulation agreements with four-year colleges and universities that allow students to further their education in advanced manufacturing.

The project, entitled the "Earn and Learn Advanced Manufacturing Career Lattice Program," specifically targeted TAA workers, veterans, incumbent workers, unemployed, and others who sought additional training to secure and/or maintain employment. The Earn and Learn Program was designed to allow participants to earn stackable, portable certificates and degrees that lead to highly paid jobs within advanced manufacturing while simultaneously working in the industry. Participants were able to enter the program at multiple points based on assessment results that matched individual skills and education needs. The diagram on the following page illustrates the Earn and Learn Program flow and components.

Figure 1-2. Earn and Learn Program flow and components



The components of the Earn and Learn model were encompassed within the six priorities and 12 strategies shown in Table 1-1.

Table 1-1. INAM Earn and Learn priorities and strategies

Earn and Learn Advanced Manufacturing Career Lattice Program Priorities and Strategies	
Priority 1.0	Create educational plans that provide a clear pathway and lattice to industry-recognized credentials in advanced manufacturing.
Strategy 1.1	Develop educational plans outlining coursework and timelines.
Strategy 1.2	Develop a mechanism for awarding academic credit for prior learning.
Priority 2.0	Implement programs along the career pathway and lattice that meet advanced manufacturing industry needs and result in industry-recognized credentials and/or associate degrees.
Strategy 2.1	Offer bridge programs in technical skills.
Strategy 2.2	Offer programming leading to the National Career Readiness Certificate (NCRC).
Strategy 2.3	Enhance programming in areas of specialization certificate programs.
Strategy 2.4	Offer associate degree completion.
Priority 3.0	Develop online and technology-enabled learning by strategically aligning INAM programs with technology purchased by the Illinois Green Economy Network (IGEN), a first-round TAA awardee.
Strategy 3.1	Engage in a partnership with IGEN in using National Training Education Resource (NTER) System.
Priority 4.0	Develop partnerships with employers that include paid internships and on-the-job training opportunities in advanced manufacturing.
Strategy 4.1	Engage employers to secure paid internships and on-the-job training.
Strategy 4.2	Conduct regular employer input and feedback sessions.
Priority 5.0	Provide placement services that connect students to available jobs in advanced manufacturing.
Strategy 5.1	Develop a platform that provides job posting capabilities for employers and résumé posting for students.
Strategy 5.2	Enhance the image of advanced manufacturing.
Priority 6.0	Improve articulation of credit between two-year and four-year colleges to facilitate pursuit of additional education in advanced manufacturing.
Strategy 6.1	Develop articulation agreements with four-year colleges and universities.

1.3 Purpose of the Evaluation

INAM engaged the team of Paul T. Bucci PhD LLC, GEM Software, and Westat as outside evaluators to provide both formative and summative evaluations of the INAM program. The formative evaluation focused on the implementation of the program and was the primary focus of earlier reports written about this program. Those reports described how the grant was carried out and provided recommendations on how the implementation might be improved. Chapter 2 of this report provides a summary of the major findings of the formative evaluation and helps to create a context for the summative evaluation. This report is the final report on the evaluation and is primarily a summative evaluation that looks at outcomes from the program, focusing particularly on the educational and career success of the participants as compared with similar nonparticipants.

1.4 Purpose of the Final Report

The first year of INAM was devoted primarily to program development, i.e., developing the overall structure of the program, setting learning objectives to guide the creation or modification of courses in advanced manufacturing, buying equipment, and making preparations for teaching the revised courses. Some of that work was performed at the individual college level, while there were also substantial activities that involved working as a consortium; these include creating and establishing consistent communications, reporting, and fiscal procedures; clarifying the six strategies so that the 21 colleges were on the same page as much as possible; completing an agreed-upon curriculum; and encouraging sharing across the group. The report on that year focused on the initial organizational and program development issues that arose.

The second year of INAM was the first full year of INAM course offerings. (One college offered one initial course during the summer of the first year as a way of testing some of the tools to be used by the program.) The report on the second year was necessarily an interim report: although some students had completed the programs at their colleges, other students only partially completed their programs, and new students continued to be enrolled. Also, some of the colleges were continuing to develop their INAM programs, sometimes adding new programs under INAM.

The third-year report focused largely on cumulative results following the end of the third year, which was the last full year of INAM implementation under the grant. (However, INAM received permission from DOL to extend the program offerings into fall 2015, which is the first term of the fourth year.) As of the end of the third year, INAM had completed six of the seven academic terms in the grant program (plus the testing of a single course in the summer of 2013), so a substantial amount of data were available for the third-year report. Also, all of the 21 colleges had hosted site visits, providing interviews and focus groups of project directors, faculty, and students and substantial contextual knowledge for understanding the programs at each college.

This final report differs from the earlier reports in the following ways. First, it provides the most comprehensive picture of INAM, covering all seven INAM terms. Second, it is the only report for which comprehensive employment data are available, providing an additional important perspective on the outcomes produced by INAM. Third, unlike the other reports, this report includes analysis of a comparison group of comparable students who took advanced manufacturing courses prior to the implementation of INAM, thus providing a way of measuring whether the outcomes from INAM are different from what otherwise might be expected. Fourth, this is the first report to also provide the perspective of employers. This phase of the study intentionally was delayed until the last year in order to broaden employers' exposure to INAM and its graduates. Fifth, responding to a request from the DOL, this report provides the results of a review of the curricula developed for INAM. One of the intentions of the DOL grant is to provide initial groundwork that other colleges or consortia might use to develop their own programs to help potential workers find a productive place in the economy. To satisfy this request, advanced manufacturing experts were asked to review the syllabi of each college's INAM courses, both evaluating the adequacy of the courses as currently designed and discussing how the courses might be improved.

The statistics in this report may sometimes differ from those in the Annual Performance Reports (APRs), either because they are based on updated data or additional data or because of differences in the definitions, as noted in the text when relevant. One such difference that applies broadly to the evaluation is that, for auditing purposes, DOL only counts students for which INAM has Social Security numbers; the evaluation study necessarily had to follow that restriction with regard to employment data since such data were only available for those students. However, there were a small number of students who

participated in INAM but did not provide Social Security numbers, and these students are counted when data are available for them, since that provides a more complete picture of what students were served by INAM and what outcomes they experienced.

1.5 Description of the Research Methodology and Analytic Approach

This study is based on multiple sources of data, using a mixed-methods approach that combines qualitative and quantitative data. The data sources include site visits at the 21 participating colleges, surveys of students as they first entered INAM and after they exited it, institutional data about the students and institutions, interviews and focus groups of employers, employment data provided by the Illinois Department of Employment Security, institutional data and employment data for a group of comparable students who enrolled prior to the implementation of INAM, a survey of project directors at the end of the grant, and reviews of the course designs by experts in the five content areas covered by INAM. Each of these is described in greater detail here.

1.5.1 Site Visits

This section provides a brief summary of the procedures used for the site visits. Additional information is provided in Appendix A.

All 21 participating colleges were visited over three academic terms, with seven colleges apiece in spring 2014, fall 2014, and spring 2015. The schedule of site visits appears in Table 1-2. The site visits were spread out over time so that all stages of the program could be observed. (The programs evolved differently across the institutions—e.g., with some institutions creating new programs in year 3—so there could be justification for visiting each institution multiple times. The design that was used was a compromise, limiting the cost and burden to the institutions, while also providing information across multiple sites and time periods.)

Table 1-2. Schedule for site visits to colleges

Spring 2014	Fall 2015	Spring 2015
College of Lake County	College of DuPage	Daley College, City Colleges of Illinois
Elgin Community College	Danville Area Comm. College	Illinois Valley Community College
John Wood Community College	Illinois Eastern Comm. Colleges	Joliet Junior College
Kishwaukee College	Oakton Community College	Kankakee Community College
Lincoln Land Community College	Southwestern Illinois College	Prairie State College
McHenry County College	Triton College	South Suburban College
Richland Community College	William Rainey Harper College	Waubonsee Community College

The site visits included interviews with the project director at the college (often conducted by telephone prior to the site visit), focus groups of selected INAM faculty, and focus groups of selected INAM students. The third-year report provides the protocols for these interviews and focus groups. The protocols changed modestly over time in order to address new issues of interest, but they were intentionally kept largely similar across all three rounds of site visits so that comparable data would be collected. However, since the INAM program continued to evolve over the course of the project, the responses obtained from a college during the second year were not necessarily expected to describe that same college's program during the third year; for example, the role of educational planners may have changed over time.

The participants in the interviews and focus groups were promised confidentiality in order to encourage complete and honest responses. For faculty, the promise included a promise not to reveal the college or the participant. Thus, no quotation or reference to an interview identifies a specific person, and many do not name the college.

Table 1-3 shows the numbers of people who participated in the focus groups and interviews. Some individuals had more than one role in the project (e.g., acting as both an education planner and a data steward). In such cases, they participated in only one focus group. Some colleges have more than one staff member filling a particular role, but typically there was one person per college in each role.

Table 1-3. Number of participants in the focus groups and interviews

Role	Round 1	Round 2	Round 3	Total
Project directors*	10	8	9	27
Education planners	0	8	6	14
Faculty	17	26	20	63
Students	50	64	49	163

*A few education planners were interviewed with project directors during round 1. In rounds 2 and 3, education planners were interviewed separately.

Data from interviews and focus groups cannot be generalized to the full INAM community. The people who participated may not necessarily be representative of the larger populations, the numbers involved were too small to justify extrapolation to the larger community, and an opinion expressed by one participant may not necessarily have reflected the opinions of all people in the focus group. Other types of data, such as surveys and student-level data, are used to examine consortium-wide activities and outcomes. The strength of focus groups and interviews is that they provide a way of collecting in-depth information about a person's experiences with INAM, helping to provide insights into the other data.

1.5.2 Surveys of Students

Two surveys of students were conducted. First, all INAM students completed an enrollment packet when they started participating in INAM. That survey collected basic information about demographics, how the student learned about INAM, the student's educational and employment backgrounds and goals, and the student's attitudes toward education and work. Second, if or when a student exited the INAM program, either by completing the program or by temporarily discontinuing participation, the student was administered an exit survey. The exit survey asked the student's reason for leaving, satisfaction with the program, types of assistance received, participation in internships or other cooperative relationships with businesses, attitudes toward education and work, future education plans, and employment. Since the INAM program continues to be in progress, and since students may take multiple years to complete their education, the data presented here are necessarily incomplete. A total of 478 exit surveys were completed from a total of 1,294 INAM participants who were known to have exited, with 125 of those surveys having been completed for the second year report.

1.5.3 Institutional Data

Data stewards at each college were responsible for collecting certain data from each student and entering them into a database. Some of the data included the survey data discussed earlier, but the data stewards also uploaded transcript data on the students and verified the students' continuing status with INAM. These data, together with the survey data, provide the basis for the quantitative data presented in

this report, such as on participants' retention in the program and their completion of the requirements for earning a certificate or degree.

1.5.4 Interviews and Focus Groups of Employers

Working with the 21 INAM colleges, employers who had hired students from INAM were identified, and that list was supplemented with local employers who were familiar with the colleges and who served on advisory committees. At two colleges, focus groups were held to facilitate interaction among the employers about the strengths and weaknesses of INAM and its students. Additionally, 17 employers were interviewed over the telephone in order to simplify the logistics of talking with the employers, provide the perspectives of a broader group of employers, and allow discussion of issues that might be too confidential to discuss in a group environment. Additional information about the methods used is provided in Chapter 5, where the results of these interviews and focus groups are presented, and the protocols are provided in Appendix B.

1.5.5 Employment Data

INAM established a cooperative arrangement with the Illinois Department of Employment Security (IDES) so that data obtained from the process for unemployment insurance could be used to obtain detailed and accurate data on the wages earned by INAM participants and the comparison group. Because employers are required to make quarterly reports and payments, this approach provides highly comprehensive and verified data on people's wages. While this data source is distinctive for its accuracy and comprehensiveness, a few weaknesses should be noted. First, the data cover only workers employed in Illinois; this is not a major weakness since all of the INAM colleges are in Illinois, but people who live or work out of the state will show no wages. Second, the data provide only the total earnings within an industry category; they do not indicate whether a person had multiple jobs (if those jobs were within the same category) or the number of hours the employee worked (e.g., whether the employee was full time or part time, or what the hourly wage was). Third, self-employed people are not included. Fourth, there is a lag time between the end of a quarter and when the employment data become available, so that employment data were not available for the students who entered most recently.

1.5.6 Comparison Group Data

The participating colleges provided administrative record data on students who enrolled in similar advanced manufacturing programs prior to the changes implemented in INAM. Sixteen of the 21 colleges provided comparison students, while five colleges did not have comparable advanced manufacturing programs prior to INAM and thus could not provide comparison students. The complete database includes 3,827 comparison students, but there are important limitations affecting how the data can be used. First, seven colleges selected the comparison students in ways that potentially may bias the results: six colleges provided only students who had completed certificates, and one college provided only students who had not completed certificates. Sometimes these differences are not critical (e.g., when calculating the length of time it takes to earn a certificate), while for other analyses one must either use statistical adjustments or drop the students from the analyses. Second, for many measures data were available only for about half of the students. The amount of missing data varied by college; for example, only seven colleges provided data on when the students first enrolled and when they finished their attendance. Third, only a limited amount of demographic data were available, limiting the extent to which one can make statistical

adjustments for differences in the samples. Overall, these data at best provide a general picture of how students performed prior to INAM, but do not support analyses at the individual college level.

Wage data also were obtained from IDES for those comparison group students for whom Social Security numbers were available, providing data on 549 of the comparison group students. Wage data were available for comparison group students at four colleges.

An online survey was attempted of the comparison group students, using both email and mail to invite participation. However, contact information for the students was often out of date, and the response rate was extremely poor, so the survey did not provide sufficient data to be useful for analysis.

1.5.7 Survey of Project Directors

At the end of the grant period, the project directors at each of the INAM colleges were asked to complete a short survey asking for their evaluation of the program and its impact, and their future plans for programs in advanced manufacturing. In some colleges, where multiple personnel shared project director responsibilities, more than one person was surveyed. Project directors varied in the length of time that they had been part of INAM, and this difference may sometimes lead to differences in perceptions. A total of 28 project directors responded, with all 21 colleges sending at least one response. A copy of the survey questionnaire is included in Appendix C.

1.5.6 Reviews of Course Syllabi

For each of the five content areas covered by INAM, one or two experts in the field were asked to review the learning objectives that INAM had set for their programs and the course syllabi for each college offering an INAM program in the content area. The results of these reviews are presented in Chapter 6 of this report.

1.6 Structure of This Report

Chapter 2 of this report discusses the operations of INAM, looking at how the program was implemented with respect to the population served, the curriculum taught, finances, coordination with businesses, the support structure for students, and other INAM features (including marketing, course delivery mechanisms, in-district tuition rates, and articulation agreements). Chapter 3 examines outcomes for INAM participants, including both educational outcomes and employment outcomes. It also reviews the results using the performance measures established by DOL. Chapter 4 examines the impact of INAM on participating colleges, looking at both how the programs have changed and how enrollment has changed. Chapter 5 presents employers' perspectives on INAM, particularly focusing on employers' experience with workers hired from INAM, but also including their perceptions of the colleges' programs overall. Chapter 6 presents the reviews of the course content being taught in the five content areas covered by INAM, with a particular focus on how these programs might serve as a model for other institutions seeking to create similar programs. Chapter 7 discusses the colleges' plans for the future, and whether the changes implemented through INAM are sustainable. Finally, Chapter 8 provides a final summary and recommendations. The appendices provide a detailed description of the methodology used by the study and the data collection instruments used in Year 4.

Operation of INAM 2

This chapter describes the INAM program as it was implemented across the 21 participating community colleges. The chapter examines the major features of the program, including marketing and student recruitment, curricular programs, supports for students during and after the program, college outreach to local employers, and collaboration among colleges. The INAM consortium did not have authority to impose particular curricula or strategies on participating colleges. Rather, the consortium functioned as a forum that allowed the participating colleges to discuss the needs of advanced manufacturing, establish common aims, and develop and share tools. Each institution retained the authority to customize its advanced manufacturing program(s) to meet local needs, and this chapter summarizes the features that participating colleges put into place. Then, the chapter explores the degree to which the program was implemented as specified in the logic model and the degree to which the outcomes of the logic model should be expected. Finally, the chapter provides recommendations for the implementation of future programs in advanced manufacturing.

2.1 Major Features

As discussed in Section 1.1, INAM is intended to provide a broad array of services, especially aid targeted to dislocated workers and veterans, but with open access to all. The goal is to support the local economies by training people in five areas within advanced manufacturing, thus both increasing the employment rate and helping industry to get qualified workers. The program included supports to facilitate student completion, including a process for helping advanced manufacturing students create and follow a coursework plan and, for students with experience in advanced manufacturing, a process for awarding college credit based on prior learning experiences. Supports for students after they had completed the INAM program included stacked credentials, articulation agreements with four-year colleges, and job placement. INAM also planned for outreach to businesses and ongoing collaboration among participating colleges.

2.1.1 Marketing and Recruitment

As indicated through interviews with INAM project directors and faculty members, some INAM colleges conducted specific efforts to recruit unemployed/dislocated workers, veterans, and/or high school students. Recruitment efforts often included the creation of special events. For instance, colleges hosted manufacturing days, open houses, tours, community fairs, career fairs, and informational meetings. In addition, some colleges recruited via flyers, websites, TV, or radio. Recruitment strategies for the INAM program did not appear to differ from previous recruitment efforts at the colleges. Recruiting results varied. Overall, only a minority of the students were those specifically targeted by (TAACCCT: 190 (7 percent) were eligible for TAA, and 343 (13 percent) were veterans.

Recruiting unemployed or dislocated workers. At a majority of colleges, at least one staff member described efforts to recruit unemployed or dislocated workers. Two project directors specifically mentioned working with a non-profit training agency serving this population, Opportunity Advancement and Innovation (OAI). One project director described working with the workforce agencies:

I've attended maybe five or six informational sessions along with our workforce agency when we've gone out to recruit students. We've held some of the sessions here on campus and some at the workforce office, and we have talked to them about the benefits of the program. And, see, the carrot there is that they're desperately looking for work and need the assistance. They're eligible for assistance, and the workforce [agency] has the dollars to help send them through training….We've gotten some good candidates through it.

Veterans. To recruit veterans, project directors or faculty members at a few colleges described going to veterans' groups and attending veterans' meetings. One project director stated that the college had a dedicated counselor for veterans and that recruitment of veterans had improved due to this effort. However, three of these project directors reported issues recruiting this group. Specifically, one project director stated that

We tried to reach out to our veterans early on but it didn't seem to have any impact at all… at the consortium level, they tried to put some [materials] out there, and we passed those materials on because they were geared towards specifically the veteran population. And it just did not seem to have any positive impact on enrollment or interest.

High school students. Community colleges are also responsible to serve their local population, including high school students and recent graduates. Some colleges recruited high school students through such methods as dual credit programs, tours for high school students, and career fairs. One project director reported the success of these efforts:

We came up with this Manufacturing Expo Day [for high school students]. The first one we did we had, I believe, 10 companies came in. They set up a booth. We put this out to the high schools.… We thought maybe we would get 50 students to come in. First year we had 200…last year we had close to 400.

Other recruitment methods. Three project directors described recruiting current employees at local companies for training. INAM students who participated in focus groups most commonly reported that they heard about the INAM program through personal recommendations from individuals such as family members, friends, faculty members, employers, or coworkers. Several students also described learning about the program while in high school, either through a bridge program or from a high school teacher. A few students had seen a flyer for the program or had read information about it online. Finally, a few students had learned about their programs through unemployment offices.

Changes in Recruitment Due to INAM

In many cases it was unclear whether colleges had changed their approach to recruitment in response to INAM. Colleges may have used recruitment methods that predated the INAM program and simply added information about the INAM program to the options that they presented to prospective students. For example, one project director stated that the college already attracted and recruited unemployed students prior to INAM. This project director specified that most of their students "are your typical non-traditional student, unemployed, laid off… dislocated, or TAA workers…we don't do anything specific [in recruitment for INAM]."

At several colleges, a faculty member stated that he/she did not see any differences in students' backgrounds since INAM. For instance, one faculty member said there was no difference between students recruited for the INAM program and those recruited previously, and he explained:

We [already] have such a diversity of students. Average age of our student here on campus is 28, and then we have, we have the veterans, we have displaced workers, we've got the high school student just graduated, we've got our dual credit students, so it's quite a potpourri of backgrounds and educational levels.

Students often were not aware of INAM as a consortium, though they still may have been attracted to INAM-related changes that they perceived at their local institutions. A minority of students were able to explain the overall purpose of the INAM grant and describe several benefits to their institutions, including equipment. Furthermore, one benefit of the INAM program is that students may attend any college in the 21-member consortium at in-district rates. Most students who participated in focus groups had not heard of the in-district tuition option.

2.1.2 Programs Offered

Curricula Offerings at Each College

Table 2-1 displays which of the INAM colleges offered each of the five programs. Each college offered between one and four INAM programs, and a few colleges offered additional INAM programs in 2014–15 that had not been offered in 2013–14. The most common programs were precision machining CNC (15 colleges in 2013–14), and welding/metal working (13 programs at 12 colleges in 2013–14, and 15 programs at 14 colleges in 2014–15; Illinois Eastern Community College has two welding programs—one at the Olney Central Campus and one at the Lincoln Trail Campus). Originally, INAM also intended to offer a program in green technology; however, though some of the INAM colleges offer programs in green technology, the programs had little in common across the colleges, and so INAM determined that defining an INAM program was not appropriate. From a broader perspective, an INAM committee of the 21 colleges met to suggest common learning objectives that could be used by all in any advanced manufacturing program, but no formal set of objectives was produced, and this report focuses on the five specific program areas INAM addressed.

Table 2-1. INAM programs offered in the second through fourth years of INAM, by college

College	Year(s) program was offered				
	Certified Production Technician (CPT)	Industrial Main-tenance	Mecha-tronics	Precision Machining CNC	Welding/ Metal Working
College of DuPage			2,3,4		2,3,4
College of Lake County				2,3,4	
Daley College—City Colleges of Chicago			2,3,4	2,3,4	2,3,4
Danville Area Community College			2,3,4		3,4
Elgin Community College				2,3,4	2,3,4
Illinois Eastern Community College*		2,3,4		2,3,4	2,3,4
Illinois Valley Community College	2,3,4	2,3,4		2,3,4	2,3,4
John Wood Community College	2,3,4	2,3,4		2,3,4	2,3,4
Joliet Junior College		2,3,4		2,3,4	2,3,4
Kankakee Community College	2,3,4	2,3,4		2,3,4	2,3,4
Kishwaukee College	2,3,4			3,4	2,3,4
Lincoln Land Community College	2,3,4				2,3,4
McHenry County College			2,3,4	2,3,4	
Oakton Community College		2,3,4	2,3,4	2,3,4	
Prairie State College				2,3,4	3,4
Richland Community College	2,3,4			2,3,4	
South Suburban Community College	2,3,4	3,4			
Southwestern Illinois College			2,3,4	2,3,4	
Triton College			2,3,4	2,3,4	
Waubonsee Community College			2,3,4	2,3,4	2,3,4
William Rainey Harper College	2,3,4			2,3,4	2,3,4

*Illinois Eastern Community College offers two different welding programs—one each at the Olney Central Campus and at the Lincoln Trail Campus.

Revision of Curricula

One of the objectives of INAM was to improve the curricula. As a first step in that process, the consortium colleges agreed to adopt a common set of terminal learning objectives for each of the five program areas taught by INAM, in each case for a beginning certificate in the program area. All INAM courses were required to align with the INAM terminal learning objectives for the appropriate program area. Next, every INAM course needed to be either a new course or an existing course that had been modified in terms of the curriculum, delivery system, or student activities. The only courses that did not need to be modified were courses outside of the INAM department, such as mathematics courses; these courses are considered part of the INAM curriculum but are not considered INAM courses and thus did not need to meet any of the criteria specified for INAM courses.

Table 2-2 displays the changes that the colleges made. To provide for consistent counts across colleges in the table, new courses are counted only as new courses and not as having made changes in the other categories, though it would be justifiable to say that every aspect was new for new courses. A mean of 1.6 of the possible changes were made to any given course. A total of 368 courses were modified, with 27 percent of the courses being new courses, 52 percent having a modified curriculum, 45 percent having a modified delivery system, and 41 percent having modified student activities. Four of the 21 colleges made curriculum changes to 100 percent of their INAM courses. Two of the colleges (Daley College and Danville Area Community College) modified all three aspects of their existing courses (curriculum, delivery system, and student activities) in 100 percent of their courses. However, these statistics only

count courses in terms of whether they were changed, not how much they changed; the latter topic is discussed next, using the focus group data.

Table 2-2. Total number of INAM courses and how they have been modified for INAM, by college

College	Total number of courses	New course		Modified curriculum		Modified delivery system		Modified student activities	
		Count	Per-cent	Count	Per-cent	Count	Per-cent	Count	Per-cent
Total	368	99	27	192	52	164	45	151	41
College of DuPage	13	7	54	6	46	1	8	5	38
College of Lake County	3	0	0	3	100	1	33	3	100
Daley College—City Colleges of Chicago	25	0	0	25	100	25	100	25	100
Danville Area Comm. Coll.	24	0	0	24	100	24	100	24	100
Elgin Comm. Coll.	15	0	0	15	100	0	0	0	0
Illinois Eastern Comm. Coll.	26	0	0	8	31	19	73	23	88
Illinois Valley Comm. Coll.	23	4	17	3	13	17	74	1	4
John Wood Comm. Coll.	28	12	43	5	18	11	39	0	0
Joliet Junior College	15	2	13	9	60	9	60	11	73
Kankakee Comm. Coll.	17	5	29	12	71	11	65	11	65
Kishwaukee College	15	6	40	8	53	0	0	1	7
Lincoln Land Comm. Coll.	23	14	61	9	39	8	35	8	35
McHenry County College	10	2	20	8	80	0	0	2	20
Oakton Comm. Coll.	23	0	0	1	4	22	96	6	26
Prairie State College	18	9	50	7	39	7	39	7	39
Richland Comm. Coll.	17	2	12	15	88	9	53	12	71
South Suburban Comm. Coll.*	9	9	100	0	0	0	0	0	0
Southwestern Illinois College	12	2	17	10	83	0	0	7	58
Triton College	14	4	29	8	57	0	0	4	29
Waubonsee Comm. Coll.	24	8	33	16	67	0	0	0	0
William Rainey Harper College	14	13	93	0	0	0	0	1	7

*South Suburban Community College did not teach any INAM courses in 2013–14 but did so in 2014–15.

Extent of Modification to Existing Courses

In focus groups and interviews, participants varied in the extent to which they reported that courses had been modified due to INAM. These variations occurred within colleges as well as across colleges. At many colleges, faculty members in one field of study reported only minor 'tweaks' to their courses, while faculty in another field reported significant curriculum changes. The changes occurred for multiple reasons: to align with INAM terminal learning objectives, to support the earning of credentials, and to accommodate new equipment that had been purchased through INAM.

Multiple reasons were given for making only minor INAM-related course changes. Programs at five colleges had been involved in other grant initiatives or had undergone internal curricular overhauls within the past few years prior to participating in INAM. One faculty member explained:

> *Well, we did change, but it was before INAM. We changed a lot of our CNC classes to reflect the NIMS* [*National Institute for Metalworking Skills, Inc.] testing process. So we*

kind of modified them… but we created that because of NIMS. Now when INAM came along, it was a great thing, but we were already on that path.

However, many colleges described making substantial changes to existing courses due to INAM. These colleges reported offering new courses and changing existing curricula to meet the INAM terminal objectives. The introduction of new equipment due to INAM was mentioned by most faculty members and project directors reporting changes as both a reason for changes to existing courses, as well as a facilitating factor for allowing existing courses to be taught more effectively.

Addition of New Programs and Courses

In 2014–15, the INAM colleges offered 123 certificates or degrees related to INAM course-taking, an increase from 109 in 2013–14. In focus groups and interviews, we asked faculty members and project directors to describe the creation of new degrees and certificates due to INAM.

In the case of one college, a project director noted that a new CPT certificate program was a "direct result of INAM." This certificate was developed with significant input from industry, who now endorse it on the college website and offer scholarship funds and job interviews to students enrolled in the program. At other colleges, certificate programs were created in new fields, added on to existing programs, or revitalized after long-dormant periods.

Project directors and faculty members from most colleges also reported that new courses had been developed for at least one program at their college. New courses were developed due to the creation of new certificates (e.g., if the college had not previously offered courses in welding) in order to meet the requirements of national credentials, in response to new equipment capacities, or due to lengthened certificates or degrees. Colleges differed on the number of new courses created, with some creating as few as one to those creating as many as seven or more. One project director reflected on the creation of a new safety course and how it was influenced by INAM:

That course did not exist before, nor did the formalized safety plans that we now have. So in a lot of this, we were looking at other schools and the consortium that have manufacturing programs that already existed in trying to align with what do their programs look like and what is industry saying that they need. And so, definitely, that safety course is born out of looking at where were we deficient, what could we do better, how could we better align with what students need to know when they leave here.

New courses were created in both existing and new certificate and degree programs.

Purchase of New Equipment

One of the major planned expenditures in the INAM budget was for new equipment, amounting to $3.8 million, or 29 percent of the total budget. All of the equipment expenditures were planned for the first two years of the grant, which helps to maximize the availability of equipment to INAM participants. The consortium colleges actually spent $2.9 million in the first two years, or 76 percent of what had been planned, and the remainder (for a total of $3.9 million) in the third year. INAM thus ultimately exceeded its original plan for equipment expenditures, though the expenditures were later than planned.

When project directors discussed the funding they had received for new equipment, they had few complaints. However, several project directors noted that their college required new or renovated

buildings to house the new equipment, and the INAM grant did not fund construction. For these colleges, construction was an unexpected expense associated with the grant.

New equipment had multiple benefits for INAM colleges. First of all, new equipment meant that colleges were able to provide more hands-on experience to students with the kinds of equipment that employers currently use. New equipment spurred and supported the changes that colleges sought to make in courses. One project director described how INAM-funded equipment helped the college to update multiple courses:

> *Our industrial maintenance mechanics certificate…did not have any electrical courses, it was strictly mechanical. So the INAM grant gave us money to purchase electrical devices necessary to add that electrical certificate. So we enhanced one electrical course, and we created a new advanced class that added both of those to that certificate. We added in the advanced classes, then we added in the prerequisites required for students to build up to that.*

A faculty member at another college noted that the purchase of tooling, such as a laser and heat treating surface for his program, had created substantial changes. He noted "we talked theory and now we're doing the theory in practice…the tactical learning is huge." Similarly, faculty members at other colleges described that they were able to test students more appropriately and teach different concepts or much more in-depth versions of concepts (such as troubleshooting in CNC). Among those faculty and project directors who described equipment as affecting course instruction or curriculum, there was a consensus that changes to courses as a result of equipment were very beneficial to students.

Internships

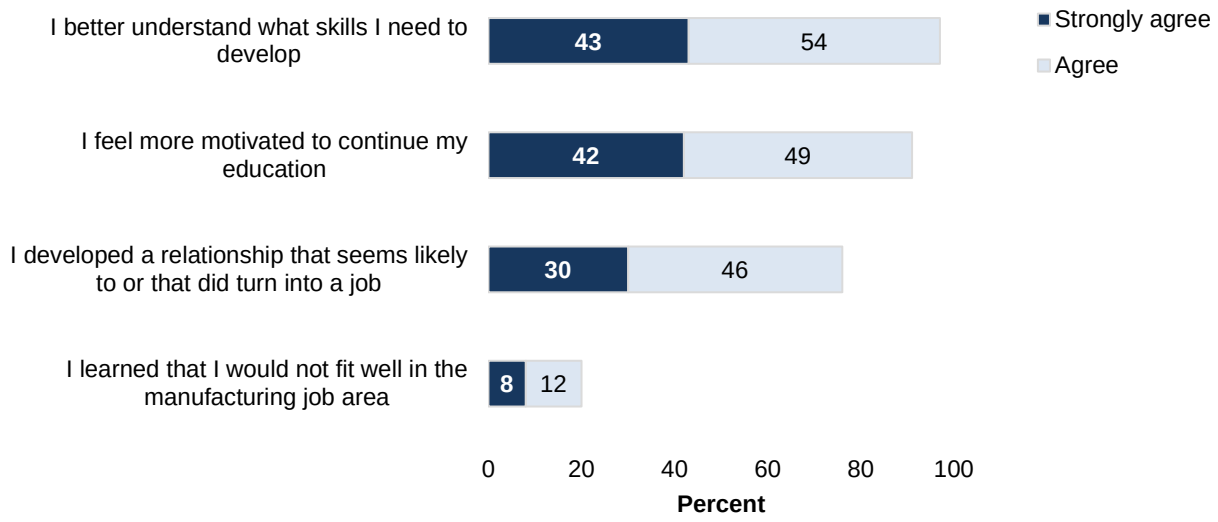
The INAM program intended to provide students with internships as part of their career preparation. Internships were expected to provide additional hands-on experience and training that was relevant to current needs of employers. As faculty members explained during focus groups, college coursework cannot include all the specific skills that each company requires. Rather, coursework provides a foundation of the core knowledge about how to operate machines, preparing students to learn more specific procedures from an employer. Internships provide students with an opportunity to apply core knowledge in a real-life work context, learning how to adjust to the demands of a specific company.

Data on participation in internships are only available for students who completed the exit survey; among them, 53 of 643 (8 percent) reported participating in an internship. The colleges they attended, along with the number participating, are Kishwaukee College (9), Danville Area Community College (8), Illinois Eastern Community College (8), Triton College (6), McHenry County College (5), William Rainey Harper College (5), Elgin Community College (4), Illinois Valley Community College (2), John Wood Community College (2), College of Lake County (1), Oakton Community College (1), Prairie State College (1), and Southwestern Illinois College (1).

Additionally, 83 students reported on the exit survey that they had worked with one or more businesses as part of their classwork. The colleges they attended, along with the number participating, are: Illinois Eastern Community College (18), John Wood Community College (13), Danville Area Community College (10), Elgin Community College (8), McHenry County College (8), Triton College (7), Prairie State College (5), Illinois Valley Community College (3), Southwestern Illinois College (2), William Rainey Harper College (2), College of DuPage (1), College of Lake County (1), Kishwaukee College (3), Richland Community College (1), and South Suburban College (1).

Students were largely positive about their experiences with businesses: 97 percent said they better understood what skills they needed to develop; 91 percent felt more motivated to continue their education; and 76 percent said they developed a relationship that seemed likely to or did turn into a job (Figure 2-1). Additionally, 20 percent said they learned they would not fit well in the manufacturing area: this might be considered either a negative outcome (in the sense that they had unfavorable experiences) or a positive outcome (in the sense that they learned where they would fit).

Figure 2-1. Percentage of students who strongly agreed or agreed with statements about internships and working with businesses as part of their classwork



2.1.3 Student Services

Community colleges often expect students to be highly independent, providing ways for students to select and register for courses while having little or no interaction with college personnel. However, perhaps particularly for students who have been out of education for several years, there is a risk that students may not properly understand the process or may not select the most appropriate courses. Additionally, students who have already worked in an advanced manufacturing field may have acquired some of required skills for an INAM program. Thus, INAM planned two support strategies that were tailored to advanced manufacturing students: (1) development of an Education Plan to meet each student's educational goals, and (2) a system to award credit for prior learning experience.

The Education Plan Process

One of the supports that INAM provided for students was the Education Plan process. This process required that all INAM participants work with an education planner who could explain all requirements for a certificate and/or a degree, help the student to select appropriate courses, and maintain contact with the student throughout his or her educational career at the college. To facilitate the planning process, INAM provided a two-page template document called the Education Plan. Each INAM college was expected to designate a staff member to serve as the education planner, confer with each INAM student, develop a plan to meet the student's educational goals, and ask each student to sign an Education Plan. As originally conceived, the education planning process was not viewed as a one-time event, but a continual process of working with students to monitor their progress and advise them on next steps.

All colleges designated one or more staff member(s) to serve as the education planner(s), though colleges had differing processes for completing Education Plans. Often, education planners communicated initial information to students as a group, during a class period, and then held one-to-one meetings to discuss students' individual plans. Many education planners also conducted follow-up meetings, often informally, and many education planners said they had an "open door" for students who had questions.

The Education Plan process proved less useful if students already had clear plans, or if education planners lacked an in-depth understanding of INAM programs and coursework. Several colleges reported that followup was not needed because students knew what they needed to take and did not want to spend additional time reviewing plans. Additionally, students in several focus groups reported that they received guidance about course sequences from individuals other than the education planner, such as faculty members. Several education planners indicated that they lacked sufficient detailed knowledge about course content to guide students. All in all, faculty appeared to be an alternative resource for many students instead of the INAM Education Plan process.

In all rounds of site visits, focus group participants shared a range of opinions about the Education Plan process. Some participants indicated that they were not familiar with the Education Plan. Faculty members were most likely to state that they were not aware of the Education Plan document. Additionally, students often had to be prompted to recall the document. Some education planners noted that students were least interested in the Education Plan when they were already sure of their educational goals and the classes required to achieve their goals. For instance, one education planner said that the Education Plan process was "almost a waste of time" for some students because the students already knew what courses they needed.

There was some indication that the Education Plan process had not achieved the maximum possible effect. For instance, one project director credited the INAM program with showing him the importance of providing more guidance to manufacturing students. He said that he wished his college had been more "intrusive" about helping students to plan their education in the past, and he concluded with comments about the potential of the Education Plan:

> *I still don't think that we took full advantage of [the Education Plans]…but I think that maybe we're starting to see how that can benefit us, to have more people communicating with the students more, in terms of where they're at, how they're doing, what's next, what they should be doing.… I think the Ed Plan has given us a way to help keep students on track towards completion.*

Credit for Prior Learning

INAM also intended to allow students to obtain course credit for prior work or life experiences. Prior Learning Credits (PLCs) were meant to reduce the amount of time and money that a student needed to complete an INAM program, thus improving enrollment rates, retention, and completion. These credits could especially be appropriate for nontraditional students who come to colleges with prior work backgrounds. As part of INAM, colleges were asked to implement a system to award PLCs.

Each college determined the specifics of how the PLC program was structured. Based on data from site visits, many INAM colleges reported having PLC systems in place, but these systems were not widely used by students.

During the site visits in spring 2014, INAM colleges generally did not report implementing PLCs. At the INAM October 2014 conference, PLCs were given considerable attention, and colleges were encouraged to implement PLC plans. During the site visits in fall 2014 and spring 2015, colleges reported having some type of PLC system in place, but focus group participants' knowledge about PLCs varied widely. At several colleges, the project directors, faculty members, and education planners disagreed about whether a PLC system was in place. PLC structures also varied widely: some PLC systems were highly informal and based on conversations and demonstrations of skills with faculty members. On the other hand, some colleges had formal PLC structures, requiring students to pass an examination to earn credit.

Frequency of PLC Use

Despite the existence of these PLC systems on paper, the actual use of PLCs among INAM students was rare. Of the 19 total students who attempted to earn PLCs, four had received credit. Eight students attempted to earn credit through veterans' programs; six students took faculty challenge exams; seven students took the College Level Examination Program (CLEP); four students had noncollege programs evaluated by the American Council on Education (ACE); one student took DSST (formerly the DANTES Subject Standardized Test); and one took the Council for Adult and Experiential Learning (CAEL) prior learning assessment (some sought PLC in more than one way). Of the four students who received credit: three passed the CLEP and one earned credit through ACE. In several cases, faculty members, education planners, or project directors had never encountered a student receiving PLC. Where site visit participants reported that they had encountered a few students receiving PLC, they indicated that the credit was uncommon.

At five colleges, individuals believed that awarding PLCs would positively influence student behavior, making it more likely that students would be recruited, would take multiple classes, and/or would complete the program. Given the infrequent use of PLCs, this claim cannot be tested empirically. However, of the four students who were given PLC credit, three completed an INAM certificate, one of the three also received Manufacturing Skills Standards Council (MSSC) certification, and one of the three received an associate's degree.

Reasons for Infrequent Use of PLC

During site visits, we asked faculty, project directors, and education planners to comment on the drawbacks and benefits of awarding PLC credit. Staff expressed three types of concerns about PLCs: the difficulty of accurate assessment, the lack of student prior work skills, and the amount of work required for faculty.

First, the faculty, project directors, or education planners at a few colleges expressed concern about the validity of using a test to assess student skills. For example, if students were assessed for PLC using a written exam, faculty worried that they did not have the necessary practical skills. On the other hand, if students were assessed for PLC using a demonstration of skills, there was concern that students might not have the necessary theoretical knowledge

Second, faculty and project directors at a handful of colleges felt that students did not have the necessary skills to gain PLC credit. According to one project director, "most students, a vast majority, from what I've seen, do not have the prior learning experience."

Third, faculty and project directors at a few colleges expressed concerns about the time it took to assess PLC. These staff explained that PLCs required time to administer, correct, and report, but teachers received scant additional compensation for the process:

> *How do you pay the teacher for spending five or six hours going through this and saying this guy does or doesn't have it? I ain't going to do it for free. That's not part of my job description, you know. And I'd love to do it, but that's a lot of work.*

2.1.4 Supports for Post-INAM Experiences

Stacked and Latticed Earned Credentials (Certificates and Degrees)

INAM supported the development of stackable certificates at participating colleges. These stackable certificate programs comprised new courses in some cases (i.e., in colleges that introduced an entirely new field of study to the college) or, in other cases where the field of study already existed, were a 'rebundling' of existing courses to create this different stackable structure.

The stackable certificates were seen as beneficial to colleges and students, as they allowed students to feel a sense of accomplishment after completion and encouraged continued enrollment, as well as facilitating student employment by providing credentials in a short time period.

INAM also supported the integration of nationally recognized credentials into college programs. When describing their degree or certificate programs, faculty or project directors representing nearly half of the colleges described the new addition of at least one, and often more than one, nationally recognized credential, including MSSC, NIMS, and American Welding Standards (AWS), into their programs. Interview and focus group participants representing three additional colleges noted that they had begun to integrate these nationally recognized credentials prior to INAM. Overall, these nationally recognized industry credentials were seen as enhancing students' employability and ability to move more freely geographically.

In many cases, the nationally recognized credentials also aligned with colleges' introduction of stackable certificates (shorter certificates that build on each other). One project director explained how the institution's certificate programs had changed due to INAM in these two ways:

> *I don't think we would have the nice structure that INAM got us kind of thinking in a way. Micro credentials with the regular credentials, the stackable credentials. We had an incredible amount of credentials that were not that stackable, so it was great from an organizing it standpoint. In welding, it was really entertaining a whole new area… a national standard area which we did not have.*

Articulation Agreements

One of the goals of INAM was to establish articulation agreements with four-year colleges to facilitate the pursuit of additional education. Four universities agreed to a Blanket Articulation Agreement with the consortium colleges, agreeing to accept all credits in a technical AAS degree. The four universities are: Governors State University, Northern Illinois University, Southern Illinois University, and Western Illinois University.

Job Placement

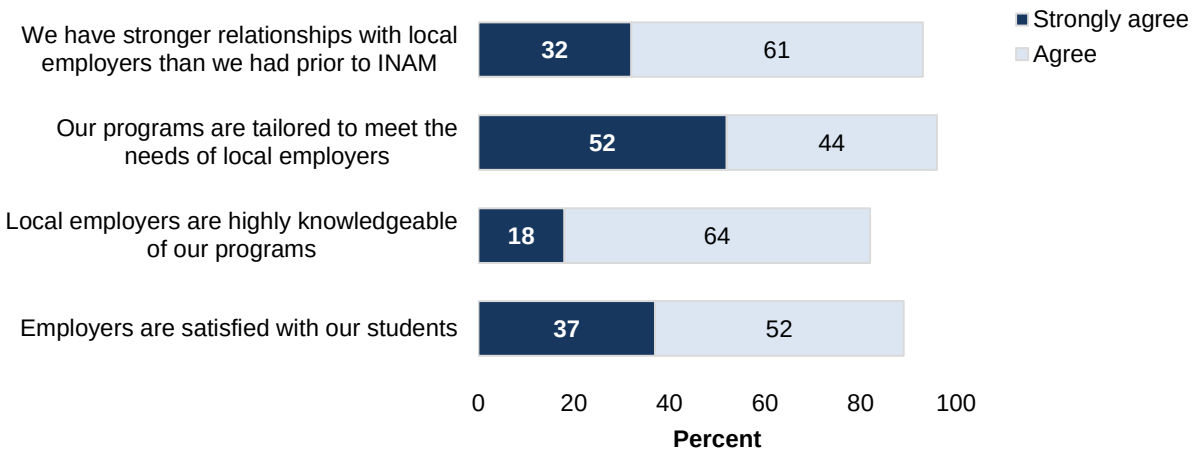
Most colleges reported that employers offered interviews, internships, and/or jobs to INAM students. Some employers hosted job fairs, allowing INAM students to see production facilities in action. In one case, the employer organized a 10-minute conversation with a hiring manager for each INAM student who toured the company facility.

2.1.5 Outreach to Business and Industry

INAM colleges already had relationships with local employers prior to the creation of INAM. Some of these relationships had been developed as faculty members worked to be responsive to industry needs for skilled workers. In some cases, the relationships had developed in previous years when a faculty member had been working in industry.

Responding to a survey at the end of the INAM college grant, the individual college's INAM project directors reported that their relationships with employers had been further strengthened through INAM: 93 percent said their relationships had strengthened; 96 percent said their programs were tailored to meet local needs; 82 percent said local employers were highly knowledgeable of their programs; and 89 percent said employers were satisfied with their students (Figure 2-2).

Figure 2-2. Percent of INAM college project directors reporting positive relationships with local employers



Additional information about employer involvement was obtained through site visits and interviews at the 21 INAM colleges. This information is provided below.

Employer Awareness and Involvement

Most respondents affirmed that employers were aware of the program, but several respondents stated that employer awareness of INAM varied. For instance, some employers knew that the INAM program existed without knowing the extent of the training that was available. One faculty member elaborated, saying that some employers thought the college had "a little room with two welders in it" but did not realize there are "a robot and plasma burners."

Around half of focus group and interview participants rated employer involvement as high. A smaller number said that involvement varied across employers. For instance, participants said that the employers who were hiring the most new employees tended to be the most highly involved in INAM. One project director also differentiated between large and small employers, saying that small employers tended to be most involved. Small employers were very concerned about hiring or establishing apprenticeships before highly skilled workers retire, to ensure that critical proprietary knowledge is not lost. Some employer involvement in college programs appears to have existed prior to INAM, and it is difficult to determine how much can be attributed to the program. However, participants at several colleges made comparisons between current and past employer involvement. These participants said that involvement was high compared with previous years because employer involvement tended to be low to nonexistent prior to INAM. As one faculty member said, "the employers are taking the college programs seriously now."

Type of Industry Involvement

Employers supported the program through a range of activities, most commonly through serving on advisory councils and hiring INAM students. These advisory committees often predated INAM, but they provided support for the grant. For example, some advisory councils selected the equipment that the college purchased with INAM funds, and some councils continue to provide input on future equipment purchases. Councils also provided feedback on program design and curriculum development. For instance, a welding instructor tailored his instruction to focus on pipe welding after local employers explained the central role of pipe welding in their businesses. Employers comment on what is working well, as well as what needs to be changed. One faculty member said that he has to have a "thick skin" because employers voice blunt complaints as well as praises. The faculty member added that local employers had a long-standing practice of giving blunt input, and the practice is not the result of INAM.

The second way that employers frequently participated in INAM was through hiring INAM students. Most colleges reported that employers offered interviews, internships, and/or jobs to INAM students. Some employers hosted job fairs, allowing INAM students to see production facilities in action. In one case, the employer organized a 10-minute conversation with a hiring manager for each INAM student who toured the company facility.

A smaller number of colleges reported that employers made donations to the college or participated in activities on the college campus. Roughly one-third of the site visit colleges reported that employers made donations of equipment, materials, or money to support the INAM programs. In addition, some employers paid for employees' tuition to attend INAM courses, and some contributed to a scholarship fund (e.g., for CPT students). Less commonly, employers participated in manufacturing activities at the college, visited manufacturing expositions at the college, or gave presentations at the college.

Factors Driving Industry Involvement

According to focus group and interview participants, the main factor that led to employer involvement with INAM was employers' need for skilled employees. Across multiple colleges, participants said that the employers that hired the most employees were also the most involved in the INAM program. Those industry leaders who had hiring needs tended to stay in touch with college faculty. In some areas, local manufacturers are experiencing such need for skilled employees that they recruit from out of state. According to one faculty member, a local company hired 3 out of 12 full-time welders from out of state, paying relocation expenses. The same company, still in need of more trained workers, sought to collaborate with the college and allow employees time off to attend classes. In another area,

local industries wanted their employees to complete CPT training, and one company declared that anyone who completed the CPT program would be granted an interview. An INAM faculty member concluded that interaction is driven by employer needs:

> *If they don't have any specific needs at this moment, then we can only do so much.... So as long as the people are in the demand and they need employees, then we're in the forefront. And we have a chance to go talk and have more influence*.

Several other factors also contributed to the involvement of local industry. First, the established relationships that faculty members have built with local employers have facilitated employer involvement in the INAM program. These relationships were developed as faculty members worked to be responsive to industry needs for skilled workers, and in some cases, the relationships had developed in previous years when faculty may have worked in industry. As a result, employers often worked directly with faculty to recruit new employees. Second, the improvements at colleges as a result of INAM, including new equipment and new curriculum, have made employers more interested in the college programs. As one faculty member explained, when the college programs are effective in training employees, relationships with local industry are strengthened. The faculty member summarized,

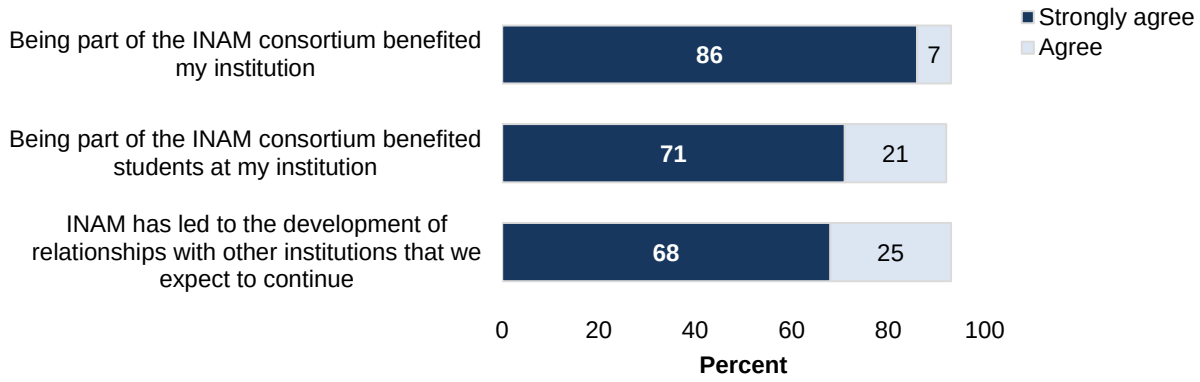
> *We all come from the private sector, so we know that if what we were doing here wasn't effective, they wouldn't be using us. It's that simple, so that's the relationship.*

The most commonly cited hindrance to employer involvement in the INAM program was a lack of time. Employers were busy, and finding time to tour college facilities or attend advisory meetings was not easy. It was also not easy to predict when time might be available, so an employer might not be able to commit to attend an advisory meeting several weeks in advance. Among the project directors and faculty who named a hindrance to employer involvement, about half said that time was a limiting factor for employers. A smaller number named a lack of employer knowledge of the INAM program as a limitation.

2.1.6 Cooperative Efforts Using a Consortium

One way to view the INAM consortium is simply as a mechanism for obtaining funding. However, the consortium itself could add value by, say, enabling activities that otherwise would have been more difficult, or subtract value by, say, creating extra obligations that were burdensome to the institutions. We surveyed project directors about their views of the consortium, and they were highly positive in their evaluations: 93 percent felt belonging to the consortium was beneficial to both the institution and the students at their institution, and more specifically, 93 percent felt that INAM had led to the development of relationships with people in other institutions that they expected to continue (Figure 2-3; details may not add to totals because of rounding). The development of relationships with other institutions in particular is a product of being part of a consortium, rather than potentially reflecting just the impact of increased funding.

Figure 2-3. Percent of INAM college project directors reporting positive impact from INAM



Additional information about the perceived value of the consortium was obtained through focus groups and interviews, as discussed below.

Collaboration

Focus group and interview participants, especially project directors and faculty members, most commonly cited the opportunity for collaboration and sharing between colleges as a reason that the consortium was valuable to them. In fact, at least one representative from nearly every college referenced some form of collaboration, knowledge sharing, partnership, or communication with another college when asked about the value of the consortium to their college. Respondents—whether project directors, faculty, or education planners—saw value in the ability to collaborate and share knowledge with other institutions. As one faculty member noted:

> *I'd say the biggest value has been that every college I've contacted that, to get information about their current program or their syllabus or their curriculum or what text books they're using, everyone had been really easy to work with. There's been no hesitation to share that information with me. We've also been able to visit a couple of the schools to look at their programs and they've been very welcoming for that. So, just in having those contacts that are part of this INAM program has been valuable as far as curriculum and course development.*

Faculty members often spoke of collaboration that involved sharing of curricula, syllabi, and instructional approaches. Project directors discussed collaboration that led to sharing of recruitment methods and the general benefit of being able to 'bounce ideas off' a network of individuals who are working in the same field.

Related to sharing of curricula and instructional approaches, at least one focus group or interview participant from half of the colleges also spoke about curriculum and program changes as part of the value of the consortium.

Shared Vision and Buy-in

Site visits participants, especially faculty and project directors, stressed the importance of new equipment for student learning. Their comments also showed that the consortium provided more than monetary support in the process of updating equipment. INAM's support for purchasing equipment also involved the development of shared vision for justifying the purchases. The existence of INAM as a statewide initiative with a shared vision led to increased administrative buy-in for investments in advanced manufacturing programs at the colleges. One project director explained:

> *I think it would have been harder to convince my boss to move in the direction of reestablishing welding without the INAM funding.… I think there's a comfort level in the consortium being statewide that not only draws a lot of enthusiasm from regional politicians and such, but from people in the upper echelon of higher ed who view this as a high risk venture because this equipment is very expensive, and it has a short shelf life.*

By the third round of site visits, a majority of faculty and project directors described high buy-in at their institutions. Several individuals noted that faculty members appreciated the boost in enrollment associated with INAM, as well as the new equipment. A few individuals also described benefits related to the exposure INAM gave to their programs.

However, site visit participants at a few colleges in the second and third rounds of site visits still reported mixed, medium, or low levels of buy-in at their institutions. For example, at one college, the project director reported a lack of administrative support for the grant at the college. On the other hand, the project director at another college reported initial concerns among faculty members about the grant, but stated that these concerns had dissipated over time. Problems with buy-in could occur at either the college administrative level (e.g., two colleges originally wanted to confine INAM to noncredit courses) or the faculty level (e.g., by resisting changes to the curriculum).

Ways of Participation

We asked project directors and faculty members to describe how they had participated in consortium activities. The most common response among the project directors was attending meetings and phone calls, followed by sharing materials and information (such as curricula) with other consortium members. A few project directors described working on specific INAM taskforces, and a few stated that they responded to specific requests for information from Harper. Two project directors described discussions around curriculum standards. One project director expressed enjoyment presenting information to local employers.

Among faculty members, the most common response was also attending consortium meetings. Some of these faculty members described active collaborations with other colleges that were facilitated by these meetings. Along these lines, some faculty members reported sharing syllabi and general information with other INAM colleges on request. A few faculty members also described working on revising courses for INAM. A faculty member at one college took classes at another INAM college to learn about how its courses were set up. Other types of involvement included helping to buy equipment, working with students, representing the INAM consortium at conferences, and attending advisory meetings.

Challenges of Consortium Participation

Finally, we examined whether there were any challenges or roadblocks to consortium participation. Some project directors and faculty members said that they had encountered no challenges and made positive remarks about the INAM program. However, other project directors and faculty members identified several factors that challenged their ability or willingness to participate as active members of the INAM consortium. Some of these challenges related to supporting the evaluation of INAM, but do not reflect enduring issues with the consortium; these include the paperwork, reporting, and response burden in maintaining the student database and responding to requests for data from the INAM central office (such as the selection of a group of comparison students).

A more systematic frustration with INAM was a perceived lack of support in recruiting students. Two site visit participants expressed a wish for more advertising associated with INAM: one project director stated that INAM did not provide funding for advertising, while another faculty member said that advertising funds had been provided, but not enough. As one faculty member put it:

> *Yeah, that I would have rather had like 10 times the amount of advertising and take it away from even some of the equipment. Because without that knowledge out there and people getting excited and coming in to take the class, that stuff doesn't do you any good sitting on the shelf.*

2.2 Programs and Students

2.2.1 Enrollment by Program and College

As of the end of 2015, INAM had served 2,645 student participants, with 12 of those starting in a limited test of the program in summer 2013, 1,045 starting in 2013–14, 1,152 starting in 2014–15, and the remainder (436) starting in fall 2015. Table 2-3 shows the distribution of the students by advanced manufacturing program and by college. The largest enrollments were in welding/metalworking, with 944 students; precision machining (CNC), with 777 students; and certified production technician (CPT), with 416 students.

Table 2-3. Number of students participating in INAM from summer 2013 through fall 2015, by college and program of study

College	Total	Bridge	Certified production technician (CPT)	Mainte-nance	Mecha-tronics	Precision machining (CNC)	Welding (metal-working)
Total	2,645	46	417	161	296	778	947
College of DuPage	53	0	0	0	12	1	40
College of Lake County	109	0	0	0	1	108	0
Daley College—City Colleges of Chicago	136	1	0	10	29	60	36
Danville Comm. Coll.	159	0	0	2	80	0	77
Elgin Comm. Coll.	85	0	0	0	0	49	36
Illinois Eastern Comm. Coll.	126	0	0	30	0	18	78
Illinois Valley Comm. Coll.	115	14	30	36	0	5	30
John Wood Comm. Coll.	153	29	15	1	0	12	96
Joliet Junior College	118	0	0	17	1	30	70
Kankakee Comm. Coll.	25	0	15	5	0	5	0
Kishwaukee College	277	0	120	1	0	2	154
Lincoln Land Comm. Coll.	100	0	47	0	13	0	40
McHenry County College	199	0	0	25	17	157	0
Oakton Comm. Coll.	97	0	0	27	27	43	0
Prairie State College	100	0	25	0	0	34	41
Richland Comm. Coll.	123	2	37	4	14	15	51
South Suburban Comm. Coll.	25	0	22	3	0	0	0
Southwestern Illinois College	166	0	0	0	25	141	0
Triton College	99	0	1	0	68	30	0
Waubonsee Comm. Coll.	49	0	0	0	8	16	25
William Rainey Harper Coll.	331	0	105	0	1	52	173

NOTE: The program of study was not available for 19 students.

2.2.2 Enrollment by Term

Table 2-4 displays the enrollment statistics for the full grant period. The total enrollment grew from 12 in the initial test term of summer 2013 to a high of 1,164 in fall 2014. Note that these statistics count students once for each term in which the students were enrolled, so the total enrollment (5,094) is greater than the totals reported elsewhere. Typically, however, the greatest number of students in any term was the cohort just starting enrollment in that term. The sole exception was in summer 2015, but the summer terms were the terms with the lowest enrollments and do follow normal patterns of enrollment.

Table 2-4. Number of students enrolled in INAM, by term in which they started

Term in which started enrollment	Enrollment during term							
	Summer 2013	Fall 2013	Spring 2014	Summer 2014	Fall 2014	Spring 2015	Summer 2015	Fall 2015
Summer 2013	12	12	9	5	7	3	2	—
Fall 2013	—	593	405	56	212	159	45	83
Spring 2014	—	—	375	73	179	119	23	53
Summer 2014	—	—	—	119	79	56	10	20
Fall 2014	—	—	—	—	678	366	59	154
Spring 2015	—	—	—	—	—	391	75	141
Summer 2015	—	—	—	—	—	—	50	34
Fall 2015	—	—	—	—	—	—	—	427
Total	12	605	789	253	1,155	1,094	264	912

NOTE: Students are counted once for each term in which they were enrolled.
—Not applicable.

Another way of looking at enrollment is to examine the number of courses involved. The average number of courses taken per student was 3.9, with an average of 3.6 courses passed.[1] The INAM students had a total of 9,580 course enrollments (counting a course once for each student enrolled in it) and passed 8,862 of them (93 percent) (Table 2-5). Fall 2014 was the busiest term, with 24 percent of the coursetaking to date. Overall, students attempted to earn a total of 28,116 credits, and earned 26,026 of them (93 percent).

Table 2-5. Students' coursetaking behavior, by term

Term	Number of courses taken	Number of courses passed	Percentage of courses that were passed	Number of credits attempted	Number of credits obtained	Percentage of credits that were obtained	Number of noncredit courses taken
Total	9,580	8,862	93	28,116	26,026	93	209
Summer 2013	17	17	100	51	51	100	0
Fall 2013	1,204	1,133	94	3,460	3,272	95	33
Spring 2014	1,612	1,504	93	4,682	4,352	93	42
Summer 2014	301	282	94	897	837	93	28
Fall 2014	2,269	2,079	92	6,616	6,088	92	34
Spring 2015	2,207	2,014	91	6,645	6,070	91	45
Summer 2015	309	296	96	897	864	96	14
Fall 2015	1,661	1,537	93	4,869	4,493	92	13

NOTE: Details may not add to totals due to rounding.

[1] No data on coursetaking were available for 193 students, and some of the transcript data appear incomplete. The totals presented here thus are underestimates, though it is not clear how the missing data would affect the means. The statistics presented here are based on those students with data. This report focuses on those courses taken after becoming INAM participants.

Students often took more than one course per term, up to a maximum of 11 courses in a single term. For example, during fall 2014, 444 students took a single course; 330 took two courses; 230 took three or four courses; and 69 took four or more courses (Table 2-6).[2] Depending on the course and the college, the courses sometimes were taught for only part of a term (e.g., a 16-week term might be split into two 8-week segments, with students taking different courses in each segment), so taking multiple courses per term did not necessarily mean all of the courses were simultaneous.

Table 2-6. Number of courses students took per term, by term

Term	Number of courses			
	1	2	3–4	5 or more
Summer 2013	7	5	0	0
Fall 2013	225	146	161	30
Spring 2014	301	227	179	50
Summer 2014	176	49	9	0
Fall 2014	444	330	230	69
Spring 2015	413	315	232	70
Summer 2015	202	39	7	1
Fall 2015	373	274	156	38

Most typically, an individual course was for 3 credits. Fifty-eight percent of the students had earned more than 6 credits, while 36 percent earned between half a credit and 6 credits, and 5 percent earned no credits (Table 2-7). Not surprisingly, since it takes time to accumulate credits, in general the earlier that students enrolled in INAM, the more credits they were likely to have obtained. For example, 58 percent of those starting in summer 2013 had earned more than 12 credits, compared with 49 percent of those starting in fall 2013 and 10 percent of those starting in fall 2015.

Table 2-7. Percentage of students earning various amounts of credit, by the term in which the students first enrolled

Term in which started INAM enrollment	Number of students	Number of credits earned				
		0	0.5–3	3.5–6	6.5–12	12.5–82
		(Percentage of students)				
All	2,482	5	17	19	25	33
Summer 2013	12	0	0	8	33	58
Fall 2013	565	2	9	11	29	49
Spring 2014	363	4	12	17	22	44
Summer 2014	118	15	17	9	15	43
Fall 2014	643	6	16	17	27	33
Spring 2015	356	6	21	20	29	24
Summer 2015	49	6	18	33	37	6
Fall 2015	376	3	33	38	16	10

NOTE: Percentages may not add to 100 because of rounding.

[2] These data differ from those in the third-year report, even though fall 2014 was included in that report. Additional transcript data became available after that report was prepared.

2.2.3 Characteristics of the Students Served

Of the 2,645 students, 2,443 (92 percent) were male; 1,802 (68 percent) were part-time students in their first enrollment term; and 650 (24 percent) were incumbent workers. The students were often economically disadvantaged, with 830 (31 percent) eligible for Pell grants; additionally, 69 (3 percent) had a disability. The students were from multiple races and ethnicities: 1,783 were white, 422 were Hispanic, 296 were black, 44 were Asian, 6 were American Indian or Alaska Native, 7 were Native Hawaiian or Pacific Islander, 45 were of more than one race, and 42 had unknown race or ethnicity. As of December 31, 2015, 53 percent of the students were 25 years or younger when they started INAM, and 31 percent were between ages 26 and 40.

The students were asked what previous training and certifications they had received in advanced manufacturing. Few students had received prior training, with the most common training being as a certified welder (1.1 percent), NIMS – Machining Level I (1.6 percent), or CPT (0.6 percent).

Current and past employment. Students were asked their current occupation, if they were employed, or their most recent occupation if they were unemployed. The most common occupation categories were the production occupations (28.9 percent); food preparation and serving (13.3 percent); installation, maintenance, and repair (12.1 percent); sales and related occupations (9.6 percent); transportation and material moving (6.3 percent); and building and grounds cleaning and maintenance (6.1 percent) (Table 2-8). All other occupations were each held by less than 5 percent of the students.

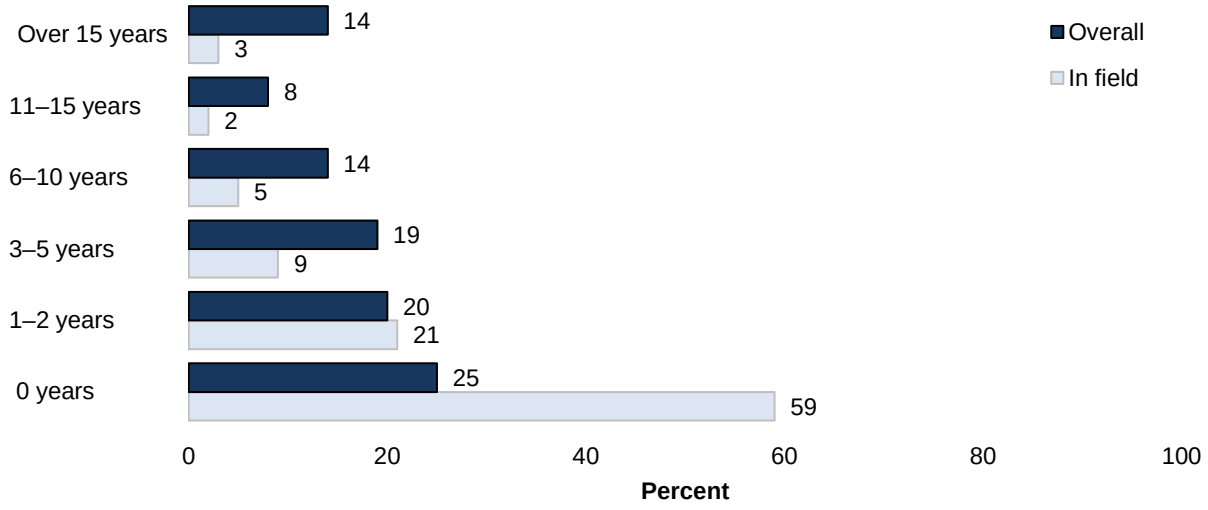
Table 2-8. Percentage of students in different occupation categories in their current or most recent occupation

Occupation	Percent
11-0000 Management Occupations	1.9
13-0000 Business and Financial Operations Occupations	0.5
15-0000 Computer and Mathematical Occupations	1.1
17-0000 Architecture and Engineering Occupations	2.3
19-0000 Life, Physical, and Social Science Occupations	0.1
21-0000 Community and Social Services Occupations	0.8
23-0000 Legal Occupations	0.2
25-0000 Education, Training, and Library Occupations	1.4
27-0000 Arts, Design, Entertainment, Sports, and Media Occupations	0.8
29-0000 Healthcare Practitioners and Technical Occupations	0.5
31-0000 Healthcare Support Occupations	1.1
33-0000 Protective Service Occupations	0.7
35-0000 Food Preparation and Serving-Related Occupations	13.3
37-0000 Building and Grounds Cleaning and Maintenance Occupations	6.1
39-0000 Personal Care and Service Occupations	2.4
41-0000 Sales and Related Occupations	9.6
43-0000 Office and Administrative Support Occupations	1.1
45-0000 Farming, Fishing, and Forestry Occupations	3.0
47-0000 Construction and Extraction Occupations	4.5
49-0000 Installation, Maintenance, and Repair Occupations	12.0
51-0000 Production Occupations	28.8
53-0000 Transportation and Material Moving Occupations	6.4
55-0000 Military-Specific Occupations	1.5

NOTE: 172 students did not respond, sometimes because they had never held a job. Percentages may not add to 100 because of rounding.

Prior work experience. The INAM participants were asked about their prior work experience, both in their field of study and overall. Many were relatively new to their field: more than half (59 percent) had no prior experience in their field of study, and 21 percent had one or two years of experience (Figure 2-4). Typically, however, the participants did have prior work experience (75 percent), and 14 percent had over 15 years of experience. Combining these two responses, 25 percent of the participants were completely new to work, and 34 percent were switching fields, having prior experience but not in their field of study.

Figure 2-4. Number of years of prior work experience for INAM participants



2.3 Validity and Implications of the Original Logic Model

The goal of the INAM consortium was to expand and improve the delivery of education and career training programs leading to industry-recognized certificates or associate degrees that can be completed in two years or less and prepare TAA-eligible and other workers for employment in high-wage, high-skill advanced manufacturing occupations.

As shown in the logic model (Figure 2-5), the INAM consortium intended to draw upon a range of inputs, some inputs specific to the grant period and some inputs that would remain in place after the end of the TAA grant funding. During the funding period, critical inputs included the INAM consortium, itself, and the TAA grant funding. Additional inputs expected to outlast the grant funding included partnerships with local industry, existing college curricula in advanced manufacturing, and a ready supply of students. Students were expected to include TAA recipients, veterans, and any other interested students.

Figure 2-5. Logic model of INAM inputs, activities, outputs, and outcomes (page 1 of 2)

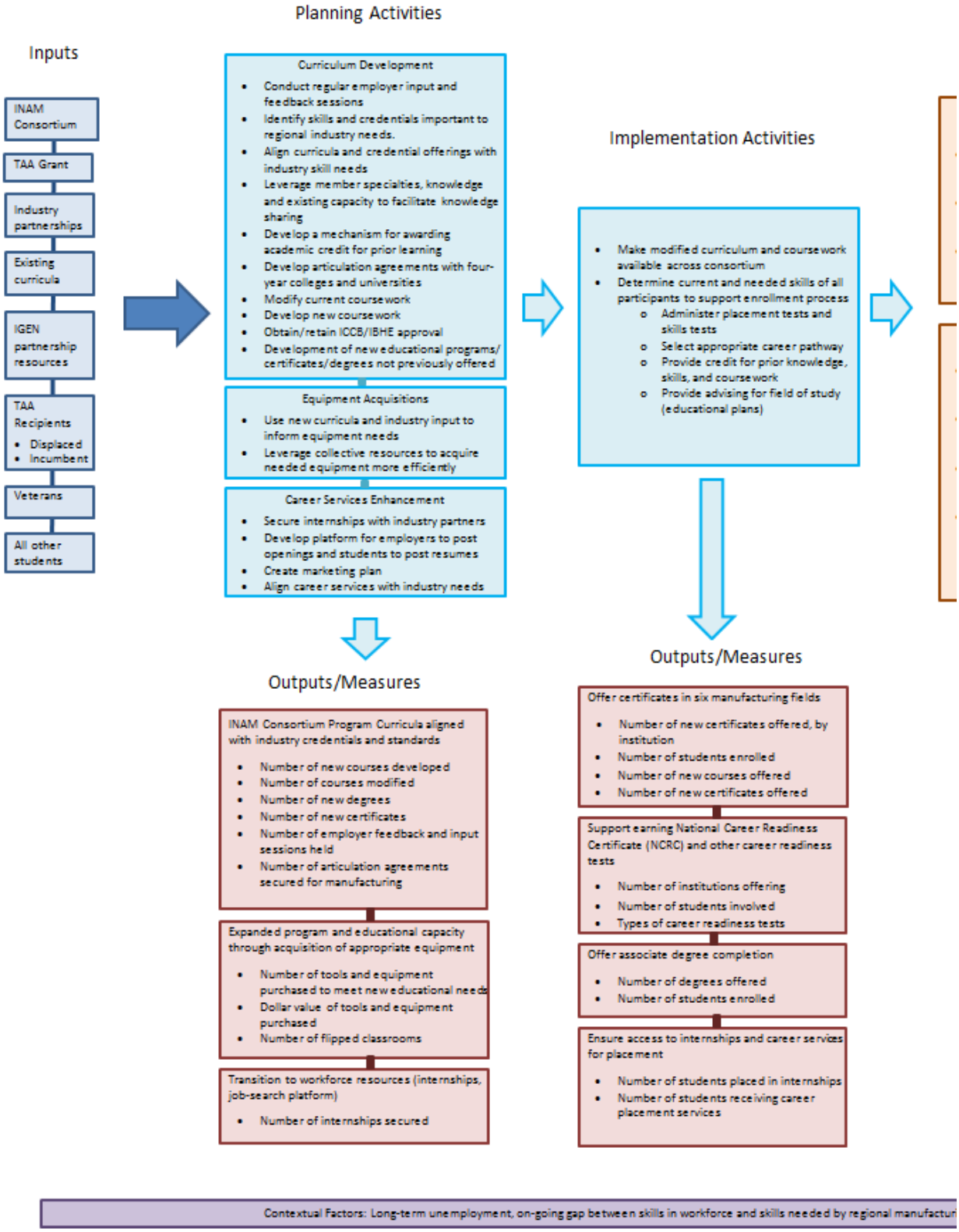
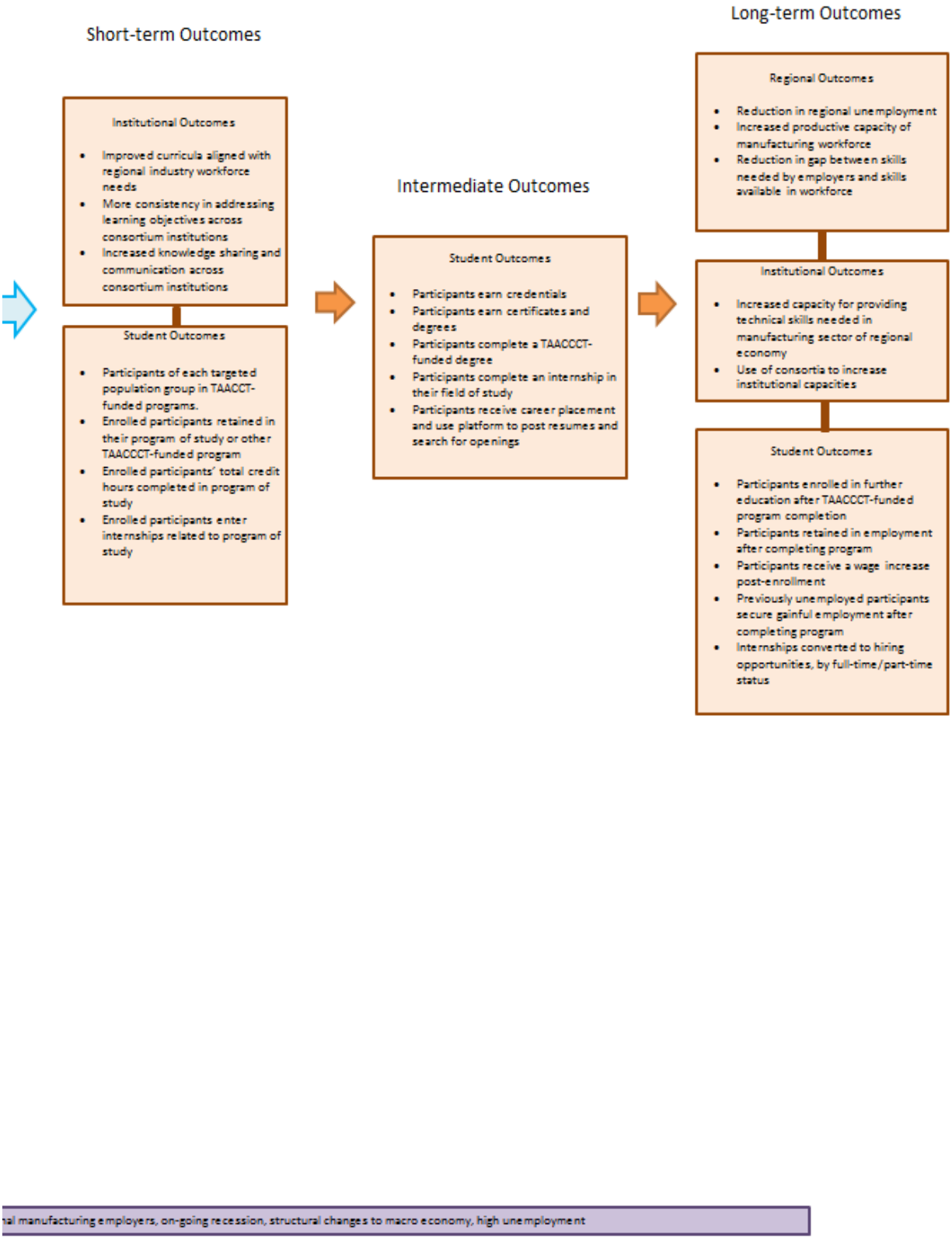


Figure 2-5. Logic model f INAM inputs, activities, outputs, and outcomes (page 2 of 2)



The logic model was based on the original proposal submitted to DOL and, in practice, some of the intended inputs to the consortium turned out not to be practical or readily implemented. One purpose of this section is to discuss how the actual implementation varied from the original model.

Two planned inputs actually were not used. INAM had planned to engage in a partnership with IGEN in using the National Training Education Resource (NTER) system, but INAM decided not to incorporate a green curriculum (due to substantial differences in each college's programs, making a unified effort difficult), and the online system did not seem readily usable. Also, INAM anticipated that partnerships with local employment agencies would facilitate recruitment of TAA-eligible students and veterans, but funding problems at the agencies prevented such partnerships from occurring.

Moving across the logic model, to the right, the model presents two distinct pipelines of activities: the pipeline of planning activities to be carried out by the consortium and the pipeline of program implementation activities to be carried out by the consortium and its constituent institutions. Measures to assess the implementation of both pipelines are listed on the model.

The consortium conducted most of the planning activities in the area of curriculum development: employers provided input about critical skills; college programs were aligned with local industry needs; and courses were redesigned. However, the plans to implement a mechanism to award academic credit for prior learning were never adopted at a scale to affect many students, partly because of a lack of many students with substantial prior experience and partly due to a distrust of and difficulty in implementing an appropriate testing system. Planning activities in the area of equipment acquisitions also took longer than expected; though the equipment purchases were ultimately completed, they did not affect the number of INAM participants that might have been affected if the purchases had been made earlier. Planning in the area of career services enhancement appeared to occur to a lesser degree: only a relatively small number of internships became available, in part because of poor economic conditions, lessening the opportunities available, and also because of concerns about liability issues for the employers involved. A consortium marketing plan was developed more slowly than had been anticipated, leaving the individual colleges to design their own plans.

The grant program was implemented in years 2, 3, and the first term of year 4, with the curricula modified and expanded somewhat in year 3. All aspects of the program were implemented in some form, but with variations in implementation across the colleges. In particular, the use of PLCs and internships was lower than anticipated, and the advising offered using the Education Plan process varied from what was largely a data collection operation to more active advising throughout students' enrollment.

Based on the stated input, planning, and implementation, the logic model projects short-term outcomes (the aligned curricula, credentials, and coursework from INAM; the access to new equipment and tools acquired by needs identified in the curricula modifications; and new internship opportunities and job search aid), intermediate outcomes (the programmatic mix of credentials formed by the combination of the three short-term outputs), and long-term outcomes at the regional, institutional, and student levels. The next four chapters will examine the extent to which these outcomes were accomplished.

Since not all aspects of the plan were fully implemented, a key question will be how their incomplete implementation might affect the ultimate outcomes. INAM could have an impact on only a small number of TAA-eligible students and veterans since relatively few such people participated, and the low participation of such groups could also affect INAM's overall performance measures to the extent that these groups might have different outcomes from those who were actually enrolled in INAM. The incomplete use of educational advising and PLCs might be predicted to affect student retention and certificate/degree completion, lessening the potential impact of INAM on both outcomes. The limited use

of internships might be predicted to lessen potential increases in retention and job attainment over what otherwise might be projected. From an evaluation perspective, these changes in the plans make it difficult to measure the value of the components that were changed. For example, it is difficult to measure the impact of offering internships because too few internships were implemented to measure their effects.

Outcomes for Students From INAM Participation 3

This chapter examines both the educational and employment outcomes of the INAM participants and assesses whether the outcomes are different from what might have happened if INAM had not existed. A complicating factor that must always be kept in mind is that, while employment with good wages might be considered the ultimate measure of success, the participants actually pursued a variety of strategies to seek that outcome, so that focusing on a measure that is tied to a specific strategy may provide a misleading picture of INAM's impact. For example, if one limits measures of success to students who received certificates, one may ignore students whose employment was improved after completing only part of the INAM program. Rather, there is no single route for students to succeed. As one INAM student participant commented:

> *They don't say you need to go and get an associate's degree in industrial maintenance…. If you want to work in maintenance, you could be a welder at a fabrication shop for a couple of years while taking a couple of machine tool classes, and you've kind of gotten in [through] a completely different way than somebody else has.*

The DOL performance measures allow for a few possible paths:

- Students come to college after high school, remain enrolled until they complete an academic degree or certificate, and then exit the college and begin employment in their area of training. During their college enrollment, they are not expected to be employed, or possibly they may hold campus or temporary jobs, but they are not expected to have jobs in their area of training (which requires first earning the appropriate academic credential).

- Students may come to college later in life after losing their previous job, but they otherwise follow a similar path, first earning an academic certificate or degree and then entering employment in their area of training.

- Students may come to college while employed, in which case the college education is expected to either help them advance in their current occupation or to switch to a different occupation. Again, the expectation is that they will complete the academic program. Since students already have a job when starting a program, they do not need to "enter" employment but they might be expected to show improved employment outcomes as measured by higher wages.

All of the above paths incorporate academic program completion as an assumed component of a student's employment strategy, while employment outcomes are measured either by the transition from unemployment to employment or by the progression from lower wages at the start of enrollment to higher wages at some later point. In practice, however, student INAM participants showed a much wider range of approaches to education and employment. Some found that completing one or a few courses was sufficient to obtain a job, without the need to complete the academic program. Some found that earning outside credentials (such as MSSC) provided employers with an alternative measure of employment qualifications, lessening the need for academic credentials. (In fact, INAM encouraged the students to earn the outside credentials, but an unintended consequence is that the value of the academic credential thereby may have been diminished.) Students may or may not continue with their academic enrollment

after obtaining employment, and if they do continue pursuing academic credentials, there may be one or more stopouts while they pursue family and employment obligations.[1]

Because of the multiplicity of strategies available to students, there are not clear boundaries for measuring outcomes. If a student interrupts his/her education, that interruption might be permanent or temporary, making it unclear whether a student has "exited." Similarly, the start of INAM-related employment may occur after the student has exited, but it also may occur while the student is still enrolled, and it may or may not be tied to the earning of academic credentials. For this reason, this report examines a wide range of outcomes, particularly with respect to employment.

3.1 Educational Outcomes

This section is divided into two parts, first examining the educational outcomes of the INAM participants, and next contrasting their educational outcomes with those of comparable nonparticipants.

3.1.1 Summary of Outcomes

While the "traditional" view of postsecondary education is that it comprises a single, uninterrupted period of study between high school and employment, that model is increasing less common, and particularly for students attending community colleges. Frequently, students enroll part time while also working, and students often temporarily interrupt their education (e.g., because of personal issues or job responsibilities). These considerations affect how long it takes for students to reach their intended academic outcomes and our ability to provide "final" outcome measures for INAM participants.

Summary statistics across all INAM participants also can be misleading because different students started in INAM at different times. The cohort of students starting in INAM in fall 2013 provides the best source for examining students' academic progress because it was the first full term of INAM and provides the greatest amount of time to monitor the students' progress. Examining the 593 students who entered in fall 2013, and counting the total numbers of terms in which the student was actively enrolled, the average number of terms was 2.6.[2] (By contrast, the overall average was 1.9 terms, but this measure includes students who entered INAM so recently that they had little opportunity to enroll over multiple terms.) However, these averages understate the extent to which INAM participation can span multiple terms. Of the 463 who both started in fall 2013 and also were enrolled for at least two terms,[3] slightly more than half (57 percent) skipped at least one term sometime during their enrollment, and 30 percent skipped two or more terms. Often the skipped term was a summer term (which is a common time not to be enrolled and is not typically considered a break in enrollment), but 26 percent skipped at least one term in the standard academic year. A consequence is that it often takes four terms or more to complete enrollment, even though the INAM certificates are designed to require one year or less. Thus, for any student who started participating in INAM after fall 2014, it may be premature to assess student outcomes. To look at the statistics in a different way, among the 600 INAM participants who received a certificate or degree from their INAM college, the length of time used to earn the first credential ranged from one term to seven terms, with 26 percent receiving the certificate within one term, 53 percent within

[1] A dropout is a student who leaves without returning. A stopout is a student who temporarily leaves but later resumes his/her education.

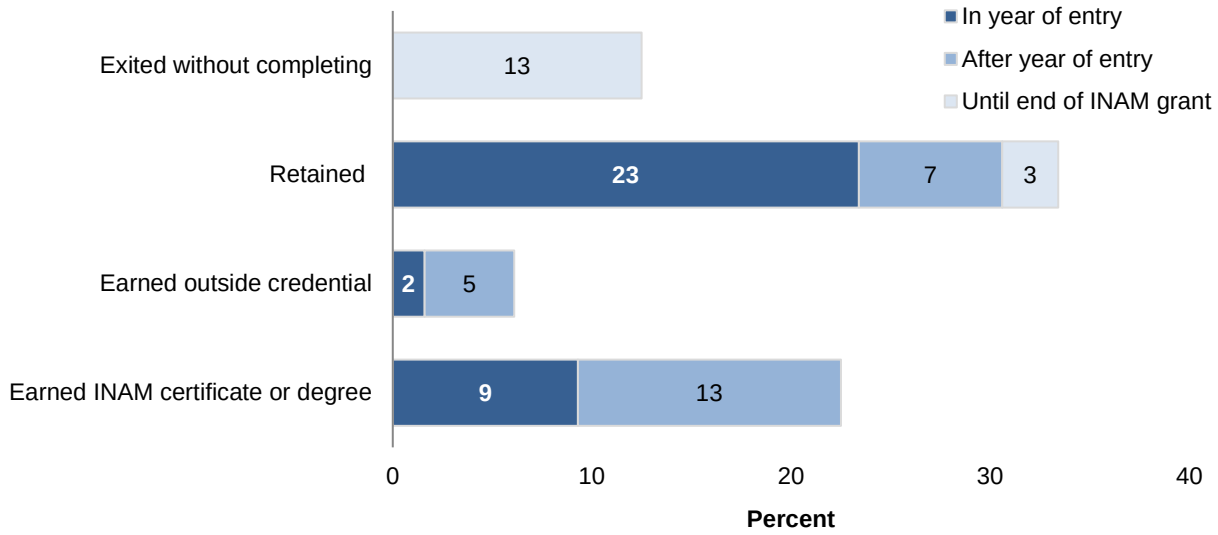
[2] These particular statistics only count terms in which a student was actively enrolled; skipped terms are not counted.

[3] The two terms may or may not have been consecutive.

two terms, and 75 percent within three terms.[4] Thus, students enrolling in fall 2015 would not generally be expected to have completed a certificate, and students entering in summer 2015 were roughly equally likely to have completed or not completed their certificate.

With these caveats in mind, we may examine the educational outcomes of the INAM participants. Overall, 23 percent received an academic credential, most commonly not in the year of enrollment (Figure 3-1).[5] Another 6 percent instead received an outside credential (i.e., an ACT, MSSC, or NIMS credential), demonstrating their skills for employment without obtaining an academic credential.[6] Twenty-eight percent were still in INAM at the time the grant ended (some of whom only started in fall 2015), and the remainder were split between those who were retained at least until the end of the year (31 percent) and those who exited during the year of their enrollment (13 percent).

Figure 3-1. Percentage of INAM participants who earned credentials, were retained, or exited



As might be anticipated, the educational outcomes varied considerably depending on the date in which the student first entered INAM. Among those entering in fall 2013, 37 percent had received an academic certificate or degree, while among those in spring 2015 only 11 percent had accomplished the same (Figure 3-2). An interesting side note is that completion of an outside credential appeared much more common starting with spring 2014 than in the earlier terms and was not greatly different for those starting in spring 2015 (9 percent) than for those starting in spring 2014 (10 percent). This may reflect a few factors: earning an outside credential may take less time than earning an academic credential, earning an outside credential may be undercounted in the earliest terms (i.e., someone earning both academic and outside credentials would be counted here as earning an academic credential), and possibly the consortium colleges gave greater emphasis to outside credentials after fall 2013.

[4] All of the INAM certificates were designed to require one year or less to complete. The length of time that a student took to receive a college credential depended on several factors: the length of the program (the INAM certificates varied in length depending on the program and the college), the number of courses the student took per term, whether a student skipped one or more terms (excluding summer), whether a term was split into smaller time periods (e.g., allowing a student to take two consecutive classes within a single term), and whether the student switched from a certificate to an AAS degree. This measure includes skipped terms.

[5] Details do not add to totals because of rounding.

[6] Some of these may still receive an academic credential at a later time. Of those receiving academic credentials, some also received outside credentials, but academic credentials are counted here as the primary focus of DOL for measuring academic outcomes.

Figure 3-2. Percentage of INAM participants who earned INAM or outside credentials, by the term in which they enrolled in INAM

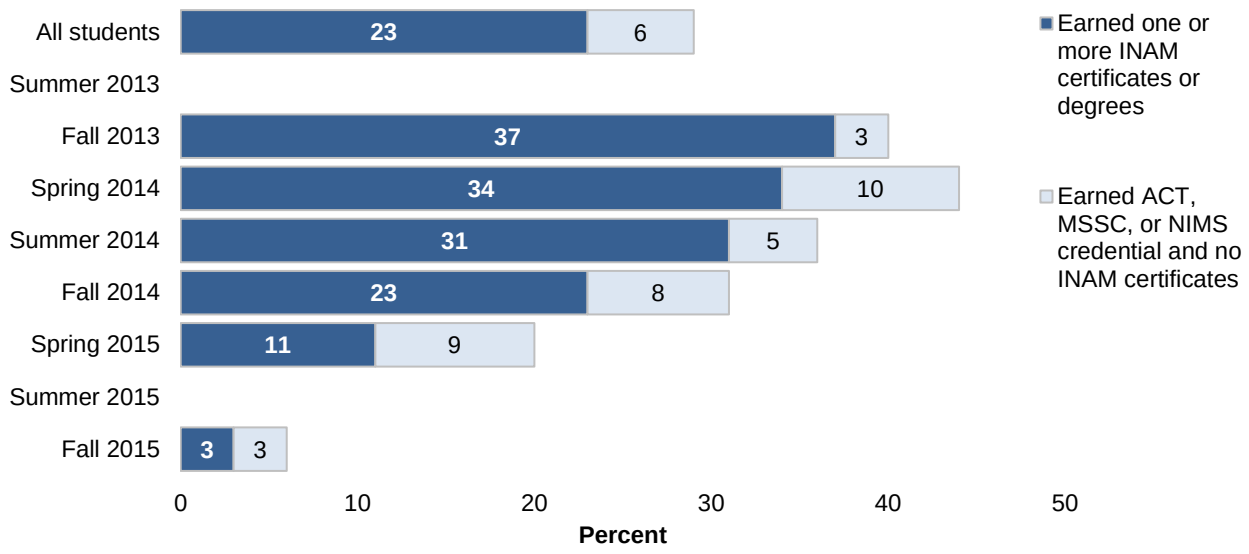
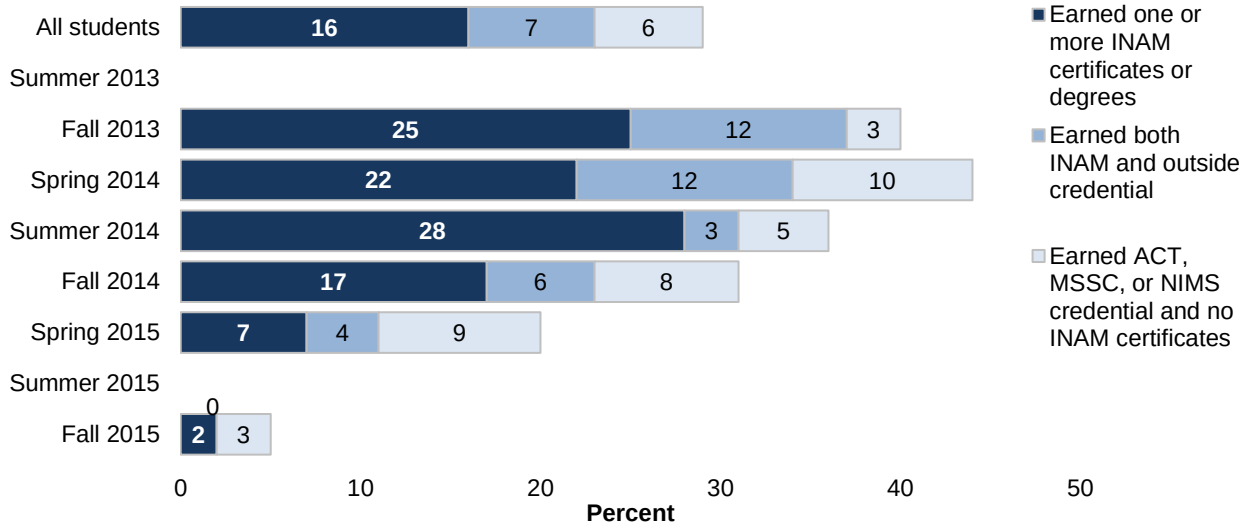


Figure 3-3 explores the earning of credentials further, distinguishing between those who earned both an INAM and an outside credential with those earning only one of those. It shows that Figure 3-2 does hide a substantial number who earned outside credentials (7 percent overall). There still is a substantial difference between the percentage earning outside credentials from students starting in fall 2013 (15 percent) and the percentage among students starting in spring 2014 (22 percent), which is consistent with the hypothesis that the colleges increased their attention to outside credentials following fall 2013.

Figure 3-3. Percentage of INAM participants who earned only INAM certificates and degrees, INAM credentials plus outside credentials, and only outside credentials, by the term in which they enrolled in INAM



The evaluation study collected only limited data on how programs varied across colleges and program areas, and thus cannot generally provide data on what program factors influenced student outcomes. For example, since all colleges made use of educational planners to advise the students, one cannot quantify the impact of the educational planning process. However, one aspect in which data are available is the number of credit hours required to receive a certificate. Depending on the college and the program area, the requirements ranged from a low of nine credit hours to a high of 33 credit hours. The results from a logistic regression analysis indicate that, as the requirements increased, the rate of completing certificates decreased. Assuming a normal completion rate of 20 percent, an increase of 15 credit hours in requirements is associated with a 14 percentage point decline in completion rates. This finding is consistent with the INAM strategy of creating stackable credentials, breaking the requirements into smaller chunks that will be more readily achievable.[7] There was no significant relationship between the number of credits required and either employment or wages, so participants' employment prospects do not appear to have been reduced at programs with lower requirements. However, the time period for the evaluation study was relatively short, and students who quickly receive certificates quickly and enter into employment (and students who jump quickly into employment without even receiving a certificate) may have a temporary employment advantage that diminishes as the time period increases.

3.1.2 Comparison of Education Outcomes for INAM Participants and Prior College Attenders

To determine whether the educational performance of INAM students was better than might otherwise be expected, this section compares their performance with the selected group of comparable nonparticipants (i.e., students who enrolled in similar programs at the same colleges prior to the creation of INAM). Superficially, the INAM participants had a slightly lower program completion rate than the comparison group students, with 23 percent receiving a college certificate or degree, as compared with 27 percent among the comparison students.[8] However, it is necessary to adjust for the longer period of time that comparison students had available to complete a degree. On average, those who completed a certificate among the comparison group took 2.7 years, with 31 percent taking over 3 years, and another 18 percent took between 2.1 and 3 years. The maximum time that INAM students had available was roughly 2.3 years, if students enrolled in fall 2013.

To provide more equivalent comparisons, comparison students who took more than 2.3 years to complete their certificates were recoded as not having received a certificate (i.e., reflecting the status that an INAM participant would show over that time period). Over 2.3 years, 18 percent of the comparison group students received a certificate, as contrasted with 37 percent of those INAM students who started in Fall 2013. Thus, the INAM students showed a superior rate of certificate completion over the time period available for this study.

Statistical testing using logistic regression produces similar results. If no allowance is made for the longer time period available to the comparison students, then the INAM participants were less likely to receive certificates. However, if comparable time periods are used for both groups, then the regression estimates show that INAM had a positive impact.[9]

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[7] The regression coefficient for a single hour of credit is -0.0707. For 15 hours of credits, this translates to an odds ratio of 0.35. These results were statistically significant at the 0.01 level.

[8] These are simple overall statistics. The time required to complete a certificate varied depending on the college and the program. Possibly, too, some of the programs changed in length as part of the transition to INAM.

[9] The regression estimate was 0.308 (statistically significant at the 0.01 level), and the odds ratio was 1.361.

3.2 Employment Outcomes

In this section, we examine the employment outcomes of INAM participants, first looking at their employment status overall and then evaluating their outcomes with relation to a group of comparable advanced manufacturing students who were enrolled prior to INAM.

3.2.1 Summary of Outcomes

At the time they started participating in INAM, students were almost equally split between those who were employed during the same quarter as their initial enrollment (51 percent), also known as incumbent workers, and those who were not employed, or non-incumbent workers (49 percent). In the last quarter for which wage data are available, 68 percent were employed. Thus, overall there was a gain in employment.

Figure 3-4 provides a graphical representation of the employment status of the INAM participants over the three years for which employment data are available (July 2012 through June 2015), showing how the status differed depending on the students' status in INAM. For a baseline measure of what might be expected for students who did not participate in INAM, we can look at those INAM students who had not yet started participating;[10] among them, there was a general increase in employment rates from 53 percent in the third quarter of 2012 to 68 percent in the second quarter of 2015, suggesting that improvements in the economy (or aging/maturation) led to increased employment over time. However, after students started participating in INAM the employment rate was higher, so that the percentage employed was consistently greater among INAM participants than among nonparticipants. Similarly, those who received an INAM certificate showed a higher rate of employment than nonparticipants, and in the last four quarters was superior than other participants. These data are consistent with the possibility that often taking just a few INAM courses (and perhaps receiving an outside credential) was sufficient to improve the job status of the participants, while there was added value from earning the certificate.

[10] Since some did not start until the summer or fall of 2015, data for nonparticipants are available for every time period.

Figure 3-4. Percentage of INAM participants who were employed, by time period and INAM status

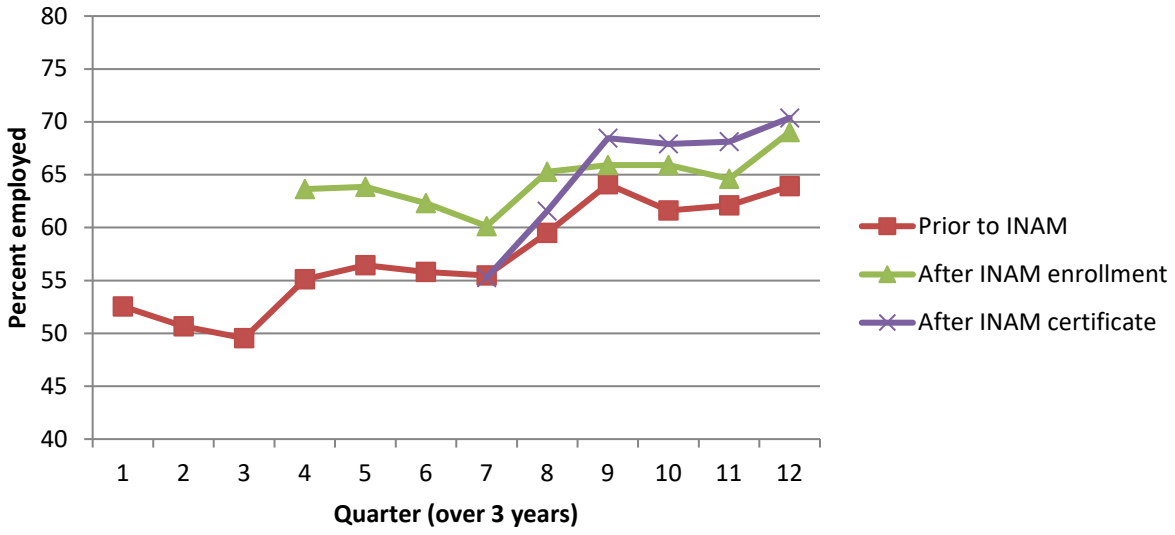


Table 3-1 shows some of the diversity of outcomes that were found among the INAM participants and the limitations of focusing on only a single measure. If one uses DOL measure 8, which is limited only to students who were not employed when they enrolled in INAM, earned a certificate, were not employed in the quarter before they exited INAM, and were employed in the quarter after exiting INAM, then only 41 students (2 percent) fit the criteria. However, the following might also be considered as positive employment outcomes: students who earned a certificate and gained employment but did so earlier than the quarter of exiting (20 students, or 1 percent), students who did not earn a certificate but gained employment (445 students, or 18 percent), and incumbent workers who experienced an increase in salary (a DOL performance measure), either after having obtained a certificate (112 students, or 5 percent) or without obtaining a certificate (533 students, or 22 percent). Collectively, these categories sum to 1,151 students (47 percent) with positive employment outcomes.

Table 3-1. Employment and education outcomes among INAM participants

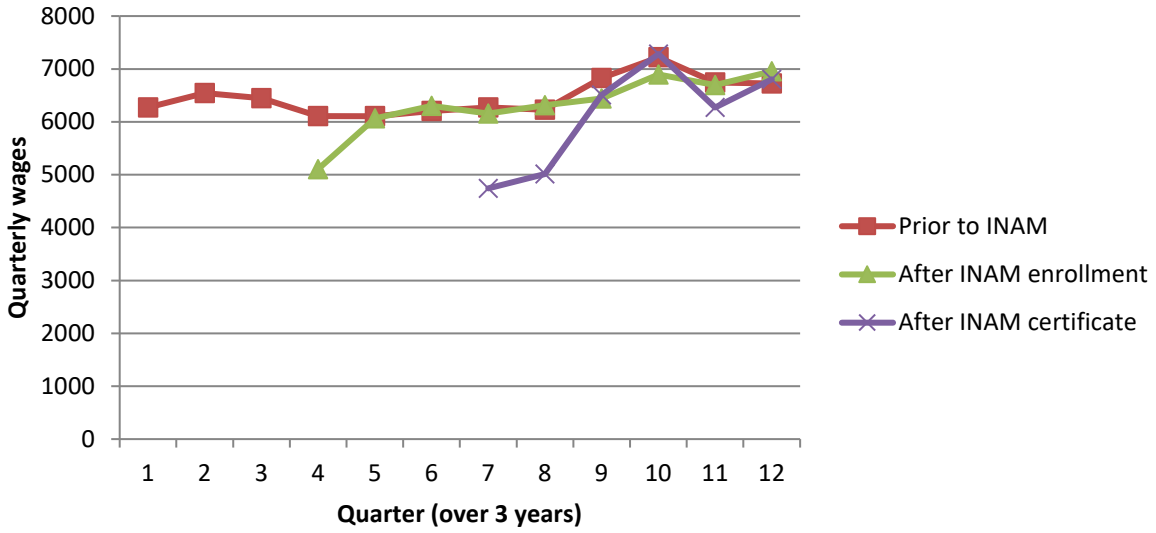
Employment and education status in first quarter after exiting	Number	Percent
Students who earned a certificate		
B8. Total employed after program of study completion (not incumbent worker, not employed in quarter before exit, and employed in quarter after exit)	41	2
Not incumbent worker, employed in quarter before exit, and employed in quarter after exit	20	1
Incumbent worker and employed in quarter after exit with higher wages	112	5
Incumbent worker and employed in quarter after exit	49	2
Earned certificate and employed in last quarter with available data	215	9
Earned certificate and still enrolled in fall 2015	37	1
Earned certificate and not employed in last quarter with available data	101	4
Students not earning a certificate		
Not incumbent worker, did not earn certificate, and employed in last quarter with data with higher salary	445	18
Incumbent worker, did not earn certificate, and employed in last quarter with available data with higher wages	533	22
Incumbent worker, did not earn certificate, and employed in last quarter with available data	305	12
Still attending college in fall 2015	246	10
Not employed in last quarter with available data	371	15

NOTE: Percentages are based on INAM participants with wage/employment data.

A similar analysis can be conducted focusing just on wages. Here the visual time trend is a little more confusing (Figure 3-5). There was not a general pattern of increasing wages over time among those who had not yet started their INAM enrollments (i.e., the baseline expectation without INAM); rather, there was a decline in the mean quarterly wages that was not reversed until the ninth quarter (July through September 2014). Further, those who participated in INAM showed roughly the same or lower wages on average than the baseline measure, possibly because some of the students cut back to fewer hours of employment while enrolled in INAM.[11] (These averages count only students who were employed, while students who left employment while participating in INAM are not included in these statistics.) Students who received a certificate also often showed lower mean wages than those who had not yet entered INAM. A possible explanation is that, to the extent that students reduced their number of hours at work while enrolled at INAM, they may have returned to a more substantial workweek after earning certificates (and thus often ending their enrollment in college). Another possible explanation is that some INAM participants were forced to change work because of poor economic opportunities in their then current occupations, helping to explain both why they enrolled in INAM and why their wages failed to increase faster than that of nonparticipants (e.g., because they had temporary work at a lower-paying occupation or switched to entry-level positions in a new area). Note also that the wages were not high even after participating in INAM, with mean quarterly wages generally between $5,000 and $7,000, depending on the students' INAM status. Of course, in general any new positions, coming after attending college, might be considered as entry-level positions and might fail to reflect their economic potential over time.

[11] The especially low wages in quarters 7 and 8 are based on only a small number of students, and are not very reliable.

Figure 3-5. Mean quarterly wages among employed INAM participants, by time period and INAM status



For additional perspective, Figure 3-6 shows the mean quarterly wages across all INAM participants, not just those who were employed. Here, the increased employment rate among INAM participants helps to improve their performance relative to those who had not yet enrolled, but these differences are also small.

Figure 3-6. Mean quarterly wages among all INAM participants, by time period and INAM status

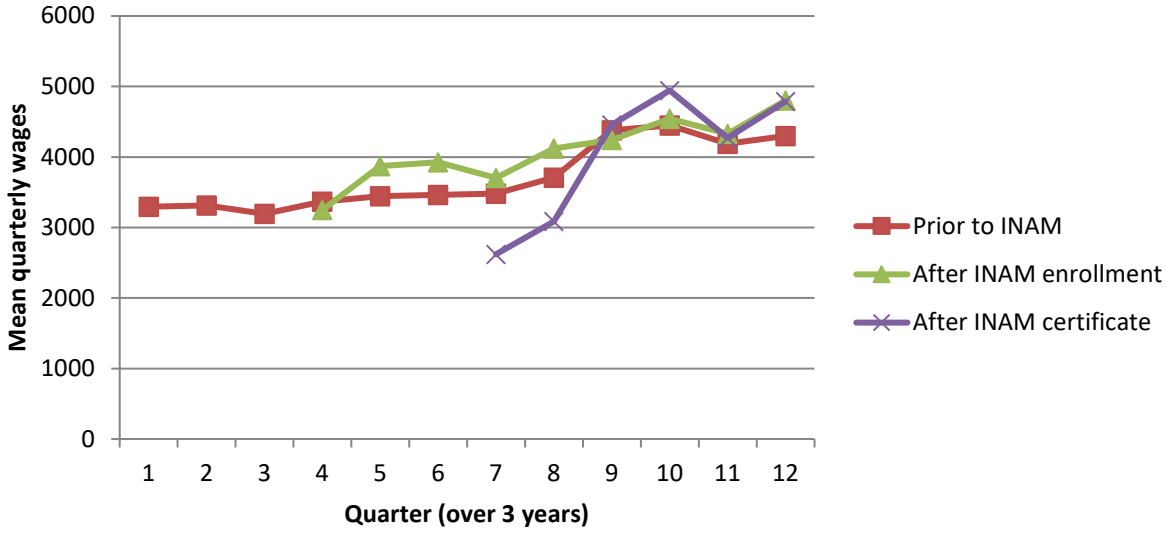


Table 3-2 provides a different way of looking at the wages: 41 percent of INAM participants experienced an increase in wages, either as incumbent workers with increased wages (31 percent) or non-incumbent workers who obtained wages after enrolling in INAM (10 percent). Meanwhile, 19 percent showed no wage increase, and 12 percent were not employed either prior to or after enrolling in INAM. Also, 19 percent cannot be evaluated because their participation in INAM was too late for wage data to be available for the time period after their participation.

Table 3-2. Wage outcomes among INAM participants

Receipt of wage increase after enrollment	Number	Percent
B10. Total employed at enrollment who received a wage increase post-enrollment (incumbent worker with wage increase)	760	31
Incumbent worker with no wage increase	461	19
Non-incumbent worker with zero wages prior to INAM and positive wages after entering INAM	146	6
Non-incumbent worker with nonzero wages prior to INAM and higher wages after entering INAM	111	4
Non-incumbent worker with zero wages both prior to and after entering INAM	304	12
Started INAM too late to measure wage increases	459	19
Other person who is not an incumbent worker	234	9

NOTE: INAM participants are restricted to those who earned certificates.

3.2.2 Comparison of INAM Participants With Prior College Attenders

For the comparison group, employment data are only available for students who earned certificates.[12] Thus, their performance should only be matched to INAM students who earned certificates.

Students in the comparison group were more likely to receive wage increases than INAM participants, both as incumbent workers with increased wages (51 percent versus 42 percent) or non-incumbent workers who obtained wages after enrolling (24 percent versus 15 percent) (Table 3-3).[13]

Table 3-3. Wage outcomes among INAM and comparison groups

	INAM participants		Comparison group	
Receipt of wage increase after enrollment	Number	Percent	Number	Percent
B10. Total employed at enrollment who received a wage increase post-enrollment (incumbent worker with wage increase)	239	42	120	51
Incumbent worker with no wage increase	94	17	16	7
Wages declined after enrollment	67	12	19	8
Non-incumbent worker with zero wages prior to enrollment and positive wages after enrollment	48	8	46	20
Non-incumbent worker with nonzero wages prior to enrollment and higher wages after enrollment	38	7	9	4
Non-incumbent worker with zero wages both prior to and after entering college	79	14	25	11

NOTE: INAM participants are restricted to those who earned certificates.

The results of logistic regression analysis indicated that participation in INAM had a small positive impact on employment, but this impact was not statistically significant. The results of regression analysis to predict wages in the twelfth quarter showed a negative association between INAM participation and wages, but this association was not statistically significant.

3.3 Department of Labor Performance Measures

When applying for the DOL grant, INAM was required to provide projections of what outcomes it anticipated using nine DOL performance measures. This section compares INAM's actual outcomes with its projected outcomes and examines what these results indicate about INAM's performance. For

[12] Only five colleges provided Social Security numbers for the comparison group students, and these were all colleges that selected only students who earned certificates to be in the comparison group.

[13] Although 24 months of wage data were available for the comparison group, only 12 months were used in order to keep the data comparable.

simplicity, this analysis focuses only on the cumulative outcomes rather than on the annual projections and outcomes. DOL suggested and INAM agreed that the first year should be devoted only to planning, largely invalidating the original calendar; also, INAM decided, with DOL's permission, to extend INAM grant activities (including student participation) into the first term of 2015–16, also complicating comparisons with the original calendar. Note also that as a condition of the grant, DOL required that INAM reduce its budget; concomitant with that reduction, INAM also lowered its targets.

Table 3-4 presents the results. The results were mixed, with INAM exceeding its goals in participation, students retained in the programs, the earning of credit hours, and the number of participants who received wage increases, but failing to meet its goals in the number of program completers, earned credentials, pursuit of further education, and job attainment after program completion.

Table 3-4. INAM projected and actual outcomes using DOL performance measures

	Outcomes	Original SOW target	Revised targets after budget was lowered	Actuals	Difference between targets and actuals
1	Unique participants served/enrollees	2,857	2,487	2,655	168
2	Total number who have completed a grant-funded program of study	1,474	1,292	600	-692
2a	Total number of grant-funded program of study completers who are incumbent workers	NA	NA	333	NA
3	Total number still retained in their programs of study (or other grant-funded programs)*	1,302	1,132	1,402	270
4	Total number retained in other education program(s)*	NA	NA	7	NA
5	Total number of credit hours completed (aggregate across all enrollees)	NA	NA	26,077	NA
5a	Total number of students completing credit hours	2,422	2,054	2,362	308
6	Total number of earned credentials (aggregate across all enrollees)	2,228	1,826	773	-1,053
6a	Total number of students earning certificates - less than one year (aggregate across all enrollees)	NA	NA	600	NA
6b	Total number of students earning certificates - more than one year (aggregate across all enrollees)	NA	NA	0	NA
6c	Total number of students earning degrees (aggregate across all enrollees)	NA	NA	35	NA
7	Total number pursuing further education after program of study completion	430	462	180	-282
8	Total number employed after program of study completion	992	1,089	41	-1,048
9	Total number employed after retained in employment after program of study completion	848	915	18	--897
10	Total number of those employed at enrollment who receive a wage increase post-enrollment	528	565	760	195

*These totals are cumulative totals across the three years since the APR defines retention in terms of the end of each reporting year. For example, there were 12 who were retained in INAM programs at the end of year 1, 567 who were retained at the end of year 2, and 823 who were retained at the end of year 3. A different approach would be to measure retention as of the end of grant activities (i.e., fall 2015). In that case, 772 were retained in INAM programs as of fall 2015, and 13 were retained in non-INAM programs.

A key question is how to evaluate this mixed set of results. Should INAM be considered a success, a failure, or as having a mixed bag of outcomes? Or, and perhaps more critically, what might INAM have done to have a more consistently positive set of outcomes? Was there a problem with the targets, the circumstances, and/or the methods used to seek the targets? One possible explanation is that some of the targets were unrealistic; this could be because the colleges failed to consider some of the complicating factors discussed below, or simply because the colleges lacked the data or expertise to know how to make accurate predictions. However, the focus of this report is on how colleges might optimize their outcomes, not on how they may make better predictions. Thus, this section in part examines whether the targets were realistic, but does so within the broader context of looking at what factors might be associated with failing to meet some of the original goals.

All of the measures of underperformance are interrelated with the length of time that INAM participants remained in college. This dimension affected whether students completed their programs of study (measures 2 and 6), whether they pursued further education after program completion (measure 7), and whether they attained employment after program completion (measures 8 and 9). Several explanations might be considered, some of which are measurement issues and some of which concern program operations:

- **Amount of time available.** The length of time that students continue at the colleges depends in part on the time period used to make the measurements. As noted earlier, students starting in fall 2013 showed higher completion rates than any group starting later, and one might hypothesize that the students entering later did not have sufficient time to reach the same level of outcomes. If one applies the same rate of program completion for the fall 2013 cohort to all of the enrolled participants, then the number of completers would be 997, still less than INAM's target but a substantial improvement over the actual 600.

- **Amount of data available.** The INAM evaluation was only able to obtain Social Security numbers, and thus track employment outcomes, for 2,483 of the 2,645 participants. If Social Security numbers had been available for all of the participants, then the number who were measured as employed after program completion is likely to have increased; however, the amount of missing data was too small to overcome the substantial deficit between the target and actual outcome. The amount of data (and time) available is also particularly an issue for outcome measure 9, which requires three quarters of data following the quarter in which the student exits with a certificate. Given that the employment data are only available through June 2015, a student must have exited with a certificate by September 2014, so that only students enrolling in year 2 of INAM can be counted.

- **Distribution of students.** INAM originally planned to recruit a substantial number of TAA-eligible students through cooperation with one-stop centers, but this plan fell through when the employment centers lacked sufficient funding. If the proportion of INAM participants who were non-incumbent workers had been higher, then the number eligible for satisfying measures 8 and 9 would have been higher. This might have improved the measured outcomes, but again the difference between the target and actual outcomes was too large for this factor alone to make the difference. Also, it is not clear that this difference would have resulted in increased program completion, a necessary step for satisfying the conditions of these two outcome measures. One might hypothesize that dislocated workers were likely to be older and to have families, increasing their economic need to move as quickly as possible from education to employment, so they might be less likely to become program completers.

- **Educational planning.** One of the original goals of the educational planning process in INAM was that the education planners would develop highly personal programs for the INAM participants and then maintain regular personalized followup with the participants over the course of the participants' educational careers. In practice, however, the colleges varied considerably in how they implemented this aspect of the program. Some made strong efforts to implement this aspect of the program, while others viewed the process as largely a one-time data collection effort to support the evaluation. If prolonged personalized followup were more strongly incorporated into the colleges' programs, then program completion might have been increased.

- **Narrowly defined performance measures.** The DOL measures were very narrowly defined, possibly in an effort to be able to more strongly attribute student outcomes to program participation. However, because of their narrowness, the measures failed to capture many outcomes that might be considered positive. For example, if INAM helped a student to gain employment, but the student immediately left the college without completing the academic program, then the student could not be considered as a program completer, as retained,[14] or even as a positive employment outcome (since measures 8 and 9 are limited to program completers). If INAM helped a student gain employment and the student took the job prior to the quarter the student exited, the employment outcome could not be counted in measures 8 and 9. Following are some of the positive outcomes missed by the DOL performance measures:

  - The count of certificates (measure 6) excludes outside credentials, such as NIMS and MSSC. These also provide a measure that the student learned the required skills and have the advantage of being nationally recognized. If the 871 outside credentials are counted, the total number is 1,644, which is still below the target of 1,826 but much closer to the target. If one assumes that all students will ultimately show the same credential earning rate as the first main term of spring 2013, then the total would be 2,668. Similarly, although INAM did not set a target for the number of students receiving credentials (measure 5), the actual number of 600 would be increased to 764 if students earning outside credentials are also counted and increased further if allowances were made for many students not having had sufficient time to earn the credentials.

  - At the time of starting participation in INAM, 51 percent were employed. In the last quarter for which employment data are available, 68 percent were employed.[15]

  - Overall, 41 percent experienced an increase in wages.

- **Misalignment between program objectives and participant objectives.** Related to the last bullet, the definition of the performance measures might be attributed to a misalignment between traditional education program objectives and the INAM participants' personal objectives. Traditionally, college attendance and employment are often considered to form two distinct times in a person's career, with someone first completing a college program and then

[14] The measure of retention depends on the time period involved. For example, the student may have been retained through the end of year 2, but not retained through the end of year 3.

[15] National employment statistics differentiate between those who were unemployed and seeking employment and those who were unemployed and not seeking employment. No data were available for this study on which time periods the participants were seeking employment, so this study simply distinguishes between those who earned wages and those who did not.

starting employment. From this perspective, program completion marks a key milestone separating education and employment. Many of the performance measures are based on this perspective, being defined in terms of whether the student completed a program of study and how the timing of employment corresponded with program completion. However, if a student's primary objective is to gain a job or learn new skills, then the student may enter employment (or switch to a better job) at any time, and may or may not continue education after entering employment. While educators may strongly believe in the value of their programs, it is hard to say that the student is wrong. The student has a legitimate objective that may be met successfully without satisfying traditional academic measures of success. By focusing strongly on academic accomplishments as the most appropriate measures of success, federal programs and postsecondary institutions may not be best serving students in meeting the students' goals, while also not adequately measuring the success of the postsecondary institutions.

- **Ambiguity in DOL definitions.** The evaluation team was unable to come to a consensus on how to define some of the APR measures, and this affects the statistics that are reported. For example, measure B7 asks for the total number of participants enrolled in further education after program completion and exit. Suppose that a student received an INAM certificate one term and continued enrollment the following term, as might easily happen if the college has stackable certificates, or if the student seeks to progress from a certificate to a two-year degree. One interpretation is that such a student should not be counted because the student never exited; if DOL wanted to count such students, then the measure could simply say "after program of study completion" rather than "after program of study completion and exit." Also supporting such an interpretation, the instructions say "exit is defined as being no longer enrolled at the college in any program of study…." However, there is no clear reason why DOL would wish to ignore further education that immediately follows program completion, only counting further education that follows program completion *and an interruption in education.* Also, the instructions say that exiting "can include formal withdrawal, expulsion, graduation, and other reasons," so it is possible to view the receipt of a certificate as defining an exit, and a student's enrollment in the following term as a new enrollment rather than as a continuation in enrollment. Thus, there are reasons to either count such a student within B7 or not count the student. These ambiguities affect both the statistics that get reported to DOL and also the ability of applicants for TAACCCT grants to project what outcomes they expected after receiving the grant, particularly considering that clarifying instructions were not issued until after the grant was awarded.

Outcomes for INAM Colleges 4

This chapter focuses on how the colleges themselves have changed as a result of INAM, while Chapters 3 and 5 discusses changes for students and employers. Sometimes, however, it is difficult to draw a clear dividing line between changes for students and changes for the colleges. For example, if student retention is increased, that affects both students (who are more likely to receive a certificate or degree) and the colleges (who have greater enrollment and perhaps enhanced reputations). Some changes, too, are difficult to document at this time. For example, changes in articulation agreements change the relationship between INAM and other colleges and change the opportunities available to students who attend INAM colleges. However, INAM students currently still are often in the process of completing their INAM enrollments, and it is too early to come to firm conclusions about their education after attending INAM.

Chapter 2 has already documented many of the changes at the INAM colleges.

- They have restructured their curricula, with essentially every course going through some kind of change.

- They have increased their program offerings. They have created new programs in CPT and other advanced manufacturing areas, but some colleges also continued revising their programs while INAM was in progress, with four colleges offering new programs in year 3 that they had not offered in year 2 and three colleges changing the requirements for existing programs in year 3.[1] Further, colleges that lacked programs or had only weak programs were able to learn from and cooperate with larger and more experienced programs.

- The colleges spent $3.87 million on new equipment, in some cases dramatically upgrading what they could make available to their students.

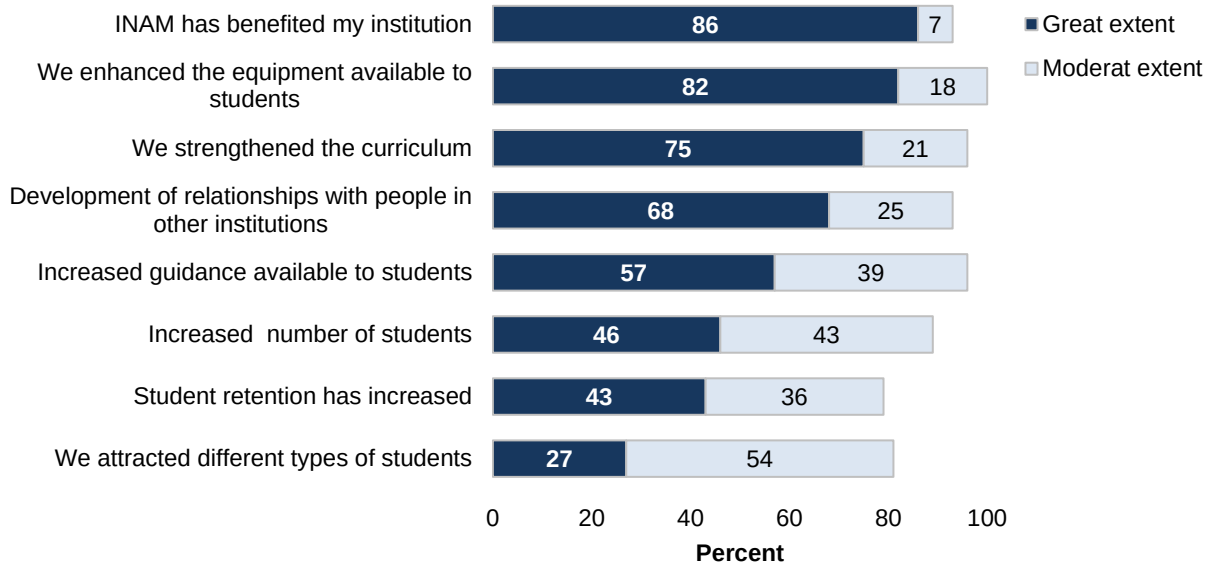
- Colleges have changed the way that course structures are sequenced, with the design of stacked and latticed earned credentials, the coordination with national credentialing opportunities, and the creation of articulation agreements with four-year colleges.

All of these help in creating the infrastructure that the colleges need for offering strong programs in advanced manufacturing.

In this chapter, we look at reports from INAM project directors concerning INAM's impact on their college. Project directors were surveyed at the end of the grant period, with all colleges responding.

[1] The changes in course requirements were at Oakton (Industrial Maintenance), McHenry (Mechatronics), and Southwestern (CNC).

Figure 4-1. INAM project directors' responses on the impact of INAM on their colleges



The project directors widely agreed that INAM had benefited their institution, with 86 percent saying their institution was improved a great extent, and 7 percent saying a moderate extent (Figure 4-1). All institutions said they enhanced the equipment available to the students, with 82 percent saying they were improved a great extent. Other changes that most project directors described as improving to a great extent were strengthening the curriculum (75 percent), developing relationships with people at other institutions (68 percent), and providing increased guidance to students (57 percent). Less than half, but still large numbers, reported great increases in the number of students (46 percent), student retention (43 percent), and attracting different types of students (27 percent).

Following are some comments that project directors made about specific improvements at their colleges. Part of what is notable about these comments is their diversity; that is, even though colleges were not asked to provide a list of improvements but rather describe what was "most beneficial to the college," they still gave a wide range of answers. In part, this diversity reflects the different starting points of each of the colleges; some already had strong programs while others were close to moribund, and some had just made improvements due to other grants, changing what their greatest needs were. Other changes reflect changes in implementation of the INAM grant in the sense that some took certain changes (such as curricular changes or student advising) more seriously than others.

4.1 Revived Programs or Greatly Expanded Programs

We had a machining program that was dormant. The grant allowed us to hire an experienced machining staff member that was able to develop the curriculum, get the equipment educational ready, and recruit and motivate students. We were also able to create the foundation for an Industrial Maintenance program.

Our welding program has increased 400% in enrollment.

INAM was responsible for breathing life back into our manufacturing programs. Because of updated labs and subsequent tours given to local industry reps, the college ended up delivering new employee training for a local company.
INAM allowed us to revive our manufacturing programs and increase awareness of what we have to offer current/potential students, the community, and local employers.

4.2 Funding Equipment and Personnel

Through INAM, the greatest direct benefit was our ability to upgrade our CNC and Welding labs to meet regional labor market demand while also benefitting from the input of our industry advisory partners.

This grant allowed us to acquire a Mechatronics lab [and] a new full-time instructor who implemented the MSSC training.

We added some new equipment to one of our welding programs that has generated a lot of new interest. Now one of our faculty has become a Certified Instructor; so he can sign off on students as certified welders.

The INAM grant allowed the college to re-purpose space and create a new state-of-the-art manufacturing lab and a state-of-the-art robotics lab that would not have been possible without the grant.

I was able to secure needed equipment to help improve the Mechatronics portion of our curriculum.

Our college has benefited greatly from the grant by purchasing equipment and supplies.

The equipment we were able to purchase in the manufacturing and welding programs has been extremely beneficial.

We spent most of our grant money on upgrading our equipment. This strengthened our program and gave it credibility to our local industries.

4.3 Cooperation With Other Colleges

The funding and the sharing of subject matter expertise among the other colleges helped us to develop, expand, and improve curricula.

The communication between my college's faculty and consortium members was most beneficial to my faculty.

4.4 Programs and Services

Although we did not meet the overly ambitious goals set at the beginning of the grant, we did retain and assist many students and expanded our programs substantially.

Now, we have a more structured way to offer credit for prior learning and will leverage what we learned from INAM to create a systematic and strategic PLA system.

Another notable aspect of the project was the stackable credential that I believe informed our curriculum development, which helped student persistence.

The individualized educational plan and interviewing was the most beneficial.

[We benefited by] Aligning the curriculum to common/shared objectives and learning more about NIMS and MSSC.

[We benefited by] Creating a manufacturing curriculum that is beneficial to both students and employers.

Outcomes for Employers 5

The Illinois Network for Advanced Manufacturing (INAM) program seeks to prepare students for high-paying jobs in advanced manufacturing. To this end, the INAM program attempts to build partnerships between the 21 participating INAM community colleges and local advanced manufacturing employers. In our previous report, we described the involvement of employers in various aspects of local INAM programs from the perspective of the INAM project directors and faculty members, including employers' participation in advisory board meetings, donations of money and equipment, and internship opportunities for INAM students.

In this report, we describe the results of the INAM program from the employers' perspective. Specifically, we asked employers about their experiences with INAM employees in terms of their technical and essential skills.[1] We also asked employers about their overall impression of their local INAM programs, the programs' alignment with their needs, and any suggestions for improvement they might have. Below, we discuss each of these topics in turn, including:

- Background and context of current hiring: the need for the INAM program;
- Employers' perceptions of INAM employees (technical skills, essential workplace skills, and willingness to learn);
- Employers' perceptions of INAM programs overall; and
- Suggestions for improvement.

The focus in this section primarily is on whether INAM, as currently configured, meets employers' needs. In some cases, employers were aware of and discussed changes over time (i.e., whether INAM introduced improvements), but not all employers could talk about this topic.

A detailed description of the methodology used for the focus groups and interviews is provided in Appendix A.

5.1 Background and Context of Current Hiring

Before describing employers' perceptions of INAM programs and their reactions to their INAM employees, it is important to provide some context about these employers' needs and the need for the INAM program: namely, employers' difficulties finding employees and the value of a college education

[1] A few notes on terminology: throughout this report, we use the phrase "INAM employees" to mean any employee who took courses at a local INAM program (who may or may not have completed a certificate). We use the phrase "essential skills" to refer to non-technical skills such as showing up on time and getting along with co-workers. Whenever we refer to "an employer," we mean the representative we interviewed from a given company: of course, not all individuals at each company necessarily share the same views. Finally, we did not use the phrase "INAM" in our questions to employers: instead, we asked employers about specific programs at local area community colleges that received INAM funding.

according to these employers. These comments do not necessarily speak about the INAM program directly, but they provide useful context to understand employers' need for and reactions to the INAM program.

5.1.1 Difficulties Finding Employees

Almost all the employers we interviewed were currently hiring, and most said they had difficulty finding qualified employees. As one employer put it:

> *…70 percent of the employees here are 55 or older… we're preparing ourselves as well as we can for the inevitable…we have a large amount of people within five years that are going to be gone, and we're gearing up for that.*

A few employers said that manufacturing was not a popular field or that employees changed their minds about the field after experiencing it. Finally, three companies located in central Illinois also said their remote location made recruitment a challenge, and most of their applicants had no experience in the field.

5.1.2 Value of a College Education to Employers Generally

Almost all employers felt that college experience was an advantage in hiring, but they varied as to the extent and reasons for this advantage. When we asked employers about the value of advanced manufacturing coursework at a community college (either taking a few courses or completing a certificate), almost all agreed that college experience would give job applicants an advantage. Often, these employers made it clear that college experience was not a prerequisite to work at these companies, but would be a plus on a resume. However, employers varied as to why college was advantageous: some felt that applicable college coursework provided the necessary technical foundation for employees to learn specific processes at the companies. On the other hand, a few other employers did not necessarily point to the coursework itself as advantageous, but rather the essential workplace skills gained through the college experience: these employers felt that students with at least some college experience showed more dedication or had better essential workplace skills than students with only a high school education.

Several employers pointed out that college coursework would be necessary only for certain roles at the company. For example, a few employers felt that college education would be helpful only for individuals interested in management positions or for employees with ambitions to rise in the company. Others felt that college coursework was helpful only for roles requiring specific technical skills. In addition, several employers felt that the value of college coursework had to be weighed against job applicants' past on-the-job experience.

Finally, a few employers did not feel that college coursework was applicable or an advantage for positions at their companies. One employer made this point throughout the interview:

> *College, I mean there's no real point to get in college to work here though they may have. First of all, I went to college for a year and hated it. I came back. Now, I mean I worked here for almost five years. I'm already a supervisor. In manufacturing, you don't need a college degree to be successful…. I know hundreds of people out here that never went to school. They're probably just as good as a professional welder that took actually a welding program and certified and all that stuff.*

5.1.3 Value of Other Credentials to Employers

We also asked many employers about the importance and benefits of credentials such as the ACT's WorkKeys test, the Manufacturing Skill Standards Council (MSSC) test, and the National Institute for Metalworking Skills (NIMS) test in their hiring process. The INAM programs often encouraged students to seek these additional credentials, and a few INAM colleges have built the testing for such credentials into their programs.

Of the three credentials, the NIMS was the most well-known. Most of the employers that we asked about NIMS said they had heard of it, and of these, almost all felt the NIMS credential was at least somewhat beneficial. Several employers also knew of the ACT, but these employers were evenly split as to its value. The MSSC was not widely known among employers we asked: only two employers knew of the MSSC. One employer valued it as a technical credential, while the other said the MSSC illustrated a general ability to improve oneself. In general, although a few of the employers were able to speak about the specific benefits of each credential, others only stated that any such credential would be a plus on a resume.

5.2 Results

5.2.1 Employers' Perceptions of INAM Employees

In this section, we describe employers' satisfaction with their INAM employees' skills and training. Specifically, we describe employers' perceptions of INAM employees in terms of their:

- **Technical aptitude;**
- **Essential skills** (showing up on time, getting along with co-workers, etc.); and
- **Willingness and ability to learn.**

INAM Employees' Technical Aptitude

All employers placed a high value on technical aptitude in potential hires. Due possibly to the diversity of interviewed companies, the specific desired skillsets varied among employers.[2] When hiring employees, employers most frequently requested general manual dexterity and mechanical aptitude; followed by math; working with machine controls, including basic programming; and blueprint reading (the latter requested only by companies hiring from computer numerical control (CNC) and welding programs). In addition, three employers requested computer skills; three requested electronics; and two companies associated with welding programs requested welding. Finally, single companies expressed interest in employees with a background in science, CNC, pneumatics, hydraulics, or robotics. Although almost every company offered some type of formal training to their employees (either through vendors,

[2] As part of this analysis, we examined patterns in employers' perceptions by INAM program type (e.g., whether companies hired from CNC, CPT, welding, etc.). In general, different patterns did not emerge across companies hiring from the different INAM program types. We therefore mention differences by INAM program type whenever these were clearly present, and otherwise collapse the findings across all INAM program types and industries. However, data on program types are only available for the individual telephone interviews; due to the diversity of companies participating in the focus groups, it was not feasible to tie comments in the focus groups to specific INAM programs. In addition, very few companies from certain program types (e.g., welding) participated in the study, making firm conclusions difficult to draw by industry.

local colleges, or on-the-job training), all preferred to hire employees with some level of technical skill or ability.

Most employers were satisfied with INAM employees' technical aptitude. These employers were impressed with INAM students' abilities or training in technical areas. For example, one employer had existing employees who attended the local INAM program and was satisfied by their development:

> *One of the things that I think is a great thing is once [employees] go to [the INAM program], they come back challenging programmers. You know, they get involved more in programming. They're able to read what the machine is doing. And their question level is a lot higher on what they were used to. They find out by themselves a faster way to do things. And also, their quality improves because now they're interested in 'why' – you know, the 'why' question comes up, and that's very beneficial for us.*

Several employers stated that although they did not expect INAM employees to be trained on all machines and in all areas, INAM employees' technical preparation was helpful for their roles:

> *I don't want someone that comes in that thinks they know everything. But at least they knew what you were talking about when you said, "you need…to change this tool. You need to change this offset." They knew what we were talking about. Other people that we hire, you have to actually teach them that, every little thing because they're not prepared. But the three guys that came from [INAM program], they were very trainable, very easy to work with.*

On the other hand, six companies had mixed impressions of INAM employees' technical skills, and two had a negative impression. These employers expressed varying degrees of concern about INAM employees' abilities or technical expertise. As one of these employers with a negative impression of his INAM employees' technical abilities stated:

> *I mean, [my INAM employee] doesn't even know how to read a tape measure. I mean, you think somebody in [an INAM] program [would] be taught how to read a tape measure. But he has to have a special tape measure…one [that] actually shows down to the 16th. He doesn't know what all the marks mean, stuff like that.*

INAM Employees' Essential Workplace Skills

Employment experts often provide lists of general, but essential, skills that employees need in addition to the specific technical skills they learn at college, such as showing up on time, getting along with co-workers, etc. We asked employers about their experiences with INAM employees' essential workplace skills.

These essential workplace skills were important to most employers we interviewed. These employers preferred employees who behaved professionally, with good attendance, good people skills, good communication skills, and a disciplined work ethic. In addition, three employers described the importance of attention to detail or safety, and one company expressed a preference that employees show stability and not "job hop." We also examined companies' responses by industry (e.g., the type of INAM program they hired from) and found some minor differences. For example, companies hiring out of CNC programs frequently emphasized the importance of good people skills and communication skills. Similarly, companies associated with CPT programs frequently mentioned the importance of drive and a

good work ethic. However, these desired essential skills were not exclusive to employers in these industries.

Most employers had positive experiences with INAM employees' essential workplace skills. These employers felt that their INAM employees conducted themselves professionally, showing up on time and getting along with coworkers. Of course, it is difficult to determine whether the INAM programs directly influenced students' essential workplace skills or, alternatively, if responsible and professional students were more likely to enroll in INAM programs. However, one employer attributed his INAM employee's professionalism directly to training he received during the INAM program:

> *…after I interviewed [the INAM student], the director of the [INAM program]…actually asked if I would get in touch with him, and he was curious as to how [the student] did [in the interview]. So I followed up with him and let him know, because he told me that he goes over that kind of stuff with him, as far as interviewing and getting in the door.*

On the other hand, two companies had mixed impressions of INAM employees' essential workplace skills, and two had negative impressions. For example, one such employer with a negative impression stated:

> *The biggest issue we had with the individual in that [INAM] program was the ability to show up on the scheduled days that they were to work and reporting to work on time.*

INAM Employees' Willingness or Ability to Learn

Almost all employers wished to hire employees with a willingness or ability to learn. Although this ability can be classified as an essential workplace skill, it was mentioned so frequently by employers that it deserves separate attention. Almost every interviewed employer described the importance of employees being willing and able to learn new skills. This flexibility was particularly important in the context of advanced manufacturing, where employers' specific processes and machines might be different from those taught in schools or by other employers.

Most employers expressed satisfaction with INAM employees' willingness and ability to learn. These INAM employees showed flexibility and an ability to build upon what they learned in school. These employers appreciated INAM employees' ability to adapt to the processes and procedures at the company. For example, one employer attributed his INAM employee's ability to learn to his INAM training:

> *… the [vendor providing training] actually said [the INAM employee] caught on so fast they only spent like four or five hours with him [instead of the usual two days]. They said he was one of the best people they have ever trained on one for picking stuff up. And I see that in him. He studies at home at night how to run the machine, to find the ins and outs of stuff. He just really picks up stuff quick. And I think that goes to the skill set of what he was handed at the school. They really did teach him to learn and he's anxious to learn still. He's impressed me.*

However, three employers had negative experiences with their INAM employees' ability to learn. As one such employer put it:

> *I don't think [the INAM employee] picks up on stuff very fast… Somebody has to be willing and have the ability to learn and have the skillset to actually to do what they're going to*

school for, which I think that's what went wrong with the guy I supervise. They don't really have the skillset, mindset, and ability to learn too fast.

5.2.2 Employers' Perceptions of INAM Programs Overall

Many employers observed changes in the colleges' advanced manufacturing programs after the implementation of INAM. However, several employers had not noticed any changes, and some employers had no knowledge of INAM.

Most employers viewed the INAM advanced manufacturing programs positively. These employers appreciated the preparation their employees had received. Several commented that even if an INAM program did not cover all topics, it provided a good overview of the basics. These employers expressed appreciation for the INAM programs, saying:

I'm highly encouraged by [the INAM program]. And I think that we have stumbled upon a program here that is going to benefit this company in years to come. And everything that we have done through [INAM school] to this point has been very, very successful with students coming out of these programs.

As another employer stated:

[The INAM program is] a good step to helping build some stronger individuals so we can get some more talent in our industry or any industry in our local economy.

However, not all employers shared positive views of the INAM programs. A few employers had mixed reactions to their local INAM programs, and three employers shared negative impressions of their local INAM programs.[3] For example, one company previously recruited students out of its local INAM program, but stopped in 2015 due to the low quality of the students. This company now recruits students based on ACT's Work Keys assessments instead, saying:

We had better luck training people that have absolutely no machining experience than people coming out of that [INAM] program.

When asked, many employers said that INAM program coursework was important in the hiring of potential employees. For example, one employer hired an INAM student who did not have prior work experience outside of the INAM program and said that the INAM coursework was important to getting the job:

… he had zero manufacturing experience whatsoever. In fact out of high school I believe he was a cook at a retirement home for three or four years. And I think he realized that that's not what he wanted to do for the rest of his life, and he wanted to get into some place where there was a chance for advancement and stuff. So, when he came in and he said he'd been taking these classes and stuff and the kind of stuff I'm looking for, just some mechanical ability, that kind of gave him a head start on some of the other people that I bring in with

[3] Throughout our analysis, the same three companies tended to have negative impressions, both of their INAM programs and of their INAM employees' willingness to work. (Two of these companies expressed dissatisfaction with INAM employees' technical skills, and one also expressed dissatisfaction with INAM employees' soft skills.) Two of these employers seemed to base their negative impressions of the program on their experiences with individual INAM employees. The third employer (quoted above) had extensive experience with the local INAM program, having visited the INAM shop area, served on the advisory board, and seen the performance of multiple INAM students

maybe some mechanical ability, but no formal training. So, it definitely set him above the rest.

Again, however, a few employers with negative views of the INAM programs did not see the added value of INAM coursework as a hiring credential.

5.2.3 Employer Suggestions for Improvement

We asked employers what they would suggest to improve the INAM programs, and most employers offered suggestions to better align the INAM coursework to their needs or offered other suggestions for improvement.

Alignment of INAM Courses With Employer Needs

When asked, most employers felt that the courses in the INAM programs aligned with their companies' technical needs. However, two employers had mixed feelings about the alignment of INAM courses to their needs. One company hiring out of a mechatronics program stated:

My impression is that it needs to improve, in that there needs to be more PLC [programmable logic controller] strength coming out of the students and more robotics background. Here's why I say that. Our industry is moving more towards robotics and automation, so having students with more of this background will really assist us in …bringing up a core group of technicians that have the abilities and skill sets to maintain that type of equipment.

Even if INAM courses did not exactly align with employers' needs, a few employers said that the courses could still be valuable background. As discussed above, almost all employers desired employees who could learn and be easily trained. For example, one employer hired out of an INAM welding program despite welding being unrelated to the company's work:

There's not really classes you can take to become a composite technician around here [in the company's field]…we look for people that have attention to detail, they're able to learn quickly, they're good with their hands. And interestingly enough, quite a few people meet that from the [INAM] welding program….

Some employers had suggestions for additional topics that could be emphasized in the INAM programs. Due possibly to the diversity of companies represented in our sample, there was no consensus on which topics should be included. Two employers recommended a greater emphasis on robotics or CNC; two suggested coursework in gear-cutting; and three suggested coursework in quality inspections or testing equipment.

Other course topics were suggested by single employers, and included PLC, troubleshooting, advanced programming, three-base power, lean manufacturing concepts, computer-aided drafting (CAD), math, chemistry, and blueprint reading. For example, one employer felt that his INAM employees were well-prepared in welding, but not in blueprint reading.

Other Suggestions for Improvement

Besides the technical classes suggested above, employers also offered other suggestions for ways to improve the INAM programs. Several employers suggested that INAM students get more hands-on opportunities to work on real equipment:

> *…going from the classroom to the production, it's a whole different ball game…. I think one thing that would probably be a plus to a program like that would be a shadowing program or externship… where they can come in and put 40 hours in at a company and just to understand the safety side of things, quality side of things, and production side of it.*

Similarly, several companies asked for changes in equipment or materials to match what the companies used:

> *I realize this takes money and I think [INAM program] would do it if they have it, but I would add more industrial equipment to the program so that it's more real-life kind of like on-the-job training.*

Two companies associated with one college wished that their INAM program would hire more experienced administrators, reach out more frequently to employers, and be more appreciative of employers' donations of materials to the INAM program:

> *…when you see some of the people that are running these [INAM] programs, they have no idea about manufacturing, but they're on the program.… you should have somebody that really understands…. [Employer 1]*

> *Sometimes we almost have to push ourselves on [the INAM program] to …donate equipment…usually the guys that run the shop and all that really appreciate it, and all that so that's good. But do other people [administrators] realize what you've done? They don't understand. Short of, if you give them a machine for that quarter million or something like that, that's a whole different ballgame. But what goes onto that machine and actually makes that machine work and cut, apparently [knowledge of the employer's donations] doesn't get far up the food chain. [Employer 2]*

Several individual companies made other suggestions. For example, one company suggested reaching out to INAM students for feedback to improve the program. Another employer suggested focusing on students' essential workplace skills in the INAM programs. Finally, one employer requested more money for marketing and more aggressive recruitment into these programs, indicating there was a great unmet need:

> *Oh, it's a great program. I'm baffled that we can't get more students in it. In my opinion, they should have a waiting list. There should be kids banging on the door. They're learning a great skill. They have a potential for an internship as soon as they graduate…. There are terrific jobs in the area coming out of that program…. Literally, there are six or seven companies in town that would fight over those kids…. I wish they had more money to market those programs for the kids better and get it more visibility so we would have more students in the programs. The community college does the best they can. But marketing is not their greatest strength…. So maybe something that came from the state or the national program that was a little higher quality marketing material. I think most kids don't know what mechatronics means. So helping them understand better what it is and what kind of jobs it would lead to, would be terrific.*

Along these lines, several employers made comments about the importance of marketing manufacturing to the next generation:

> *… we really need more children interested in manufacturing. Our country needs more people interested in that and it's got to start younger. We've got to get children, like high school students, to think about manufacturing as a career. And I'm sure you understand that there's a huge shortage of manufacturing people to fill the jobs; we're going to have a massive problem here in 10 years, and there're so many parents that do not think that manufacturing is safe. They think it's a dirty, dangerous kind of a job that's low paying… breaking down some of those barriers is really important.*

As another employer put it:

> *And I don't know at the local college level how many people are participating in the program right now, but I'm going to have a need for it. If not by the end of this year, next year I'm going to be looking to hire several more people, and I'm going to need that help, and I hope they're there for me.*

Review of Curricula By Content Experts 6

The project evaluators hired outside consultants to act as curricula review experts in the five areas of advanced manufacturing addressed by INAM. The reviewers were asked to evaluate the curricula in terms of their usefulness as a national model for other such programs; this is a high standard to set for the INAM colleges, but one of the purposes of the DOL grant is to have the grantees post course syllabi on the web so other programs can learn from the grant activities. It should be noted that colleges have multiple strategies available for offering such programs; for example, a college might break a program into multiple parts (i.e., creating stackable credentials), so any individual certificate program must be viewed in terms of the larger context of programs offered by the college. In that sense, a fully comprehensive program might appear desirable in terms of the completeness of its content, but might be intimidating or hard to complete for students facing employment and family obligations, while a stackable credential may look less impressive but show greater retention and completion rates. INAM chose to focus on the initial studies that students would pursue when first entering the advanced manufacturing area, but some of the colleges plan to expand to more advanced programs in the future. This review focuses only on the beginning programs and does not necessarily reflect everything offered by the college in the advanced manufacturing area.

This section summarizes the results of the expert reviews, which were divided into two parts: reviewing the INAM learning objectives (which were collectively shared across all of the INAM colleges) and the course syllabi (which varied by college). The course syllabi do not provide a complete picture of how a course was taught, but they are the documents that potentially might be used as models by other colleges. This chapter is a summary, while the actual reviews were much more extensive and detailed. At times, there were minor disagreements between the reviewers in their comments. This is probably due in part to the fact that the reviewers had only course syllabi to work with, so they sometimes had to make judgment calls as to how to interpret the language in the syllabi.

We should note that the term “learning objectives” can be used in multiple ways. Most typically, a statement of learning objectives provides a specific description of what knowledge and skills should be learned by the students, in such a way that the learning objectives are specific and measurable. The INAM-specified learning objectives were often general statements of learning goals, rather than being highly specific and measurable. These broadly stated learning goals were meant to be applicable across 21 colleges, whose programs often differed, served different geographic regions within Illinois, and were customized to meet the needs of local employers. As such, an individual college seeking to use the INAM learning objectives as a model might use them as the starting basis for creating learning objectives that are more specific and also tailored to the needs of the local manufacturers. For example, within the field of industrial maintenance, a college serving pharmaceutical packaging might give special emphasis to sanitation standards, while a college serving automotive assembly might require a larger emphasis on mechanical systems.

The experts involved in the content reviews are listed below:[1]

[1] This chapter sometimes directly quotes the experts and sometimes attempts to synthesize their comments, but in all cases, this chapter is based completely on the comments of the experts. This is fundamentally their intellectual product, not that of the report’s authors.

Exhibit 6-1. List of content experts, by area

Content area and expert	Title	College/firm
CPT		
Stanley McCord	CNC Instructor and Program Coordinator	Rock Valley Community College (retired)
CNC		
Richard Haring	Sr. Test Development Engineer	Philips Lighting Systems & Controls
Stanley McCord	CNC Instructor and Program Coordinator	Rock Valley Community College (retired)
Industrial Maintenance		
Linden Griesbach	Faculty	Rock Valley College (retired)
Richard Haring	Sr. Test Development Engineer	Philips Lighting Systems & Controls
Mechatronics		
Linden Griesbach	Faculty	Rock Valley College (retired)
Richard Haring	Sr. Test Development Engineer	Philips Lighting Systems & Controls
Welding		
Thomas Buscaglia	Retired Welding Instructor	College of DuPage
Ronald Sanderson	Retired Welding Instructor	Lake Land College (retired)

6.1 Certified Production Technician

6.1.1 Learning Objectives

INAM set the following learning objectives for Certified Production Technicians (CPT).

Exhibit 6-2. Learning objectives for CPT

At the successful completion of this certificate, the student is able to:
1. Utilize effective, safety-enhancing workplace practices in multiple industries.
2. Demonstrate an understanding of quality practices and measurement.
3. Identify basic fundamental of blueprint reading.
4. Determine resources and workflow required of the production process.
5. Document product and process compliance with customer requirements.
6. Recognize potential maintenance problems, issues or concerns with basic production systems.
7. Recognize preventative maintenance indicators to ensure correct operations.
8. Identify different types of basic production and related mechanical principles, mechanical linkages, and production materials.
9. Demonstrate use of basic math skills to facilitate technical competences.
10. Sit for the national Certified Production Technician (MSSC-CPT) exam.

These learning objectives are more than sufficient for students to complete and pass the MSSC/CPT certification. One thing to stress is the absolute need for some type of blueprint reading/interpretation class. Employees have to be able to interpret many different types of graphic languages today, including additive manufacturing, and utilize many different styles of drawings.

Following are comments about each area:

- **Safety.** Employees will use a wide variety of equipment, mobile and stationary, and will be exposed to many types of chemicals, oils, and airborne contaminants. Knowledge of Occupational Safety and Health Administration (OSHA) regulations and Materials Safety Data Sheets information will be important.

- **Quality.** Quality practices may be applied to any type of workplace, and in manufacturing it is vital. Use of proper measuring equipment and documentation procedures should be part of this program.

- **Blueprints.** Blueprint reading and interpretation is usually one of the first courses taught, along with quality, as they are both fundamental in all industry training. In the manufacturing world, there are a variety of blueprints dealing with machining, assembly, construction and electronics. This is one subject that may need to be customized to suit local needs.

- **Resources.** All employees should understand the materials and equipment used to manufacture their products. Companies should cross-train employees so they can see how every process affects another. Classes need to foster curiosity and where and how to find information desired.

- **Process compliance.** The need to create a product the same way, every time, and to develop new processes to improve production is vital. Students need to understand the importance of following procedures for customer satisfaction.

- **Maintenance.** Students need to take ownership and pride in the use of their equipment and workspace. Proper maintenance of any equipment is important, and knowing equipment well enough to understand the need for preventive maintenance is every employee's responsibility, not just the maintenance department's.

- **Production systems.** We use an amazing variety of systems to produce our products. While no one can be an expert on all of them, knowledge of the different systems can foster thoughts for continuous improvement. Lean manufacturing techniques are valuable in this study.

- **Math.** Industry uses many different types of math, and all students should be confident that they have the ability to solve everyday problems and tasks, but to also explore avenues and concepts that we do not normally use.

- **MSSC exam.** Certification is important for employers to know that job applicants and trainees have already acquired core knowledge to make further training quicker and easier. Students need certification for confidence in knowing these fundamental ideals. They will be more likely to pursue employment in jobs that are more highly skilled and technical.

6.1.2 Review of Individual College Programs

Following are comments about the specific college programs. All of the programs meet the requirements for passing the MSSC exam except for the program at Lincoln Land.

- **Harper College.** This is a strong program, especially with the internship as a capstone. Students completing this course should have no issues with the MSSC testing and will be good candidates for employment. It will provide a good foundation for working in most industries. Due to the variety of manufacturing, blueprint reading cannot focus on one style, so in depth knowledge may need to be reinforced.

- **Illinois Valley.** This is a good program overall. It appears that the majority of class time will be spent in lecture. It is hoped that the students would receive some shop time or onsite visits

to local manufacturers. Students should be able to successfully complete MSSC testing. Some internship or shop lab time would be very valuable.

- **John Wood.** This program has the least amount of credit hours for the manufacturing classes. While this will probably be sufficient for the students to be successful in passing the MSSC exam, some expansion of the courses or an addition to the program in some area such as lean manufacturing or an internship/shadowing would give the students more confidence for the exam.

- **Kankakee.** This is a strong program, and students will have few issues with the MSSC testing. This is the only program with lean manufacturing as a complete course. Some shadowing experience or company visits would be an advantage for this program.

- **Kishwaukee.** This program will prepare the students for the MSSC testing very well. The quality course could be expanded a bit, perhaps to include more blueprint reading material. The MT-104 course includes lab time, which is important for the students to get that hands-on practical knowledge they cannot get out of a textbook.

- **Lincoln Land.** This program lacks the credit hours and instruction time needed to fully meet the needs of the MSSC program. Suggestions are to expand the 102 course (quality) to a minimum of 3 credits with blueprint reading and measurement stressed. The 103 course should also be expanded to include some lab time or job shadowing to give students hands on experience. The 104 course (maintenance) could be expanded to include some lean manufacturing principles.

- **Richland.** This is a strong program that should prepare the students for the MSSC exam. All courses cover a good variety of subject matter and in depth, so students should be confident on most subject matters. It appears the blueprint reading will provide the math skills needed, but it would be an advantage to have a stand-alone tech math course of 2 credits or so. All of the other courses are very strong in their coverage. The option of students taking blueprint reading or motor control fundamentals is unique and may be beneficial to the area manufacturers.

- **South Suburban.** This is a good strong program that will provide the adequate study time, in-depth knowledge of subject matter and hands on practical application throughout the internship. Students should be confident in taking the MSSC exams.

6.2 Mechatronics/Robotics

6.2.1 Learning Objectives

INAM set the following learning objectives for mechatronics.

Exhibit 6-3. Learning objectives for mechatronics

At the successful completion of this certificate, the student is able to:
1. Understand the electronic and mechanical parts of an automated system.
2. Interpret electrical wiring diagrams and symbols.
3. Install, program, and troubleshoot Programmable Logic Controllers (PLCs).
4. Understand and explain the principal operations of the mechatronic subsystems in a complex system.
5. Understand and implement safety regulations required for operation of the system.
6. Diagnose and resolve equipment problems by utilizing technical assessment skills that include planning, reliability, logical thinking, ability to use drawings, schematics, and documentation.
7. Differentiate between thermal, mechanical, fluid and electrical power systems in a variety of settings.

Two experts commented on these objectives. Griesbach commented that these learning objectives cover the necessary areas of electrical, pneumatic, and hydraulic systems, as well as sensors and control systems. They could be improved by being more specific and by providing measurable activities. In addition, some may be at too high of a level for a beginning certificate. For example, an entry-level technician would probably not be expected to install or program a PLC (objective 3). Limited troubleshooting might be expected. Also, limited diagnosis and repair of equipment problems would probably be within the realm of an entry-level technician (objective 6). Planning and reliability would probably not. Linden Griesbach noted: *In my opinion, an entry-level technician should be able to diagnose and repair simple malfunctions of electrical control systems, small electrical power systems, pneumatic systems, and hydraulic systems. For example, such a technician should be able to locate a defective sensor and replace it or locate a defective pneumatic valve and replace it. I would not expect an entry-level technician to design systems, write programs, or to do work normally done by a skilled tradesperson (*e.g. *an electrician or pipe-fitter).*

Richard Haring provided additional comments. He noted that while he assumes that these objectives are designed for a beginning certificate, it would be helpful to show they fit into the context of a larger program. He also suggests the following:

- Since objectives 1, 4, and 7 all mention the ability to understand or differentiate between the various subsystems of an automated/mechatronic system and would therefore seem to be somewhat redundant, the three objectives could be combined into a single, more robust objective which fully reflects mechatronic concepts.

- While objectives 2, 5, and 6 seem to adequately cover the basic technology requirements such as schematic interpretation, and troubleshooting skills and an understanding of safety regulations, there is no mention in any of the objectives of the use of computers, which are now essential for control, communications, and troubleshooting of mechatronics systems.

- Some of these objectives could benefit by expanding upon the description and including specific references to the subjects covered in the curriculum. For example, in regard to objective 3 (Install, program, and troubleshoot PLCs), students enrolled in the program would benefit, and it may be more desirable in the workplace, if at least a basic understanding of sensors and actuators, human/machine interfaces (HMIs), and data handling were included in this objective as these devices are now quite common in automated systems. An introduction to robotics technology may also be considered desirable experience by potential employers.

- Haring's interpretation is that the emphasis of these objectives seems to focus on the individual parts of the system rather than an integrated whole. In addition, the objectives should have more of an emphasis on a systems approach to be used as an example for a national Mechatronics certification program.

6.2.2 Review of Individual College Programs

Following are comments about each college's programs:

- **College of DuPage.** This program fully meets the learning objectives. It could be strengthened by mentioning safety as related to electricity and electrical circuits and discussing HMIs. It has limited if any discussion of thermal power systems. The program also would benefit by adding an advanced level PLC course and discussing the installation of PLCs.

- **Daley.** This program fully meets most but not all learning objectives. It has a limited discussion of safety regulations with regard to automated systems and no discussion of thermal power systems. The program may benefit by replacing MFG251 with a secondary- level PLC course. Welding, while useful in a manufacturing environment, is not part of the mechatronics curriculum. Major topics that are not addressed are interpreting relay ladder diagrams, the installation of PLCs, the safety of hydraulic systems, and mechanical systems.

- **Danville.** One expert said the program meets all learning objectives, and the other said it meets all but two: objectives 3 and 7. It has no discussion of thermal power systems. The program would benefit by adding a secondary-level PLC course or combining motor controls with ELEC168 and devoting ELEC269 entirely to PLCs.

- **McHenry.** This program only partially meets objectives 1 and 4 and does not meet the remaining objectives; it would be more appropriate as a specialized or more advanced-level certificate geared towards robotic programming and related skills.

- **Oakton.** This program partially meets objectives 2 and 5 and fully meets the remaining objectives. Little emphasis is given to electrical wiring diagrams and symbols, and there is no discussion of thermal power systems. This could be remedied by augmenting the existing program with a basic industrial electrical course. All major topics are covered except installation of PLCs, the safety of pneumatic and hydraulic systems, and mechanical systems. The certificate offers a choice between MFG111 and MFG140; however, MFG111 better addresses the objectives. MFG240 and 250 might be helpful pre-requisites to MFG111.

- **Southwestern.** This program partially meets objectives 4 and 5 and fully meets the remaining objectives. Safe practices and the National Electrical Code are discussed; however, there is no specific mention of safety regulations. While basic concepts of fluid power may apply, there is no specific discussion of pneumatics, which is one of the most common methods of automation.

- **Triton**. This program partially meets objective 5 and fully meets the remaining objectives. This is the only program to specifically discuss temperature controls. Safe practices are discussed, but there is no specific discussion of safety regulations. All major topics appear to be addressed except mechanical systems and installation of PLCs.

- **Waubonsee.** This program fully meets all learning objectives. It is the only program to have a course devoted to safety. The HVAC course has limited discussion of thermal power systems; however, the program may be better served by a Technical Electronics course. All major topics appear to be addressed except mechanical, hydraulic, and pneumatic safety.

6.3 Industrial Maintenance

6.3.1 Learning Objectives

INAM set the following learning objectives for industrial maintenance.

Exhibit 6-4. Learning objectives for industrial maintenance

At the successful completion of this certificate, the student is able to:
1. Identify different careers available in the Industrial Maintenance field.
2. Describe physical properties of a variety of equipment used in the workplace, including force, torque, simple machine, and mechanical drives.
3. Utilize effective, safety-enhancing workplace practices in multiple sites.
4. Demonstrate an understanding of safe and proper use of tools/supplies required to diagnose/repair a malfunction in the workplace.
5. Employ a systematic approach to troubleshooting a scenario based upon an industrial equipment system failure/problem/complaint and prepare an effective repair solution.
6. Interpret basic fundamentals of blueprints mechanical drawings, designs, sketches, layout drawings, plans, specifications, shop drawings, service and repair manuals, and schematics used in industrial maintenance.
7. Demonstrate the fundamentals of industrial fluid power, which includes pneumatics and hydraulics, and electrical theory.
8. Identify and demonstrate proper use of different types of basic electrical testing equipment. Understand how electricity is produced and the physics behind it such as voltage, amperage, resistance, and power.

The content experts provided a mixed review of these objectives. On the positive side, the objectives "*appear to provide a reasonably complete framework that addresses the basic requirements for an Industrial Maintenance Technician and, with some minor improvements, may provide a suitable framework as a national model for other colleges/consortiums to design similar certification programs.*" (Haring) However, several improvements were suggested:

> *Some of the INAM objectives seem to be rather vague, and the scope of these objectives could perhaps be better defined. For example, the objective describing the utilization of safe workplace practices should be clarified with respect to what type of work practices should be covered and expanded to include an overview of OSHA safety regulations. (Haring)*
>
> *The objectives that describe the use of tools and electrical or mechanical measurement equipment should provide examples of the appropriate tools and equipment. For example, it should be clear what constitutes basic electrical testing equipment (i.e. digital multi-meter, oscilloscope, etc.), and what types of tools may be required to diagnose/repair a malfunction in the workplace (i.e. measurement, hand/power tools, welding equipment, machine tools, etc.). It should be reasonable to expect that an industrial maintenance curriculum include at least a brief exposure to machining, welding, and fabrication techniques, as these skills are essential to repair a wide variety of mechanical problems. (Haring)*
>
> *It is recommended that a certification program require at least 20–30 credit hours of pertinent course content to meet the INAM objectives. This should include an introductory course in Industrial Maintenance, which could perhaps be combined with a discussion of the various career options available in the workplace and may be combined with an overview of OSHA safety regulations and safe work practices in typical industrial environments (3–5 credit hours); an in-depth overview of electrical, mechanical, and fluid*

power systems, with each subject requiring at least 4 credit hours due to the level of technical content, with perhaps a secondary electronics course (12–16 credit hours). The curriculum should also include a course offering an introduction to basic machining and welding practices (4–8 credit hours). Any certificate program with less than a requirement of 20 credit hours would not seem to offer the depth of content to sufficiently cover the entire scope of objectives, and this seems to correspond with the results for the various certification programs reviewed in this study, which ranged from 13 to more than 40 credit hours. Those programs that had significantly more may require course material that would be of limited value to the student or to prospective employers. (Haring)

A beginning-level certificate in Industrial Maintenance that leads to an employment-ready graduate will probably be very skill based. There is simply not enough time in a 36-hour curriculum (approximately one academic year) to fully develop a complete theoretical background. Objectives 2, 7, and 9 emphasize very theoretical concepts. Devoting curriculum time to these items would require omitting many practical skill components. (Griesbach)

The description of this program on the website mentions mechanical drives and motors/ motor controllers. This list of Learning Objectives does not significantly address this important area. There is also no coverage of pumps, preventive maintenance, or computers as described on the website. (Griesbach)

As mentioned earlier, a one-year certificate does not allow much room for extraneous material. Several of the objectives include items that I believe are non-essential. For example, identifying different careers within Industrial Maintenance (Objective 1) and understanding how electricity is produced (Objective 9) are probably not essential to the extent that they should be included in this kind of document. (Griesbach)

A final comment with particular relevance for those who may wish to use these criteria as a national model is that: *While the INAM objectives cover a strong core competency, skillsets may vary somewhat depending on the type of industry (i.e. Good Manufacturing Practices (GMP) for pharmaceuticals), or even locality (as many industries tend to be regional). It is quite common for educational institutions to consult with local manufacturers to design their curricula around the demands of local employers*. (Haring)

6.3.2 Review of Individual College Programs

Following are comments about each college's programs:

- **Illinois Eastern.** This program partially meets the learning objectives. This program does a good job of addressing workplace safety and electrical theory. It also includes a good coverage of mechanical drives. Fluid power and troubleshooting are not addressed at all. The program would benefit by the addition of a secondary electronics course pertaining to AC circuits and equipment, and the use of hand and power tools commonly used in fabrication and industrial maintenance.

- **Illinois Valley.** This program does a good job covering workplace safety, blueprint reading, fluid power, and electrical theory. It also includes a good coverage of mechanical drives. Certificate requires ELE1202 (Motors and Controls I) or ELE1204 (Programmable Logic Controllers I). ELE1202 addresses program objectives better. Three of the 10 courses in this

program emphasize material that is not required in the learning objectives. The curricula seems to be specifically designed to fully meet most of the INAM objectives, but there is little discussion devoted to the different careers available in the Industrial Maintenance field. However, exposure to different skills necessary in the workplace (such as PLC programming) may provide some insight to the student. The program may also benefit from instruction on basic machining practices. Safety concepts are reinforced in multiple courses.

- **John Wood.** Overall, this is a well-designed and well-rounded curriculum that meets and, in many instances, exceeds the INAM basic objectives. This program offers good coverage of Troubleshooting, Blueprint Reading, Fluid Power, and Electrical Theory. At 10 courses and 31 credits, this is the largest of the Industrial Maintenance certificate programs. Three of the 10 courses in this program emphasize material that is not included in the INAM Industrial Maintenance Learning Objectives. Safety concepts are reinforced in multiple courses. The program may be improved somewhat, by offering other technical course options to some required courses (i.e. FYE101, MAT100) in order to meet the credit hour requirement for students who already have proficiency in these areas.

- **Joliet.** The program appears to meet many of the INAM objectives; however, this is difficult to determine accurately due to the limited information provided in many of the syllabi. This program offers good coverage of Fluid Power. It also includes a good coverage of mechanical drives. It appears to be weak in Workplace Safety, Troubleshooting, and Electrical Theory. The curricula does not provide any discussion devoted to the different careers available in the Industrial Maintenance field. Two of the seven courses in this program emphasize material that is not included in the INAM Industrial Maintenance Learning Objectives. The program may benefit by addressing safety practices and interpreting schematics/diagrams and symbols appropriate to course technology. A consideration should also be made to provide instruction on the use of hand and power tools as well as basic machining skills.

- **Kankakee.** The program appears to only partially meet the INAM objectives; however, this is difficult to determine accurately due to the limited information provided in the syllabi. This program does a good job covering Blueprint Reading and Electrical Theory. The curricula does not offer any discussion devoted to the different careers available in the Industrial Maintenance field. There is no discussion of mechanical, pneumatic, or hydraulic power systems, and limited discussion of safety regulations and troubleshooting equipment. The program would benefit by adding at least an introductory course on mechanical systems

- **Oakton.** This program meets some of the INAM objectives; however, there is no discussion of the potential career choices available in the Industrial Maintenance field, and there is little emphasis given to the topic of safety or to mechanical systems. It is surprising that MFG250 is offered as an alternative to an electronics class. PLCs are not part of the INAM Industrial Maintenance Learning Objectives. While this program has the most credit hours required for certification (as compared to other programs in this study), a significant portion (approximately 30%) of the curricula has very limited applicability to the defined objectives. In light of this, it is not understood why courses such as Introduction to Manufacturing Automation Systems (MFG111) and Introduction to Manufacturing Processes (MFG110), which would seem to be more appropriate for an Industrial Maintenance certification, were deleted from requirements. The INAM objectives may be better addressed by replacing required courses with limited applicability in the existing program (i.e., CAD116, CIS103, MFG165) with other technical courses for mechanical power transmission, applications, and troubleshooting and basic machining and welding practices.

- **South Suburban.** The program meets many of the INAM objectives; however, there is no discussion of career choices available in the field of Industrial Maintenance, or of hydraulic systems, controls, or automation concepts. This program provides comprehensive coverage of Safety and Blueprint Reading. Coverage of Troubleshooting seems to be very light. The program may also benefit from instruction on hand and power tool usage and basic machining practices as well as offering other technical course options for some required courses (i.e., MFG102, MIS101) to meet certification requirements for students who may be proficient in these areas.

6.4 Precision Machining CNC

6.4.1 Learning Objectives

INAM set the following learning objectives for precision machining CNC.

Exhibit 6-5. Learning objectives for precision machining CNC

	At the successful completion of this certificate, the student is able to:
1.	Demonstrate knowledge of basic OSHA requirements, general shop safety, and machine tool safety procedures.
2.	Interpret basic part prints and/or technical drawing including Geometric Dimensioning & Tolerancing (GD & T) and apply the information as it relates to gauging, dimensioning, and tolerancing.
3.	Apply a working knowledge of basic measuring and inspection tools and use appropriate measuring devises to confirm a part's compliance to required specifications, including GD&T symbols.
4.	Preform conversion, computations, and calculations that result in parts production to specific industry standards and specifications.
5.	Demonstrate entry-level skills to set up and operate machine tools.
6.	Interpret CNC G&M code programs and apply editing procedures as needed.
7.	Use basic communication skills (reading, writing, speaking, and listening) to understand technical manuals and written work instructions while interacting well in a team/group environment.
8.	Demonstrate use of basic math skills to facilitate technical metal cutting competencies.
9.	Sit for the relevant National Institute for Metalworking Skills (NIMS) credentialing exams.

McCord describes the above learning objectives as establishing both an adequate and a minimum standard for CNC: "The objectives listed in the document for Precision Machining CNC are all very important to the success of the student in finding employment or seeking advancement. These objectives are adequate for success and should be a minimum of standards for any program." However, it is helpful to distinguish between two types of CNC positions: CNC programmer and CNC operator. The INAM course objectives would seem to be more appropriate to that of a beginning (entry level) CNC operator. By contrast, the NIMS certificate requirements are relatively advanced, describing a journeyman CNC programmer position. The core competencies identified in NIMS but not in INAM include basic machining skills and more advanced skills such as the ability to use CAD/CAM or solid modeling software to create CNC programs. (Haring)

In terms of basic non-machining skills such as safety requirements, interpreting technical drawings, and math skills, the INAM objectives and the NIMS requirements seem to be well aligned. These skills are well-defined and their significance understood. However, the subject of basic computer skills is not addressed by the INAM objectives and might be added as part of Objective 7. Following are additional recommendations.

The INAM objective 5 describes entry-level skills to set up and operate machine tools; this objective is somewhat vague and should be elaborated upon. Basic machining skills include the ability to set up and operate manual milling machines and lathes. The NIMS requirements describing these skills are more in depth and specific in nature. Without having more than basic machining skills, employers may be reluctant to hire those who possess only a CNC programming certificate without having additional experience. (Haring)

While it is necessary to have the ability to manually edit a program, or create short programs to perform secondary operations, in a modern machine shop, a large percentage of CNC programs are typically generated from CAD drawings by computer applications. Increasingly, many employers require CNC operators to have basic computer programming skills and experience with CAD and manufacturing programs. I believe employers will find exposure to this technology highly desirable in prospective hires. In this respect, I find the INAM curricula to be a bit dated. (Haring)

I would recommend, for example, that all courses include some training in 3D modeling or use of software such as Solidworks. Many of the CNC computer-aided programs use 3D models for program creation, and many of the blueprints being created today utilize 3D graphics. Some CNC machines have the capability of part creation and programming directly at the control. Rapid prototyping, or additive manufacturing (3D modeling), is an interesting course or section of a course that students will enjoy. They can design a part or assembly, build the parts themselves in little time, and discuss problems and solutions for creating these parts on CNC machines. (McCord)

Although many machines used today are CNC, care should be taken to expose the students to the use of non-CNC equipment, such as manual lathes and mills, grinders, drill presses, saws and other 'old school' equipment. Many companies today expect their machinists to possess the skills to use these types of machines, and machinists who are comfortable with them can expect to be employed faster and earn more money. These classes should be taken right before taking CNC classes or in conjunction with the CNC classes. (McCord)

6.4.2 Review of Individual College Programs

Following are comments about each college's programs:

- **Daley.** Fulfills requirements for NIMS CNC Operations Turning & Milling Certificate. Students in this program could attain up to six NIMS credentials and would be considered very good candidates for CNC employment. This program provides all the necessary ingredients, including communication skills such as lab reports, setup and programming documentation, and inspection reports.

- **Elgin.** Students would be able to achieve at least four NIMS certifications. It is strong in the use and understanding of entry-level machine tools and meets the needs for CNC operation and entry-level programming. The math class is very helpful for programming both CNC lathes and machining centers, as math in the CNC field is essential. There are not many communication skills defined in the course descriptions other than understanding of and creation of setup and programming information.

- **Harper.** The strength of this course is that the students may earn NIMS credentials in manual machining (lathes, mill, drill and grinding) as well as credentials in lathe and mill operator level 1 and lathe operator/programmer. Students coming out of this program should be well equipped with the knowledge and skills to enter the workforce. This program fully meets the requirements of the objectives, except perhaps the need for more in-depth blueprint reading and geometric tolerances. McCord assumes that some of the GD & T principles will be covered in the MFT120 (machining processes), MFT123, and MFT125 (intro to CNC and CNC lathe operation and programming). McCord recommends that the MNT111 (prints & schematics) be replaced by MFT130 (machining blueprints). This would be ideal for this course and ensure that GD & T principles are covered. The addition of a stand-alone technical math course is helpful as math skills are more vital in the CNC field of machining.

- **Illinois Eastern.** It is unclear from the syllabi if the program fulfills requirements for NIMS CNC Programming, Setup & Operations Level III credential. This program would fully meet the objectives, but may be designed more for students who have manufacturing experience already and are looking for careers in CNC programming, particularly in computer aided manufacturing (CAM). All of these courses heavily use computers in their coursework, except the MAC2231 course. This can be an advantage in the CNC career field in these times, as most CNC machines have computer-aided programming available right at the control panel.

- **Illinois Valley.** This is an outstanding program and exceeds the requirements of the objectives. Students graduating from this program will be able to receive at least six NIMS upper-level credentials. This program incorporates Microsoft office skills (CSP1203), which is a very valuable addition. Much of the documentation, programming, and quality control work is performed on these products, and all students should be familiar and comfortable with them. The four CNC courses allow the students to get in-depth training with the various pieces of equipment and become proficient at programming. There is no better way to learn CNC than to experience each type of machine (lathe, mill), using knowledge of workholding, tooling, feeds and speeds, and programming. This course requires two technical math courses, which may be a bit much unless they can use these credits in lieu of other degree math courses. One course of technical math is sufficient for most programs. This course also requires a speech class, which is very unique and a great addition. Employees today need to be able to meet with other employees and their supervisors, quality control personnel, and others and should be confident in knowing how to communicate clearly and logically with their peers.

- **John Wood.** This is a very good program and will produce top-quality entry-level and more advanced skilled CNC machinists. More advanced CNC programming is missing, especially CAD, but students may elect to take those at a later date. This program will easily meet the requirements of the objectives. The lower level classes will provide the instruction and experience to help with the more difficult classes. Just about all of the manufacturing classes offer either an MSSC or NIMS credential. Employers will appreciate the broad knowledge and skills these students are learning, including welding. Welding is a valuable skill to have. The math will be sufficient for these students. The addition of a metallurgy class is a nice extra, as the different types of metals will machine differently and may require using special tooling and techniques.

- **Joliet.** The program partially fulfills requirements for NIMS Certified CNC Operations - Turning & Milling, but would not fully meet the requirements of the objectives. It would be acceptable for students who trying to get entry-level jobs in the CNC field or for employees seeking to further their skills in programming. The program should consider adding OSHA safety requirements such as Lock Out/Tag Out & Hazardous Materials Communication.

Subjects such as safety and quality control are limited in these classes. Most of the use of measuring tools and quality standards would have to be learned in the MFG101 and MFG111 classes. The CADD101 class would be equivalent to most blueprint classes, but topics like geometric tolerances might not be covered adequately. There is no individual math class, so any shop math would have to be covered in the MFG101 and MFG111 classes.

- **Kankakee.** This program does not fully meet the requirements of the objectives. It is a good program for students wishing to learn the very basic concepts of manufacturing, including manual lathes and mills, but there is no CNC machine operator training or CNC G & M code programming. The addition of basic and advanced CNC classes would make the program fully acceptable for the listed objectives. To meet NIMS Measurement, Materials and Safety Level I credential, OSHA safety requirements such as Lock Out/Tag Out & Hazardous Materials Communication should be covered specifically.

- **Kishwaukee.** Overall, this is a very good program, exceeds the requirements of the objectives, and is a very good certificate program for students who desire a well-rounded and broad knowledge base in manufacturing. However, it is a bit heavy in the credit hours. McCord would recommend this program to students. The program fulfills the technical requirements for NIMS CNC Operations - Milling and Turning and partially meets NIMS CNC Set-Up Programmer - Turning certifications; however, there is no discussion of basic OSHA requirements or how basic communication skills may be addressed in any of the syllabi. The addition of a metallurgy class (MT205) and fixture design (MT264) will give the students a better knowledge of various metalworking materials and how that affects machining operations and tool choice. The MT264 class will give the students the opportunity to learn some very important concepts of machine tool setup for quality and production. The two levels of shop math will give the students a broader experience in problem solving, including gears, power trains, and standard shop math issues. There is plenty of hands-on experience in the manual machine tools, and the CNC classes are adequate to provide good operation skills and programming for CNC lathes and mills.

- **Lake County.** This program does not fully meet the requirements of the objectives. NIMS has multiple credentials for machine tool operators. This program would meet the requirements ONLY for the most basic CNC machine operator for very entry-level jobs. An additional class in CNC operation for lathes and mills would be a huge benefit to the program, along with some G & M code programming. The students would then be eligible to test for the second level of NIMS machine operator, which requires programming along with setup and inspection.

- **McHenry.** This program will not fully meet the requirements of the objectives. There is not enough hands-on work required in the CNC field. It would be a huge advantage to add at least one other class, IMT106 (CNC programming 1), which allows the students to learn how to set up and operate basic CNC lathes and mills and receive a NIMS credential as an Operator Level 1. The IMT155 does allow students to learn the G & M codes and use computer-aided software to create programs, but without the skills needed to set up the machines and install proper tooling and observe how toolpaths work together to create a workpiece, the students will lack a full understanding of creating proper toolpaths.

- **Oakton.** This program would not fully meet the requirements of the objectives. It is recommended that MFG141 (CNC machine operation - NIMS test preparation) be included as a starter course and at least a blueprint reading and measurement class in conjunction with the MFG141 class. A manual machining class would also be an advantage to prepare the students for CNC machining. As this certificate program is focused solely on CNC Programming,

Setup, & Operations, the program would need to include coursework to meet the requirements for NIMS Measurement, Materials, and Safety Level I, Job Planning, Benchwork, and Layout Level I to achieve certification for CNC Operations - Turning & Milling.

- **Prairie State.** The experts had differing evaluations of this program. Haring comments that the program partially meets requirements for NIMS CNC Operations - Turning & Milling certification. A minimum of CNC Operations - Milling credentials would be needed to fulfill requirements. As manual drafting is essentially obsolete, perhaps CADMD141 could be combined with CADMD243 to allow more relevant coursework. McCord says the program exceeds the requirements of the objectives. Three levels of math prepare the students for a wide variety of programming problems they might encounter. The multiple levels of blueprint reading also help to prepare the students for more complex machining and blueprints. Students may earn four NIMS credentials and will be ready to earn several more (Lathe and Mill Programmer/Operator). This course is well designed to allow the students to achieve the NIMS credentials and have a very solid foundation in math, blueprints, and manual and CNC machine operations.

- **Richland.** This program exceeds the requirements of the objectives. There is plenty of fundamental training in blueprint reading, measurement systems, manual and CNC equipment. There are opportunities for students to receive up to six NIMS certifications and possibly more with the robotics class The addition of metallurgy and robotics will provide a more educated employee. While there is no individual math class, the students will receive adequate instruction in the math they need to pass any certification. A technical math class would be a good addition, and another 3-credit class would not be a burden.

- **Southwestern.** This program does not meet the requirements of the objectives. The PMT110 and 111 classes allow students to learn the basics of CNC operation, but there is little math or blueprint reading, particularly GD & T, in the curriculum. This program would only be sufficient for very entry-level positions, leaving the burden of proper training to the employer. As this certificate program is focused solely on CNC Programming, Setup, & Operations, the program would need to include coursework to meet the requirements for NIMS Measurement, Materials, and Safety Level I & Job Planning, Benchwork to achieve certification for CNC Operations - Turning & Milling.

- **Triton.** This program fully meets the requirements of the objectives. There is a good foundation of blueprint reading and GD &T, as well as plenty of CNC machine time allowed. The students may earn up to four NIMS and one MSSC certifications. Although there is no individual math course, the students will receive the basic math instruction required to pass the certifications. The addition of a manual machine tool course could add another NIMS credential and give students the opportunity to get the ‘feel’ of using manual equipment before using CNC.

- **Waubonsee.** This program fully meets the requirements of the objectives. This is a well-rounded course, with good foundational classes in blueprint reading, metrology, GD & T, basic machine tool operations, and CNC operation. Students will be well prepared to enter the workforce. It would be desirable to add an advanced CNC course for another NIMS certification (Lathe/Mill Programmer/Operator) or perhaps a computer-aided manufacturing (CAM) course.

6.5 Welding / Metalworking

6.5.1 Learning Objectives

INAM set the following learning objectives for welding/metalworking.

Exhibit 6-6. Learning objectives for welding/metalworking

At the successful completion of this certificate, the student is able to:
1. Identify safe welding practices and procedures conforming to American Welding Society (AWS) Z 49 standards.
2. Demonstrate practical knowledge of making welds with all types of mild steel electrodes, arc air gouging, and the welding of mild steel in all positions in a safe manner.
3. Exhibit a basic understanding of metallurgy required of a competent welder.
4. Interpret both basic and advanced welding fabrications blueprints, including welding symbols, weld testing symbols, structural steel shapes, and welding specifications.
5. Document advanced knowledge and techniques for the safe and successful operation of gas tungsten welding, shielded metal arc welding, gas metal arc welding, and oxy fuel gas welding.
6. Demonstrate knowledge of code practices and procedures in American Welding Society (AWS) D1.1.
7. Perform an American Welding Society (AWS)1G with a backing strip test or 3G with an open root.

The expert reviewers considered the INAM learning objectives to provide important necessary requirements for welding programs, but also offered several suggestions and comments:

- While objective 2 focuses on welds with mild steel, Sanderson suggests that stainless steel and aluminum also be covered. Stainless steel welds are used in the oil industry and food industry, as well as any industry that requires resistance to forms of corrosion. Aluminum welds are used on lightweight manufactured equipment and any item constructed from aluminum. Both are so widely used that their inclusion would strengthen a national model.

- Regarding objective 3, Buscaglia notes that a basic knowledge of magnetic versus non-magnetic materials should be sufficient for beginners and that a competent welder should be able to identify mild steel and to perform base and filler metal selection.

- Sanderson commends objective 4 for including both basic and advanced welding, while many programs only cover basic welding. This inclusion helps the student to be more employable and makes the objective more appropriate as a national model.

- Successful completion of objective 7 validates that all of the previous objectives have been accomplished.

6.5.2 Review of Individual College Programs

Following are comments about each college's programs:

- **College of DuPage.** This program fully meets the learning objectives. It is a very good course for students interested in learning the welding trade, from the basics to the AWS Bend Test. The contact hours ensure student(s) understanding of the subject manner as well as enough "Hands On" time. It would help to add a "Basic Hand Tool" course, or at least some shop time devoted to the subject.

- **Daley.** The Richard J. Daley College Welding Course program suggests that this instruction has been designed to be very targeted and specific to production line welding. If the objective of the student is to earn a basic, beginning certificate (in a program that requires multiple certificates in order to be fully qualified), this Daley College program would be sufficient. Otherwise, it is not a course geared toward the welding trade, and that is primarily because of the lack of lecture time and practical workshop time (referred to in individual syllabus as 'lecture' and 'contact' hours). More detail is needed. The syllabi do not mention AWS Z 49 standards, arc air gouging, metallurgy (other than in outline), AWS 1G or 3G AWS 1G or 3G, or provide sufficient detail on interpreting blueprints and advanced techniques.

- **Danville.** This program fully meets the learning objectives. They stress what an employer is expecting you to perform as an employee. There is no mention of AWS Z 49 standards and arc air gouging. More detail is needed in the outlines.

- **Elgin.** This program has excellent presentation and content; however, there is no mention of AWS Z 49 Standards or of AWS 1G or AWS 3 G (only mentioning a qualification test). Elgin courses are good courses for both the beginner and the more experienced welder who wants to gain more knowledge and experience. Its syllabus covers all the bases and meets INAM's requirements in an understandable presentation. This is a very good model for INAM to use.

- **Harper.** This is a good advanced welding course, with good blueprint, topical, and student outcomes, and solid fundamentals. However, there is no mention of AWS Z 49 standards. AWS standards are mentioned but not specific to AWS 1G or AWS 3G.

- **Illinois Eastern (Lincoln Trail).** There is no mention of AWS Z 48 standards or AWS D1.1, and more detail is needed on understanding metallurgy and advanced techniques.

- **Illinois Eastern (Olney).** This program fully meets the learning objectives.

- **Illinois Valley.** The assessment matrix used in this program is an excellent teaching and learning tool. This course could serve as a good INAM model/standard However, there is no mention of AWS Z 49 standards, arc air gouging, or AWS 1G or 3G.

- **John Wood.** The course opens on a great, positive, confidence-building note via opening statement under course goals "Students who satisfactorily complete course will be able to perform goals without use of reference manuals and be employable." MFG#102: Very well presented. Good course. Schools within INAM could use this as a model. However, there is no mention of AWS Z 49 standards, and more detail is needed on practical knowledge, understanding of metallurgy, and advanced techniques.

- **Joliet.** In general, this program meets requirements in a well-presented manner. However, there is no mention of AWS Z 49 standards, AWS 1G, or AWS 3G, and more detail is needed on practical knowledge.

- **Kankakee.** The syllabus is basic, yet effective in presentation. The courses appear to meet the learning objectives, though more detail is needed on understanding of metallurgy, interpreting blueprints, and advanced techniques. The program has excellent 'testing' courses (to gauge pipe and plate welding aptitude—2071 &/or 2072). The teaching of safe welding practices is implied by the use of AWS handouts, but there is no mention of AWS Z 49 standards. It appears that students choose one of WELD 2062, WELD 2072, and WELD 2172, but WELD 2062 is the only course that meets the AWS1D1.1 and AWS 1G or 3G requirement.

- **Kishwaukee.** The blueprint course is well planned, as are the welding contact hours. More detail is needed in the course outlines for blueprints.

- **Lincoln Land.** This is a good basic welding program, though it is lacking some details. There is no mention of AWS Z 49 standards, arc air gouging, AWS D1.1, and AWS 1G or AWS 3G. More detail is needed on understanding metallurgy, interpreting blueprints, and advanced techniques.

- **Prairie State.** One reviewer said this program fully meets the objectives, but the other noted a lack of specificity in the outlines. There is no mention of AWS Z 49 standards, AWS D1.1, or AWS 1G or AWS 3G. Course outlines do not address interpreting both basic and advanced welding symbols, weld testing symbols, structural steel shapes, and welding specifications. Course outline does not include the documentation of advanced knowledge and techniques for safe and successful operation of gas tungsten welding, shielded metal arc welding, gas metal arc welding, and oxy fuel gas welding.

- **Richland.** This program meets all AWS, ASME, NCCER standards.

- **Waubonsee.** There is no mention of AWS Z 49 standards, arc air gouging, AWS D1.1, and AWS 1G or AWS 3G.

6.6 Summary of College programs

Exhibit 6-7 provides an overview of all of the INAM programs, by college, showing which learning objectives are met for each program.

Exhibit 6-7. Summary of the extent to which the colleges' programs satisfy the learning objectives

College and program	Learning objective									
	1	2	3	4	5	6	7	8	9	10
College of DuPage										
Mechatronics	F/F	F/F	F/P	F/F	F/F	F/F	F/F			
Welding/Metal Working	F/F	F/F	F/F	F/F	F/F	F/F	F/F			
College of Lake County										
Precision Machining CNC	F/N	F/F	F/F	F/F	F/F	F/N	F/N	F/N	F/N	
Daley College—City Colleges of Chicago										
Mechatronics	F/P	F/P	P/P	F/P	P/P	F/F	P/P			
Precision Machining CNC	F/F	F/F	F/F	F/F	F/F	F/F	F/F	F/F	F/F	
Welding/Metal Working	P/F	F/F	P/F	P/F	P/F	F/F	P/F			
Danville Area Comm. College										
Mechatronics	F/F	F/F	P/F	F/F	F/F	F/F	P/F			
Welding/Metal Working	P/F	P/F	F/F	F/F	F/F	F/F	F/F			
Elgin Comm. College										
Precision Machining CNC	F/F	F/F	F/F	F/F	F/F	F/F	F/F	F/F	F/F	
Welding/Metal Working	P/F	F/F	F/F	F/F	P/F	F/F	N/F			
Illinois Eastern Comm. College*										
Industrial Maintenance	P/P	P/F	F/F	P/F	N/F	P/P	P/F	P/F	F	
Precision Machining CNC	P/F	F/F	F/F	F/F	F/F	P/F	F/F	F/F	U/F	
Welding/Metal Working (Olney)	F/F	F/F	F/F	F/F	F/F	F/F	F/F			
Weld./Metal Work. (Lincoln Tr.)	P/F	F/F	P/F	F/F	P/F	N/F	F/F			
Illinois Valley Comm. College										
Certified Production Tech CPT	F	F	P	F	F	F	F	F	F	F
Industrial Maintenance	N/P	F/F	F/F	P/F	P/F	F/F	F/F	P/F	P/F	
Precision Machining CNC	P/F	F/F	F/F	F/F	F/F	F/F	F/F	F/F	F/F	
Welding/Metal Working	P/F	P/F	F/F	F/F	F/F	F/F	N/F			
John Wood Comm. College										
Certified Production Tech CPT	F	F	P	F	F	F	F	F	F	F
Industrial Maintenance	P/F	P/F	P/F	P/F	F/F	F/F	F/F	P/F	F/F	
Precision Machining CNC	F/F	F/F	F/F	F/F	F/F	F/F	F/F	F/F	F/F	
Welding/Metal Working	F/F	U/F	U/F	U/F	U/F	F/F	F/F			
Joliet Junior College										
Industrial Maintenance	N/N	P/F	P/P	P/F	P/F	P/P	P/F	P/P	P/F	
Precision Machining CNC	P/N	F/F	F/N	F/N	F/F	F/F	P/N	P/N	P/F	
Welding/Metal Working	P/F	P/F	F/F	F/F	F/F	F/F	N/F			
Kankakee Comm. College										
Certified Production Tech CPT	F	F	P	F	F	F	F	F	F	F
Industrial Maintenance	N/N	N/N	P/P	P/F	N/P	F/P	P/M	P/P	P/P	
Precision Machining CNC	P/F	F/F	F/F	F/F	F/F	N/N	F/N	F/F	/F	
Welding/Metal Working	P/F	F/F	P/F	P/F	P/F	F/F	F/F			
Kishwaukee College										
Certified Production Tech CPT	F	F	P	F	F	F	F	F	F	F
Precision Machining CNC	P/F	F/F	F/F	F/F	F/F	F/F	F/F	F/F	/F	
Welding/Metal Working	F/F	F/F	F/F	P/F	F/F	F/F	F/F			

Exhibit 6-7. Summary of the extent to which the colleges' programs satisfy the learning objectives (continued)

College and program	Learning objective									
	1	2	3	4	5	6	7	8	9	10
Lincoln Land Comm. College										
Certified Production Tech CPT	F	P	M	P	P	F	F	F	N	P
Welding/Metal Working	P/F	P/F	P/F	P/F	U/F	P/F	N/F			
McHenry County College										
Mechatronics	P/N	N/N	N/N	P/N	N/N	N/N	N/N			
Precision Machining CNC	F/F	F/F	F/F	F/F	F/N	F/F	F/N	F/N	F/F	
Oakton Comm. College										
Industrial Maintenance	N/N	P/P	P/P	N/P	N/P	N/U	P/F	N/F	P/F	
Mechatronics	F/P	P/F	F/P	F/P	P/P	F/F	F/P			
Precision Machining CNC	N/N	F/N	F/F	F/F	F/F	F/F	P/N	P/N	/F	
Prairie State College										
Precision Machining CNC	F/F	F/F	F/F	F/F	F/F	F/F	F/F	F/F	P/F	
Welding/Metal Working	F/P	F/F	F/P	F/P	F/P	F/P	F/P			
Richland Comm. College										
Certified Production Tech CPT	F	F	F	F	F	F	F	F	P	F
Precision Machining CNC	F/F	F/F	F/F	F/F	F/F	F/F	F/F	F/F	F/F	
Welding/Metal Working	F/F	F/F	F/F	F/F	F/F	F/F	F/F			
South Suburban Comm. College										
Certified Production Tech CPT	F	F	P	F	F	F	F	F	F	F
Industrial Maintenance	N/N	P/F	F/F	P/P	N/F	F/F	P/P	P/F	P/F	
Southwestern Illinois College										
Mechatronics	F/P	F/F	F/F	P/P	P/F	F/F	P/P			
Precision Machining CNC	F/N	F/F	F/F	F/F	F/F	F/F	F/N	F/N	P/F	
Triton College										
Mechatronics	F/P	F/F	F/P	F/P	P/F	F/F	F/P			
Precision Machining CNC	F/F	F/F	F/F	F/F	F/F	F/F	F/F	P/F	F/F	
Waubonsee Comm. College										
Mechatronics	F/F	F/F	F/F	F/F	F/P	F/F	P/F			
Precision Machining CNC	F/F	F/F	F/F	F/F	F/F	F/F	F/F	F/F	F/F	
Welding/Metal Working	P/F	P/F	F/F	F/F	F/F	N/F	N/F			
William Rainey Harper College										
Certified Production Tech CPT	F	F	P	F	F	F	F	F	P	F
Precision Machining CNC	F/F	F/F	F/F	F/F	F/F	F/F	F/F	F/F	F/F	
Welding/Metal Working	P/F	F/F	F/F	F/F	F/F	F/F	N/F			

NOTES: To be concise, the learning objectives are listed here only by number; the full statements of learning objectives are provided in sections 6.1 through 6.5. The ratings in this scale are based on the following rating scheme: F=fully meets learning objective, P=partially meets learning objective, N=does not meet learning objective, U=unable to judge based on syllabus. When two experts reviewed a program, the two experts' ratings are separated by a "/" so that both are shown.

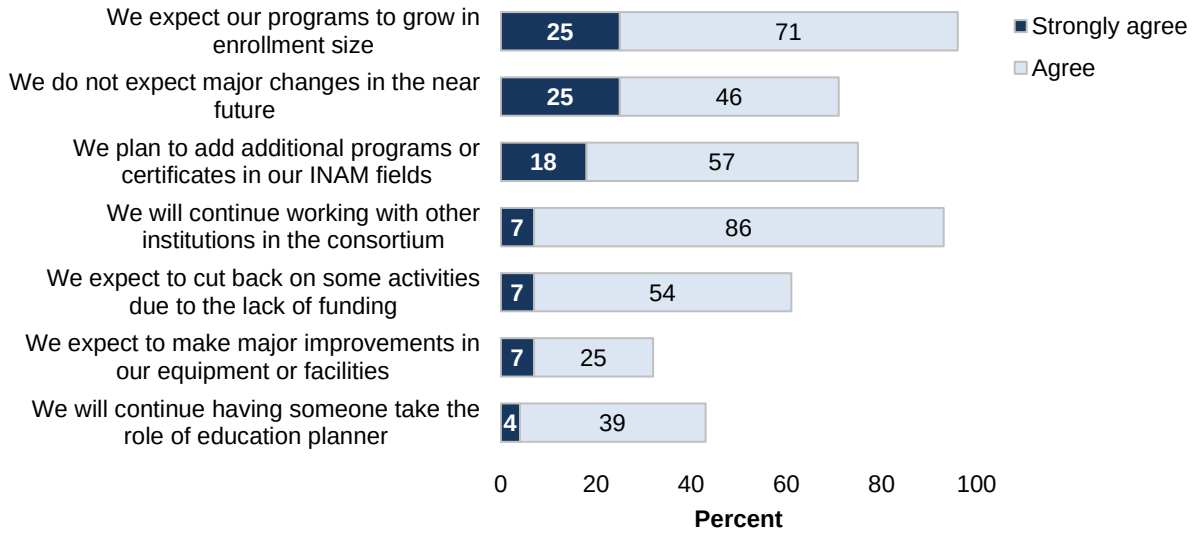
INAM Colleges' Plans for the Future 7

A natural concern for DOL or for anyone initiating a project is whether the changes made by that project will be lasting changes or will later be abandoned. One might anticipate that some INAM-related changes are more likely to be maintained over time than others, depending in part on the continued investment required in the future and also on what type of commitment is expected of the personnel involved (e.g., on the extent of their buy-in into their program). For example, equipment purchases might be considered to be relatively permanent; though the equipment may need continued maintenance, and over time the equipment could be become outdated. On the other hand, if new personnel are hired to teach in or administer the program, then their continued involvement might depend on the availability of funding to maintain their positions. Illinois colleges, in particular, have faced recent funding difficulties when a failure to reach agreement between the governor and the state legislature has led to the passage of at best temporary funding bills that fail to address all of the areas normally in the state budget.[1] Postsecondary education in particular has been affected, with some colleges performing layoffs.

In late 2015, responding to both the end of the grant activities under INAM and the political deadlock affecting state funding for community colleges, INAM project directors were asked whether various INAM-related changes were likely to be sustained. In many respects, the project directors expected continued growth (Figure 7-1): they expected growth in enrollment size (25 percent strongly agreed, and 71 percent agreed), through adding additional programs or certificates (18 percent strongly agreed, and 57 percent agreed), and some expected to make major improvements in their equipment or facilities (7 percent strongly agreed, and 25 percent agreed). Still, they did not expect major changes in the near future (25 percent strongly agreed, and 46 percent agreed). Most expected to make at least some cutbacks in activities (7 percent strongly agreed, and 54 percent agreed), and only a minority planned to have someone continue in the role of education planner (4 percent strongly agreed they would continue, and 39 percent agreed). Almost all agreed that they would continue working with other institutions in the consortium, an activity with little or no financial costs, but their agreement was not strong (7 percent strongly agreed, and 86 percent agreed).

[1] See, for example, "Rauner signs stopgap budget, school funding bill — but relief from stalemate proves temporary," *Chicago Tribune*, June 30, 2016, found at: http://www.chicagotribune.com/news/local/politics/ct-illinois-budget-impasse-madigan-rauner-met-0701-20160630-story.html

Figure 7-1. Total number of INAM courses and how they have been modified for INAM, by college



7.1 INAM College's Plans for Expansion

In their responses to the survey of project directors, several indicated plans for expansion. Following are selected written comments.

7.1.1 Program Expansion

Will continue to grow program in advanced manufacturing.

We now plan to add to the welding curriculum and thus expand the program.

We will also be expanding our welding program to include more specialized welding and increase the program to a one-year program.

We need to expand our welding program that has increased 400% in enrollment.

We hope to expand our manufacturing program with CNC.

7.1.2 Equipment

Additional equipment is being purchased for our Industrial Maintenance and Machining programs.

I am now focused on securing welding equipment and vending for use in our new space, hoping to one day get into Robotic Welding.

7.1.3 Outreach

We need to expand outreach to companies and recruitment of students.

7.1.4 Degrees and Certifications

We would like to expand industry certifications.

Expanding AAS degrees in specific tracks in manufacturing.

7.2 INAM College's Plans for Cutting Back

The project directors also indicated areas in which they plan to cut back. Not all colleges anticipated cutbacks; when they did, the expected cutbacks were most often those involving personnel, and particularly those involving INAM's education planning process.

7.2.1 Education Planning and Coaching

We cannot continue the personalized interviews due to lack of time and personnel.

Education plans will be housed online. No hard copies.

There is no college money to support the ed plan person as we move forward from the grant.

We will revise the input form to capture only the information that we found useful. The INAM exit survey will be eliminated. The college has a standard student follow-up survey in place that will be used in place of the exit survey.

Continuing with a dedicated INAM advisor through our Workforce Development branch would be ideal but instead will now continue with career path academic advisors.

We are unable to continue the one-on-one advising to the extent that we did during the grant, and that is problematic.

Budgetary constraints do not allow us to continue our Manufacturing Coordinator position. This is a huge concern as the intrusive coaching was beneficial to students!

7.2.2 General Concerns

With only three years we can't demonstrate that this pathway is achievable, and with the economic environment in Illinois, the community colleges do not have the financial resources to sustain this program at the level needed (without the $104,000 in equipment funding) to keep the traction required.

As with any grant that supports personnel, when the grant goes away, it becomes difficult for the college to continue this support. Financially, this is currently a very tough time for colleges in Illinois. We will make all attempts to continue this program as defined through the INAM project, but may not be able to support all facets.

Final Summary and Recommendations 8

8.1 Conclusions

By several standards, INAM was a success:

- It exceeded its projections in terms of enrollment, retention, the number of credits earned, and the number receiving a wage increase after enrollment.
- Colleges strengthened their academic programs, with some that can be viewed as exemplary.
- Colleges purchased new equipment that will provide a lasting resource for continued instruction.
- College faculty have developed relationships with faculty at other colleges that they expect to continue.
- The colleges have established articulation agreements with four four-year colleges, making it easier for graduates to earn four-year degrees.
- The colleges indicate that they plan to continue most of the changes they made and to strengthen their programs further.
- Students frequently earned outside credentials, which should be helpful in finding employment.
- Partnering with local businesses has increased at some of the colleges.
- The rate of certificate completion was improved relative to the rate found for the comparison group.

However, not all of the goals were met, as discussed in Chapter 3. In three inter-related areas, INAM did not meet its goals.

- Program completion was lower than desired, though it was higher than that of the comparison students if one adjusts for the amount of time available to complete the program.
- The number of non-incumbent workers who gained jobs after receiving certificates and exiting was lower than projected, though job attainment was higher among participants than nonparticipants.

The challenge is to reconcile this mixture of positive and negative findings. Part of the explanation has to with timing. Given that enrollment into INAM was delayed until the second year (at the suggestion of DOL), many students did not enroll until late in the INAM grant period (the peak term for new enrollments was fall 2014, and 63 percent of the students started in fall 2014 or later); students often enrolled part time, and students often temporarily stopped out; there was not sufficient time for many

students to receive certificates or to start employment after receiving the certificates. Also, for students who started their participation late in the grant period, data on their employment statuses often was not available. Another part of the answer appears to be that neither DOL, in designing the performance measures, nor INAM, in making projections, appreciated the diversity of outcomes that would appear among the student participants. The DOL measures were often defined in terms of program completion, but students often started employment either before exiting or before earning a certificate, making them ineligible to be counted in the measure of job attainment. If one counts both those starting employment after enrolling in INAM and those who experience wage increases after enrolling, then the number of positive job outcomes is greatly increased.

There also is the possibility that changes in INAM's plans may have affected the outcomes in either positive or negative ways.

- The use of prior learning assessments to help students accelerate their completion of INAM programs was much lower than originally planned; as a result, PLAs affected only a few students, and the intended effects on retention and completion rates and reduced time to completion were not achieved.

- The change in timing, by delaying enrollments until the second year, reduced the number of students who might be expected to complete the programs during the INAM grant period. (However, the change in timing was probably necessary, and some colleges did not fully implement the program until the third year even with the delay.)

- Education planning as a tool to advise and support students was applied inconsistently across the colleges, lessening the power of this tool to aid students at those colleges where less attention was given to academic advising.

- One of the intended INAM areas, green programs, was never implemented because the programs across the college had too little in common to craft a joint effort. If this program had been implemented, one might expect enrollments to have been higher, probably resulting in greater absolute numbers of students meeting the targets, though the percentage of students who met the targeted outcomes may not have changed.

- The intended cooperative effort with employment centers did not happen (for funding reasons at the employment centers); such an effort might have increased enrollments (with impacts as discussed above) and change the mix of student characteristics (with unclear implications). Some evidence suggests that dislocated workers are more likely than other students to complete the programs and obtain employment.[1]

- Some of the equipment purchases were later than intended, potentially lessening the potential impact of the program on the student participants.

- The creation and use of internships was underutilized, often for reasons outside of INAM's control (such as the condition of the economy and employers' concerns about liability issues), and a greater use might have improved retention, completion, and job attainment.

[1] Eyster, L., Derrick-Mills, T., Trutko, J., Compton, J., Stancyzk, A., & Nightingale, D. (2012). *Implementation evaluation of the Community-Based Job Training Grant (CBJTG) program: Final report.* Washington, DC: Urban Institute. Available online at http://www.urban.org/research/publication/implementation-evaluation-community-based-job-training-grant-cbjtg-program

- The number of program completers appears likely to end lower than in the original projections. In part, this anticipated result may be because some "successes" are occurring in ways other than had originally been anticipated. Students sometimes obtained jobs based on their INAM coursetaking, but discontinued their education because it was no longer needed. Students also sometimes used national credentials as alternative ways of demonstrating their skills, without completing their academic requirements to receive a certificate. Some students remained in college, but not in an INAM program. Still, even allowing for these other definitions of success, a large number of INAM students withdrew without a positive result: overall, 33 percent exited without completing a certificate, credential, or degree, but only 5 percent in the exit survey said they left to start a new job.

- The colleges may have handicapped themselves by giving relatively little attention to recruiting dislocated workers.

As a rule, however, it is very difficult to produce dramatic changes in outcomes, particularly when a program is largely working well already. Thus, though some aspects of INAM's implementation might be improved, it is unlikely that all of the goals originally set by INAM could be met. Most likely, some of the goals were overly ambitious, particularly considering the alternative pathways that students might take towards successful employment.

8.2 Recommendations

In this section, we consider three types of recommendations: (1) for INAM colleges that will continue to be carrying out their advanced manufacturing programs, (2) for other colleges or consortiums that may seek to implement similar programs, and (3) for the U.S. Department of Labor as it conducts similar grant programs.

8.2.1 For INAM Colleges

Following are recommendations for the INAM colleges.

- Offering students the potential of lowering their educational costs and shortening their completion time through prior learning assessments could be helpful in increasing the retention and completion rates. Faculty have a valid concern that students should have a clear mastery of the material before being given credit. Yet colleges should be able to develop methods of testing for such skills, and the result may be increased enrollments rather than lost tuition. Colleges also should look for ways of providing for such evaluations without increasing the burden on faculty.

- Both prospective students and employers are often unaware of the value of national credentials, so the colleges should work to help others recognize the value of the credentials.

- The use of internships at local businesses seems a valuable tool for providing students with practical experience, facilitating graduates' later chances of being hired by those or other businesses and increasing local businesses' connections with INAM colleges. Currently, the use of internships appears to be limited by both the economy and liability issues. Possibly by enlarging the number of businesses involved in the internship program or by working

cooperatively with businesses to lower the cost of accepting interns, INAM could increase the number of interns.

- The colleges may wish to reassess their plans for using (or not using) an educational planner. Educational planners had three potential purposes: to support the current evaluation, to provide an ongoing source of data that could be used to track students or support/evaluate program improvements, and to provide the student with personalized assistance as a tool for increasing student retention and completion rates. The first of these purposes expired with the end of the INAM grant, but the remaining two purposes remain as valid goals. Some colleges may have other mechanisms for accomplishing these goals; e.g., they could already have data collection and evaluation procedures in place, and they may use faculty advisors or college counselors rather than education planners to provide personalized assistance. (Some students considered the education planners to be unqualified to help them and intentionally worked with faculty instead.) Whatever the mechanism being used, colleges might consider whether these purposes are being accomplished and how they might best be accomplished.

- College faculty and staff appeared to appreciate the contacts they made with those at other colleges, and INAM should seek to continue to promote such contacts.

- The focus on enabling students to earn credentials and satisfy national standards is useful, but INAM should be careful not to prevent customization to meet the needs of local employers.

- By learning from the syllabi posted by the other INAM institutions, and especially those rated as exemplary, colleges can continue to work to improve their programs.

- Although the colleges met their enrollment targets, they may benefit by seeking new ways to target prospective students. Often their recruitment strategies were directed to traditional targets, such as high school students; however, dislocated workers constitute an important alternative target.

- Colleges should seek to provide sufficient hands-on experience (a need expressed by students), particularly time in the lab. A number of students remarked that they would benefit from an "open lab," where they could come in for additional practice or to work on coursework.

- Colleges should seek to ensure that students have sufficient availability to instructors and aides. Students particularly expressed this need in relation to lab time, as students described having to use class time waiting for an instructor to assist them on a task or 'pass' them on a hands-on test. Students added that 'traditional' tutors from college-wide academic support services were not prepared or able to support advanced manufacturing-specific needs, such as blueprint reading. Additional support or time with faculty outside of class hours was also desired by students and was helpful to those who had experienced it at their colleges. Two students raised the idea of online or computer-supported learning aids as an additional idea to support student learning outside of the classroom, which may provide a valuable alternative or supplement at relatively low cost.

8.2.2 For Other Colleges Considering Similar Programs

Other colleges may wish to replicate the INAM program at their own institutions. Following are recommendations for such colleges.

- Institutions wishing to replicate this program should allow considerable time for planning when setting up a similar program, particularly if there is a need for formal changes such as the approval of new curricula or facility changes with respect to the purchase of equipment. DOL was correct in advising INAM to make the first year a planning year, but even this amount of time was not fully sufficient. Some certificate programs were not fully implemented until after the second year, and some planned equipment purchases were not made in time for early INAM students to benefit from the purchases.

- Careful planning and extensive consultation are especially important when preparing the budget for the program. Colleges often found that their initial budgets were unrealistic in terms of not addressing the most important needs and sometimes failed to anticipate the full extent of the costs associated with their plans. Colleges also often failed to anticipate the staffing that would be required to administer the program. Colleges also sometimes faced unintended expenses, such as the need to create a building to house the new equipment, which could not be financed using grant funds.

- Obtaining buy-in for the program can be difficult, especially among the faculty. Buy-in was also an issue when the people responsible for implementing the program were different from those who wrote the original grant proposal. One way to address this is to incorporate greater involvement in the original planning and proposal writing process, realizing that this is difficult given the time constraints in the proposal preparation process.

- The active involvement of the INAM project director, including visits at each campus, appears to have been important in creating a common understanding of INAM and in encouraging the colleges to implement INAM program features. Such a role should be anticipated in other consortiums seeking to implement similar programs.

- Some of the programs reviewed by the content experts were rated as exemplary, and using syllabi either from the best programs or from an amalgam of programs (choosing the strengths of each) could be very helpful in getting a high-quality program established.

8.2.3 For U.S. Department of Labor Grant Programs

Following is a recommendation concerning the TAACCCT grant program that also may apply to other DOL grant programs.

- The performance measures currently used in the APR do not fully measure all appropriate outcomes that might come out of the program. If participants get jobs as a result of being in the program, then those jobs might be considered positive outcomes even if the participants do not complete a college certificate or degree. Similarly, the earning of an outside credential such as MSSC can be a positive outcome that can take the place of an academic certificate or degree.

Appendix A
Detailed Methodology

A.1 Student Recruitment Into INAM Study

Not all students who took INAM courses were considered to be INAM participants. After students enrolled in an INAM college course, they were recruited to participate in the INAM program. Each INAM college assigned a designated education planner to talk with students, inform them about the INAM evaluation, and request their participation. The education planner asked those students who agreed to participate to complete an Enrollment Packet and an Education Plan.

In focus groups with the education planners, some education planners indicated that they intentionally excluded some students from the study. Generally, they invited the participation of most students in INAM courses. Some reported that they attempted to ensure that students "fit the intent" of the INAM program. Two did not enroll students who only wanted to complete a single course for personal interest rather than complete a sequence of courses for future employment. For instance, several older students had enrolled in a single course in order to work in their personal shop, at home. A third education planner did not enroll students who already had completed substantial coursework in an INAM area. Such students may have taken courses before the INAM course revisions, and their inclusion could have inflated the college completion rate. Because the number of allowable courses differed by INAM program, the education planner checked with his program director on a case-by-case basis to ensure that a student was eligible. Finally, a fourth reported that he excluded students who already were enrolled in another program and taking one INAM course as requirement for that program. Welding classes, in particular, were incorporated into many different programs, and the education planner invited welding students to enroll in INAM only if they were interested in pursuing one of the INAM programs.

In addition to education planners who sought to restrict INAM enrollment to students who fit the intent of the program (described above), at one college, the education planner indicated that he excluded students who had less desirable transcripts. Specifically, he reviewed student transcripts for previous course withdrawal or previous credits in fields other than engineering. He said:

> *I can see their total credits so far. Are they in the engineering field at all? You know a lot of them aren't.*

These actions by the education planners help to focus the study on those who express interest in a program of study rather than taking an isolated course for personal or other reasons. Otherwise, for example, the analysis of completion rates might produce misleading results by including students who never had an intention of completing an INAM program of study.

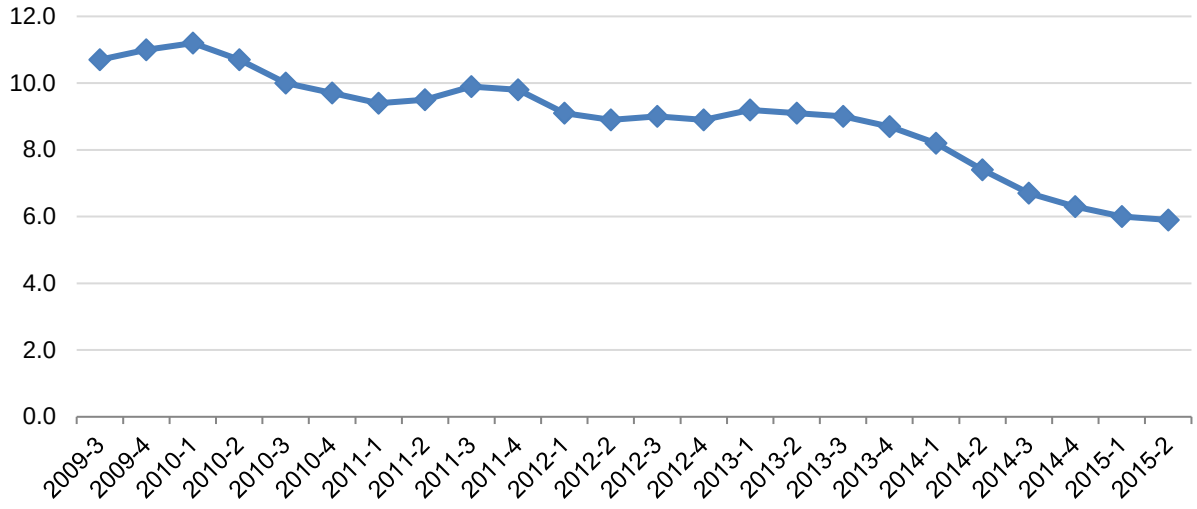
A.2 Student Comparison Group

Students for the comparison group were largely chosen using similar approaches as the INAM participants, which is important in order for the two groups to be comparable. That is, they were chosen from students who enrolled in similar programs at the same colleges, but prior to the creation of INAM; the colleges also sought to exclude students who were taking only a single course (such as hobbyists) and select only those who appeared interested in seeking certificates. However, some colleges selected only students who had completed certificates into the comparison group, possibly because such lists were the easiest to compile. Such an approach creates a sample that is biased (i.e., the comparison group can be expected to have outcomes that are superior to the INAM participants) and that is limited in terms of the data can it can provide (e.g., to measure what factors affect program completion). For those analyses that might be biased through such selection techniques, comparison students from these colleges were omitted.

Originally, we planned to select the comparison group using a two-step procedure, first selecting a larger group of potentially eligible students and then using propensity scoring to pick a subsample with characteristics that were similar to those of the INAM participants. However, the colleges did not have sufficient data available to perform such matching and did not have a large enough potential sample to allow subsampling. Unfortunately, only very limited data were available for detecting or adjusting for differences across the two groups.

Because the comparison group students attended during a different time period, it is possible that changes in the economy could affect student outcomes, making it more difficult to assess the impact of INAM. However, since many INAM participants did not immediately enter into INAM when INAM courses first started being offered, they also can be considered as part of the comparison group (prior to their entry), and they offer the advantages of both being directly comparable to the INAM participants and for providing comparison data contemporaneous with the INAM program. Figure A-1 provides data on the unemployment rate during the time monitored in this study: July 2009 through June 2015. Unemployment declined substantially roughly concurrently with the implementation of INAM. This is consistent with the data in Figure 3-4, which shows that even the nonparticipants showed an increase in employment over the study period and suggests that some of the improvement in employment was associated with the improved economy. On the other hand, the improvement in the economy may have negatively affected retention and completion rates by giving INAM participants a reason to leave the college.

Figure A-1. Unemployment rate in Illinois from July 2009 through June 2015, by quarter



A.3 Interview and Focus Group Participants (Project Directors, Faculty, Students, and Employers)

At each college, we conducted focus groups and/or interviews with project directors, faculty, and students. Below, we describe the recruitment strategies and participant characteristics pertaining to each type of respondent. Table A-1 presents the number of participants within each respondent group.

Table A-1. Number of participants in the focus groups and interviews

Role	Round 1	Round 2	Round 3	Total
Project directors*	10	8	9	27
Education planners	0	8	6	14
Faculty	17	26	20	63
Students	50	64	49	163

*A few education planners were interviewed with project directors during round 1. In rounds 2 and 3, education planners were interviewed separately.

A.3.1 Project Director Interviews

At each of the 21 colleges, we used a structured protocol to interview project directors about the influence of the INAM consortium, the influence of INAM on course offerings, student recruitment for INAM, student assessment, the influence of INAM Education Plans, and the involvement of stakeholders such as local industries in the INAM project (see Appendix B). The protocols changed slightly from one round to another in order to deal with new issues and changing circumstances, but were largely similar in order to maintain comparability across the three rounds. Appendix B provides the protocols used in the third round of visits.

We recruited project directors by emailing them requesting an interview prior to our visits. Based on their availability and preferences, we interviewed project directors before the site visit over the phone and/or during the site visit in person. Project directors were not compensated for their participation. All 21 project directors participated, yielding a participation rate of 100 percent.

The project directors' specific titles varied within their colleges. For example, at some colleges, the project director was also a dean at the college. At other colleges, the project director was a faculty member. In addition, the project directors also served various roles within the INAM project. For example, at some colleges, the project director served as the education planner and database manager. At other colleges, these duties were shared among multiple individuals such as program coordinators or case managers.

At a majority of colleges, only one individual participated in the project director interview. However, occasionally two individuals jointly participated in the project director interview, leading to a total of 27 participants rather than 21. Such joint interviews occurred when there were two co-project directors or the project director requested that another knowledgeable individual also participate in the interview. For simplicity, throughout this report, we refer to all individuals who participated in project director interviews as "project directors" regardless of their specific title or role within the INAM program.

A.3.2 Faculty Focus Groups and Interviews

We used a structured interview protocol to conduct focus groups and/or interviews with faculty members at the 21 colleges (see Appendix B in the third-year report for the protocol that was used). The protocol covered the same general topic areas as the project director protocol, with variations in question wording and emphasis for faculty members.

To recruit faculty participants, we used multiple methods. At a few colleges, we directly emailed INAM faculty members to request their participation in focus groups. At these colleges, however, we obtained very few responses to our initial and follow-up emails, and we realized that faculty members might be more likely to respond to an individual within their institution (such as the project director) versus an external request.

In response, we modified our strategy and recruited faculty members with project directors' assistance. Project directors varied in their level of involvement in faculty member recruitment. Some project directors recruited and contacted all faculty members for the focus groups at individual colleges. At other colleges, some faculty members participated in response to our emails, and others were recruited by the project directors. In a few cases, project directors worked with us to follow up on our initial emails and emphasize the importance of participation.

To maximize participation, we offered faculty members the option of participating in focus groups during our site visits or participating in individual telephone interviews on another date. Because not all faculty members were on campus or available during our site visits, some faculty interviews were conducted over the phone. Faculty members were not offered compensation for participation. However, depending on the time of day and the colleges' preferences, we provided food (typically pizza or salads) for some faculty member focus groups that occurred in person.

In the end, 63 faculty members participated in focus groups or interviews.[1] Within each college, faculty participation rates varied widely. These faculty participation rates reflect multiple factors. First, some colleges simply had more faculty members than others. One college had 15 faculty members, which is too large for a single focus group. We did not expect or seek a high participation rate at colleges with large numbers of faculty. In addition, project directors varied in their level of encouragement to participate in the focus groups and interviews. We suspect that the support of project directors resulted in higher faculty participation rates, perhaps particularly at colleges where the project director also served in a supervisory role such as dean. Other factors influencing individual colleges' faculty participation rates may have included the number of adjunct faculty versus full-time faculty at a college, as well as the number of college courses offered during the day versus in the evening. Full-time faculty members or faculty members teaching courses during the day may have been more likely to have the time to participate in a focus group.

A.3.3 Student Focus Groups

To address our research questions, we created a structured interview protocol for students (see Appendix B in the third-year report). These protocols covered student awareness of the INAM consortium, student completion and enrollment, student recruitment for INAM, student support services,

[1] At one college with four INAM faculty members, one faculty member also served as project director. The project director at this college was also the only faculty member who agreed to participate. We used the project director protocol to interview this individual, and we treat this individual's responses as a project director throughout this report.

the influence of INAM Education Plans, and student assessment. Because we anticipated that students might be less likely to recognize the terms “INAM” or “Education Plan,” compared to faculty and project directors, we included language explaining these terms as appropriate.

When recruiting students for the focus groups, we used multiple methods and adapted our recruitment strategies as necessary to ensure adequate student representation. Initially, we attempted to recruit students for the focus groups via flyers and emails. Project directors emailed students our recruitment template and distributed our recruitment flyers around campus. In our recruitment materials, we asked students to call a toll-free number if they were interested in participating in the focus group. A Westat staff member answered students’ calls, confirmed that students appeared in the INAM database, and scheduled students for focus groups.

In the process of student recruitment, it became apparent that additional measures were needed to ensure adequate student representation in focus groups. Therefore, we asked project directors to encourage and recruit students to participate, and several did so. Project director recruitment efforts resulted in additional INAM student participants who had not called our toll-free number.

At colleges that still had few or no students signed up for a focus group, we asked project directors if we could conduct a student focus group during an INAM class. Project directors assisted in finding a suitable INAM class to visit, contacting the faculty member, and arranging for focus groups to be held during class time.

We compensated each student participant with $20. We also provided food (typically pizza) to student focus groups. In all student focus groups, held during or outside class time, we emphasized that participation was voluntary. In classrooms we visited, non-participating students were still eligible for compensation and food. All students chose to participate and signed a consent form.

In total, we held 23 student focus groups across the 21 colleges, with 163 students participating in our focus groups. Our goal was to recruit 8–10 students at each college, and we met this goal at nearly every college.

We obtained demographic information from students who participated in the focus groups through the INAM database. Roughly one-third of students participating in focus groups (35 percent) were born between 1934 and 1979, with an average age of 31.2 across all of the participants. Student ages ranged from 19 to 64. Most students were white (70 percent). Roughly one-tenth of students were identified as dislocated workers. As shown in Table A-2, 30 percent were enrolled in a CNC program, 24 percent in a welding program, 16 percent in a CPT program, 15 percent in a mechatronics program, and 10 percent in a maintenance program.

Table A-2. Student focus group participant characteristics

Characteristic	Number (*N* = 50)	Percent
Average age in years	31.2	NA
Born between 1934 and 1979	51	34.9
Gender		
Male	128	87.7
Female	6	4.1
Race/ethnicity		
White/Caucasian	90	61.6
Black/African-American	15	10.3
Hispanic/Latino	19	13.0
Classification		
Veteran	11	7.5
Dislocated	19	13.0
TAA eligible	3	2.0
Program of study		
CPT	24	16.4
CNC	44	30.1
Welding	35	24.0
Maintenance	15	10.3
Mechatronics	22	15.1
Multiple	5	3.4

TAA = Trade Adjustment Assistance; CPT = certified production technician; CNC = precision machining/computer numerical control.

NA = not applicable.

NOTE: The table counts INAM students only, while some non-INAM students also participated in the focus groups.

A.3.4 Focus Groups and Interviews of Employers

We spoke to 25 employers, 17 of whom were contacted over the phone. In addition, we conducted two in-person focus groups, one at Southwestern Illinois College (six employers) and one at Harper College (two employers).

Recruitment for Phone Interviews

To recruit employers for this study, we contacted all 21 community colleges participating in the INAM program. We asked the colleges to provide a list of three to four employers that hired INAM students from their college (including students who graduated as well as those who attended classes). We received responses from 16 of the colleges; 5 colleges did not respond. In total, we received the names of 75 employers. We determined that 61 of those employer names were usable: the other names were missing essential employer contact information. We contacted the 61 employers, and representatives from 17 employers agreed to participate in telephone interviews. In general, we attempted to recruit the direct supervisors of INAM students to participate in the study. When this was not possible, however, we spoke to an individual working in the Human Resources department who was familiar with the INAM employee.

Recruitment for Focus Groups

In addition to the telephone interviews, we also conducted two in-person focus groups. The first focus group occurred at Southwestern Illinois College (SWIC), and participating employers were a

convenience sample of employers attending an advisory board meeting. Six employers participated in this focus group. The second focus group occurred at Harper College. To recruit employers to participate in this focus group, we asked the president of a local business group that was involved with the INAM program, the Golden Corridor Advanced Manufacturing Partnership, to ask local area companies to participate. We also obtained a list of additional employers in the area from Harper and called them to ask them to participate. In the end, two employers participated in the Harper focus group.

Summary of Employers Participating in the Study

Representatives from 25 advanced manufacturing employers in Illinois participated in this study. As described above, for phone interviews, we recruited employers that hired from INAM programs. For the focus groups, we also permitted employers to participate that did not hire INAM students but were associated with INAM programs in other ways (e.g., participating in INAM advisory board meetings or sending employees to a local INAM program). In our final sample of employers in both interviews and focus groups, all but three of the employers stated they had hired employee(s) from INAM programs: one sent employees to an INAM program, and two participated in an INAM program's advisory board.

The interviewed employers represented a variety of regions in Illinois and hired from a variety of INAM community colleges and INAM program areas. Most participating employers were small or medium companies, and relatively few large companies participated. Many companies (13 of 25) hired from the CNC area, seven from CPT, six from mechatronics, and three apiece from maintenance and welding.[2]

Almost all interviewees were managers, owners, or supervisors. In two cases, a supervisor was not available for an interview but a Human Resource representative who was knowledgeable about the INAM employee agreed to participate.

Almost all interviewees had knowledge of one or more INAM hires at their company. Some interviewees had knowledge of three or more INAM hires at their company. However, several interviewees knew of only one INAM hire, and several other interviewees knew of two INAM hires.[3] As described above, three interviewees had not hired INAM students: one sent existing employees to the INAM program, and two participated in an INAM program's advisory board.

Interviewees varied in their involvement in and knowledge of their local INAM program. Some employers were involved in their local INAM program, either through attending advisory board meetings, sending existing employees to INAM programs, donating equipment or materials, or frequently communicating with the college. Six employers described apprenticeship programs at their companies for INAM students. However, several interviewees had no personal knowledge of or involvement in their local INAM program beyond their experiences with hiring one or more INAM students.

Many of the employers we spoke to recruited from the INAM programs at their local community colleges, although several did not, and a few were unsure if their companies did. One employer worked very closely with his local INAM program: his company offered a two-year apprenticeship program to students while enrolled in the INAM program, and for students maintaining a specific GPA, his company paid for all tuition, books, and fees associated with the program.

[2] Some hired from more than one area, so these numbers add to more than 25.

[3] We examined the results reported here by the number of INAM hires reported by the interviewee. No patterns of interest emerged, so this factor is not discussed further. However, one should note that among interviewees with knowledge of only one INAM hire, their comments regarding INAM employees are based on their experiences with that single hire.

A.3.5 Data Collection and Analysis

We analyzed focus group and interview data using standard qualitative analysis procedures. We first transcribed each audio recording. Next, we developed a coding scheme to reflect prevalent responses to each question in the protocols. We reviewed this coding scheme on an ongoing basis and made adjustments when necessary. Finally, we reviewed the coded data and summarized responses to each question in the protocol, including quotes when these were helpful.

A.3.6 Limitations

The focus groups and interviews had a few limitations that are important to discuss. First, participants in the focus groups were not randomly selected, and their responses cannot be generalized to larger populations. Although we strove to be inclusive in our data collection methods, participating faculty members, students, and project directors could choose whether to participate in the study, and individuals with stronger points of view may have been more motivated to participate. In addition, individuals may have been more interested in participating if they were familiar with the INAM program. In many cases, project directors actively assisted in the recruitment of students and faculty for interviews and focus groups. We cannot rule out the possibility that project directors may have selected individuals who were more knowledgeable about INAM and/or had a positive perspective on the program.

In addition, at some colleges, some students were selected for participation based on their enrollment in the class we visited, yielding an over-representation of students in particular classes. Similarly, faculty participation in the focus groups also was not random and could have been influenced by multiple factors. For example, full-time faculty members might be more able or willing to participate in focus groups, versus adjunct faculty who may have multiple jobs. Together, the nonrandom selection of participants means that caution should be used before generalizing findings from the focus groups.

Some limitations of this study are intrinsic to qualitative research. For example, not every question was asked of every interviewed employer, due to time constraints or the applicability of certain questions to employers' experiences. Similarly, in focus groups, not all participants responded to every question. In addition, although we strove to ensure equal participation, some participants in focus groups may have felt uncomfortable speaking in a group. Some interviewees may also have been reluctant to be candid about their employer or, among students, about faculty members who provided them with grades or employment recommendations. Despite these limitations, this study provides a unique window into the opinions of students, faculty members, project directors, and employers regarding the implementation and impact of the INAM program.

One caveat is important to mention: we recruited employers from lists of local employers provided by INAM colleges. Colleges were probably more likely to provide names of employers that were highly involved in INAM programs. In addition, employers were probably more likely to agree to participate if they were involved or invested in an INAM program. For this reason, our sample may be more likely to view local INAM programs positively. However, interviewees still provided comments and suggestions about the programs that provide a useful window into the experiences of local INAM employers.

Appendix B
Protocols Used for Employer Focus Groups and Interviews

INAM PHONE INTERVIEW
FOR EMPLOYERS

Revised May 4, 2016

INTERNAL INFORMATION ONLY

Purpose of this focus group: To learn the results of INAM programs from employers' perspective.

Intended Outcomes:

Results of INAM programs from employers' perspective

- Experiences with employees who graduated from or took courses in INAM programs (technological skills, soft skills, etc.):
  - Comparisons with other/previous hires in terms of readiness to work
- Barriers, if any, to hiring employees who graduated from or took courses in INAM programs
- Reputation of INAM programs among local area employers
- Alignment of INAM programs with local area employers' current and future needs:
  - What they want from INAM hires (e.g., a few key courses, certificates, national credentials)

2. **Employers' involvement with INAM programs**
   - Involvement in program design or curriculum development
   - Existing employees sent to training in INAM programs
   - Employees teaching INAM classes

ROADMAP OF ACTIVITIES PLANNED

Categories of Information to be Covered	Approx. Time Set Aside
Introduction	5 minutes
Issue 1. Background information	20 minutes
Issue 2. Involvement in programs	10 minutes
Issue 3. Impressions of programs	15 minutes
Close	time permitting
Total Time Allotted	**50 minutes**

INTRODUCTION

(5 minutes)

Thank you for agreeing to participate in today's discussion and for fitting this session into your busy schedules. My name is [insert name here] and I work for Westat, a social science research firm in Rockville, MD. Today, I will be the moderator for this 50-minute group discussion.

We are conducting a study of the U. S. Department of Labor's grant for the Illinois Network for Advanced Manufacturing program, or INAM. As part of this study, we are talking to employers that hired students from particular advanced manufacturing programs in the INAM community colleges across Illinois. It's not important whether you know about INAM; what we want to learn from you is whether the students you hired were well prepared for their jobs.

Participation in this discussion is voluntary. If you agree to participate, we will not use your name in any reports, notes, or communications with our client. In our report, we will list the names of the companies that participated in this focus group, but we won't tie specific comments to specific companies, colleges, or employees.

I encourage you to speak honestly and candidly, and we would like to hear as many perspectives as possible. The session is being recorded to enable me to write an accurate report, not of who said what but "what was said." Does anyone have any questions?

Does everyone consent to participate and to have this session recorded?
[Wait for everyone to say yes.]

In order to make this an efficient session, here are some guidelines:

- I don't expect that everyone will answer every question. But I don't want to leave anyone out of the conversation. If you have an opinion that has not been expressed, I encourage you to share it. If I don't hear from you on some important questions, I may call on you.
- We have a number of topics to cover in a short period of time; therefore, I apologize up front if I must interrupt you so we can move on to the next topic. If time permits, I will return to any unfinished discussions.

We would like to be on a first name basis. Let's take a moment and get acquainted.

Can everyone please share their first name, and the name of your company.

ISSUE 1: BACKGROUND INFORMATION

(20 minutes)

We'll begin by getting some background about your company.

1. ***Can you tell me a little about what your company does?***

2. ***Approximately how many employees does this branch of your company have?***

3. ***By way of background, how many employees a year is your company hiring?***

PROBE: If unknown: do you know if your company is currently hiring?

4. ***When you need to hire new employees at your company, where do you look?***

PROBE: Does your approach vary depending on the role you're recruiting for?

Do you do anything to specifically recruit students from [name of college]?

5. ***How easy or hard is it to find qualified employees to work at your company?***

PROBE: In what ways?

PROBE: What are some of the challenges in finding qualified employees?

6. ***Show of hands. Is anyone aware of the following credentials?:***

- Manufacturing Skill Standards Council

  [STATE COUNT]

- NIMS (National Institute for Metalworking Skills)

  [STATE COUNT]

- AWS (American Welding Society)

  [STATE COUNT]

PROBE: Are these credentials something that you value when hiring?

PROBE: What are some reasons this credential is valued?

7. ***Which programs at Harper is your company most likely to hire from?***

- Manufacturing Production Certificate/ CPT
- CNC Operator 1
- Welding
- Other advanced manufacturing programs

PROBE: Do you *send* employees to any of these programs?

8. ***To your knowledge, roughly how many individuals have been hired by your company who studied advanced manufacturing at Harper since 2013?***

PROBE: What program / area of study were they hired from?

PROBE: What types of roles were they hired into?

PROBE: Do you know if they completed a certificate or just took a few courses?

PROBE: When hiring these employees, how important to you was it that they had studied FIELD at Harper?

PROBE: Have you worked directly with these individuals?

IF YES: In what capacity, and what is your impression of their job performance in terms of technical and soft skills?

9. ***What role do/did these individuals work in?***

PROBE: What were their duties?

10. ***When searching for potential employees for this role, what skills and characteristics are most important to you?***

PROBE: Technical skills? Soft skills? How do you identify these skills when hiring? Do you test for technical skills when hiring?

11. ***What educational background is helpful for this role (HS diploma, a few college courses, college degree, college certificate?)***

PROBE: In general, how important is college attendance in your decision to hire new employees for this role? Could college attendance make up for a lack of on-the-job experience?

All things being equal between two job applicants, would college attendance increase an applicant's chances of being hired for this position? In what way?

12. ***Once employees are hired in this role, do you provide additional training?***

PROBE: On the job training, sending employees to training elsewhere (if so, INAM programs?)

ISSUE 2: INVOLVEMENT IN PROGRAM
(10 minutes)

13. ***Has your company been involved in changes to the advanced manufacturing programs at Harper since 2013?***

Probes:

- Choices about new equipment?
- Design of the certificate and degree program?
- Development of curriculum?

14. ***Have you participated in the advisory board or in other ways to guide the development of advanced manufacturing programs at Harper?***

IF YES: In what ways?

PROBE: What are the benefits to your company for this participation?

PROBE: What are the benefits to the college?

PROBE: How long has your company been involved?

ISSUE 3: IMPRESSIONS OF PROGRAMS

(15 minutes)

Next, we are going to talk about your impression of the advanced manufacturing programs at Harper.

15. ***What's your impression of the programs in Manufacturing Production Certificate/ CPT, CNC Operator 1, Welding, or other advanced manufacturing programs at Harper since 2013?***

PROBE: What makes you say that?

PROBES (if needed): Is this impression based on…

- Individual(s) you have hired?
- Information learned in the advisory board meetings?
- Information from others in the community?
- Employees who work as adjuncts at the local community college? (If so, did you learn anything about the program from them?)

16. ***If you were designing an advanced manufacturing program at a community college, what would you change so that future employees are better prepared to perform the positions your company is seeking to fill?***

PROBE: Barriers, if any, to hiring employees who graduated from or took courses in such programs

17. (If time permits) **Distribute handout of courses**

Can you talk about whether these courses are related to the work your company does, and in what way?

If time does not permit, ask them to please write a number 1-10 beside each course name where 1= not at all related to their work and 10= extremely related to their work. Collect at end of session.

CLOSE

Thanks again for your time. As we wrap up, we had one final question:

18. ***The purpose of our study is to understand whether the INAM grant has made students more prepared to enter careers in advanced manufacturing. Have we missed anything in today's discussion regarding that purpose?***

We appreciate your help today. Your feedback will help ensure that local community college programs meet your needs as employers. Thanks again for your help!

Appendix C
Survey Questionnaire Administered to INAM Project Directors

INAM Project Director Survey

1. Please evaluate the impact of INAM on your institution's advanced manufacturing programs. *(Mark one for each row.)*

	To a great extent	To a moderate extent	Only slightly	Not at all	Not applicable
a. We enhanced the equipment available to students.	☐	☐	☐	☐	☐
b. We strengthened the curriculum.	☐	☐	☐	☐	☐
c. We increased the number of students.	☐	☐	☐	☐	☐
d. We increased the amount of guidance available to students.	☐	☐	☐	☐	☐
e. We attracted different types of students.	☐	☐	☐	☐	☐

2. Please evaluate the impact of INAM *on students* in your institution's advanced manufacturing programs. *(Mark one for each row.)*

	To a great extent	To a moderate extent	Only slightly	Not at all	Not applicable
a. Students are more likely to complete a certificate or degree.	☐	☐	☐	☐	☐
b. Students are more likely to earn a national credential (such as MSSC or NIMS).	☐	☐	☐	☐	☐
c. Students are more likely to get a job.	☐	☐	☐	☐	☐
d. Students are better informed on what courses to take.	☐	☐	☐	☐	☐
e. Student retention in the program has increased.	☐	☐	☐	☐	☐
f. Students are more likely to seek additional certificates or complete a degree.	☐	☐	☐	☐	☐
g. Students involved in the INAM program have more opportunities for hands-on or field experience than other students had in the past.	☐	☐	☐	☐	☐
h. Most students will be able to get a job in this field after they complete their certificate.	☐	☐	☐	☐	☐
i. Students are prepared to enter and succeed in the workplace.	☐	☐	☐	☐	☐

3. Overall, what is your impression of INAM as a consortium? *(Mark one for each row.)*

	To a great extent	To a moderate extent	Only slightly	Not at all	Not applicable
a. Being part of the INAM consortium benefited my institution.	☐	☐	☐	☐	☐
b. Being part of the INAM consortium benefited students at my institution.	☐	☐	☐	☐	☐
c. Participating in INAM has led to the development of relationships with people in other institutions that we expect to continue.	☐	☐	☐	☐	☐

4. What are your plans concerning your advanced manufacturing programs over the next 3 years? *(Mark one for each row.)*

	Strongly agree	Agree	Disagree	Strongly disagree	Not applicable
a. My institution's programs are solid in their current form, and we do not expect major changes in the near future.	☐	☐	☐	☐	☐
b. We plan to add additional programs or certificates in our INAM fields.	☐	☐	☐	☐	☐
c. We will continue having someone take the role of education planner, similar to the INAM education planner.	☐	☐	☐	☐	☐
d. We will continue working with other institutions in the consortium.	☐	☐	☐	☐	☐
e. We expect to cut back on some activities due to the lack of funding.	☐	☐	☐	☐	☐
f. We expect our programs to grow in enrollment size.	☐	☐	☐	☐	☐
g. We expect to make major improvements in our equipment or facilities	☐	☐	☐	☐	☐

5. Please describe your relationships with employers. *(Mark one for each row.)*

	Strongly agree	Agree	Disagree	Strongly disagree	Not applicable
a. We have stronger relationships with local employers than we had prior to INAM.	☐	☐	☐	☐	☐
b. Our programs are tailored to meet the needs of local employers.	☐	☐	☐	☐	☐
c. Local employers are highly knowledgeable of our programs.	☐	☐	☐	☐	☐
d. Employers are satisfied with our students.	☐	☐	☐	☐	☐

6. **When did you become the INAM project director at your college?**

   Month and year ....._____/20_____

7. **Please comment on what you have learned from the project.**

_____

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8. **What from INAM was most beneficial to your college? What, if anything, do you plan to expand?**

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9. **What from INAM was most difficult or problematic? What, if anything, do you plan to drop?**

_____

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The information you provided in this survey is greatly appreciated. It is important that you fill in the name of the college that you work at. Your name is not required, and these surveys will only be reviewed by the independent evaluators.

College: _____

Thank you for your participation in this survey. Your responses are essential to improving and understanding the INAM project.