Enhancing the manufacturing workforce through increased visibility, education, and training

Cumulative Findings from a 4-year Evaluation of 360

AUGUST 2017

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Acknowledgments

We would like to thank the staff of the 360 Manufacturing and Applied Engineering ATE Regional Center of Excellence for their insights and contributions to this report, as well as to the entire evaluation over the past four years. In particular, we would like to thank Jeremy Leffelman, Director, Karen White, former Director, and Jessica Gehrke, Communications Specialist. We would also like to thank Paula Hoffman, Dean of Student Affairs at Pine Technical & Community College for her contributions.

Also, thank you to the following Wilder Research staff who provided their expertise on this project over the past four years:

Mark Anton
Barry Bloomgren Jr.
Marilyn Conrad
Phil Cooper
Maddie Hansen
Ron Mortenson
Dawn Mueller
Nam Nguyen
Ellen Shelton
Matthew Steele
Kerry Walsh

Executive summary

The mission of 360 is to increase the quantity, quality, and diversity of skilled and knowledgeable workers in the field of manufacturing. As a recipient of the National Science Foundation (NSF) ATE Regional Center award, 360 has engaged in rigorous annual evaluation of its work, centered around its primary goals of increasing the quantity, quality, and diversity of manufacturing workers; increasing the visibility of manufacturing careers; enhancing the educational pipeline for the manufacturing industry; and refining the curricula that contributes to the education of manufacturing employees. This report summarizes the evaluation outcomes measured during the first four years of 360's implementation, from June 2012 through May 2016.

During this time frame, evaluation findings suggest that the quantity and diversity of workers in 360's affiliate programs has increased, 360 partners feel the level of collaboration among partners is high, manufacturing employers are at least somewhat familiar with 360, and that 360 has improved perceptions of the manufacturing industry through its youth and community outreach events.

With respect to challenges, partner ratings of 360's structural, organizational, and operational processes have declined slightly over time; the most frequent areas of concern were funding, workload, and timely progress. This first stage of the evaluation struggled to measure some aspects of 360's work, largely due to low survey response rates and logistical difficulties. During the next four years, Wilder and 360 should identify new strategies to survey students enrolled in 360 programs, measure 360's impact on the quality of workers, and learn whether 360's outreach activities—such as its summer camps and VEX program—directly result in manufacturing-related college course enrollment.

Introduction

Over the past four years, through a grant from the National Science Foundation (NSF), the 360 Manufacturing and Applied Engineering ATE Regional Center of Excellence (360) has been working collaboratively to recruit, educate, and train workers for careers in manufacturing. 360 works with partner institutions in the Minnesota State colleges and universities (Minnesota State, formerly MnSCU) system to prepare students for careers. 360 also works with industry leaders to attract and develop the highly skilled workers needed to keep Minnesota businesses competitive and profitable. This work has been especially important recent years, as the grant came on the heels of the Great Recession. In addition, the manufacturing industry, both pre- and post-recession, has struggled to fill positions with qualified workers.

The overall mission of 360 is to increase the **quantity**, **quality**, and **diversity** of skilled and knowledgeable workers in the field of manufacturing. To accomplish this mission, 360 developed several program objectives to be implemented over the course of the grant; those objectives are:

- **Increased visibility:** Improve the image of manufacturing careers and the manufacturing sector.
- **Enhanced pipeline:** Prepare students for rigorous manufacturing technician-level programs and entice them to pursue manufacturing careers, and implement strategies to target under-represented student groups.
- **Industry-driven curricula:** Refine curricula that are relevant to today and tomorrow's manufacturing industry.

Over the course of the four-year grant (June 2012 through May 2016), 360 has completed many activities to help meet these objectives and ultimately increase the quantity, quality, and diversity of workers in the field of manufacturing. In order to measure the impact of its work, 360 asked Wilder Research to conduct a rigorous and unbiased evaluation of the project. Evaluation data were shared with multiple stakeholders, including 360 leadership, NSF, and others in the field of advanced technical education to help provide timely and useful feedback.

The following report details the cumulative evaluation findings over the past four years and is organized around the logic model that was developed at the beginning of the project. The logic model and additional information, such as the research methodology, can be found in the Appendix.

Overall impact of 360

The ultimate goal of 360 is to increase the **quantity**, **quality**, and **diversity** of skilled and knowledgeable workers in the field of manufacturing. By increasing the visibility of manufacturing, as well as enhancing the curricula and pipeline for technician-level programs, it appears that 360 has met at least part of this goal. Over the past four years, there has been an increase in the quantity and diversity of graduates from 360-related programs, but evidence related to the improvement in graduate quality is less certain.

Quantity of workers

In Wilder's 2016 survey of regional manufacturing employers, 44 percent of respondents believed that 360 had at least some impact on the quantity of graduates from 360-affiliated manufacturing and engineering programs (Figure A1). Furthermore, graduate data from the 360 Core schools (the 10 original partner institutions) shows a 33 percent increase in graduates between the 2010-12 baseline and 2015 (Figure 1). This is an increase to 606 graduates in 2015 compared to an average of 457 during 2010-12. During the same period, the total number of system-wide graduates in the same 360-related programs (but not at 360 Core institutions) increased 20 percent, from an average of 1,094 per year during 2010-12 to 1,314 in 2015.This increase suggests that 360's strategy may have a positive impact on the number of graduates.

The increase between baseline and 2015 was driven by an increase in Precision Production and Diploma/Associate graduates. For 360 Core institutions, the number of 360 Precision Production graduates increased by 60 percent, compared to only 39 percent among other schools. 360 Core schools also experienced a 40 percent increase in Diploma/Associate graduates, compared to an 11 percent increase among other schools.

Tracking enrollment of student majors helps to provide an early indication of successful inspiration and recruitment, and a healthy pipeline of students who will potentially become the graduates in the future. The 360-related programs experienced an increased number of majors during 2014, up 40 percent to 1,554 from an average of 1,112 during 2010-12 (Figure 1).

1. 360-related program enrollments and graduates by year

	2010-12 Baseline	2013	2014	2015	% increase, 2015 over baseline
360 graduates	457	525	637	606	33%
Total graduates in 360 programs at non-partner institutions	1,094	1,066	1,208	1,314	20%
360 majors	1,112	1,335	1,554	NA	40%*

Note. Asterisk denotes comparison of 2014 to baseline average. All graduate data reflects the ten "Core" 360 partner institutions; major data reflect all ten except Bemidji State. Data on the number of graduates come from Minnesota State's ISRS data system; enrollment information comes from 360. More information available in the Appendix.

Quality of workers

In terms of quality, it is difficult to say definitively if 360-affilliated workers are of a higher quality than other workers in manufacturing fields. Currently, the best source of data regarding 360-impacted worker quality is the employer survey conducted earlier this year. About half of respondents believed 360 had at least some impact on the quality of workers (10% said "a big impact," 44% "some impact"; Figure A1).

Over three-quarters (77%) of respondents had hired manufacturing or engineering graduates from a 360-affiliated school in the past year. When asked to compare those graduates with other new employees on a series of 14 types of skills and qualities that are important for manufacturing workers, majorities of respondents rated 360 graduates' skills as equal to or higher than other new employees (Figure 2). 360's impact was highest on technical skills and general preparedness, with roughly three in ten respondents reporting that graduates from 360-affiliated schools had better technical skills related to the job (34%) and were generally better prepared for the job (28%). Very few respondents reported that non-360 graduates were more skilled than 360 graduates in any area.

2. Comparing the skills of graduates, 2016 (N=35-40)

How would you compare the skills of recent graduates from 360-affiliated colleges to other new employees your company has hired in the past year?	360 graduates are more skilled in this area	They have equal skills in this area	Other graduates are more skilled in this area	Don't know
Technical skill related to the job	34%	40%	8%	18%
General preparedness for the job	28%	45%	10%	18%
A positive attitude	26%	49%	0%	26%
Problem solving	22%	49%	5%	24%
Working effectively with a team	20%	51%	0%	29%
Completing work in accordance with quality standards	19%	51%	3%	27%
Correct use and operation of equipment, tools, and materials	18%	53%	5%	24%
Showing respect for other employees	17%	61%	0%	22%
The ability to accept advice and constructive criticism	17%	53%	6%	25%
Creativity and innovation	14%	54%	5%	27%
Continuously improving work performance	11%	64%	0%	25%
Strong written communication	8%	53%	3%	37%
Completing tasks on time	8%	70%	0%	22%
Strong verbal communication	5%	55%	5%	34%

Diversity of workers

In 2015, one-third (32%) of employers surveyed felt that 360 had "some" or "a big" impact on the diversity of graduates from 360-affiliated manufacturing and engineering programs (Figure A1).

Administrative data show some positive diversity outcomes when 360 Core schools are compared to others in the Minnesota State system. 360 tracks graduate diversity on four dimensions: race, gender, first generation college student status, and graduate age (under age 35 vs. age 35 and older). In three of the four measures (all but graduate age), the increase in diverse graduates has outpaced the increase in other graduates within the 360 Core schools (Figure 3). Most remarkably, compared to baseline, the number of graduates of color more than doubled, from an average of 57 during 2010-12 to 117 in 2015; a 105 percent increase in graduates of color, compared to a 24 percent increase in white graduates.

3. 360 Core partner graduate diversity by year

	2010-2012 Baseline	2013	2014	2015	% increase over baseline
White graduates	388	428	521	480	24%
Graduates of color	57	85	102	117	105%
Male graduates	411	464	601	557	11%
Female graduates	44	57	35	49	36%
Not first-generation graduates	319	375	454	420	32%
First generation graduates	105	124	163	164	56%
Graduates under age 35	335	397	476	459	37%
Graduates age 35 and older	121	126	158	147	21%

Note. Percent increase over baseline compares the 2015 number to the 2010-2012 baseline average. Due to missing data, adding the number of graduates in this list (e.g., under 35 and 35 and older) may not sum to the total provided in tables showing the total number of graduates.

Between the baseline years and 2015, 360 Core programs outpaced other Minnesota State programs on all four diversity measures (Figure 4). Again, 360 experienced its largest increases in graduates of color (105% increase vs. 39% increase in non-360 Core programs). Of note, 360 Core programs experienced growth in the number of first generation college student graduates (56%) and graduates age 35 and older (21%), whereas other Minnesota State programs saw declines in both populations (7% decrease for both).

4. Percent increase over baseline, 2010-2012 to 2015

	360 Core programs	Other programs
White graduates	24%	15%
Graduates of color	105%	39%
Male graduates	11%	20%
Female graduates	36%	19%
Not first-generation graduates	32%	31%
First generation graduates	56%	-7%
Graduates under age 35	37%	30%
Graduates age 35 and older	21%	-7%

Note. Percent increase over baseline compares the 2015 number to the 2010-2012 baseline average. "Non-360 Core graduates system-wide' refers to graduates of Minnesota State schools that were not affiliated with 360 at the time of the grant.

Perceptions of stakeholders about 360

Wilder also looked at the impact of 360 on some of its key stakeholders, including project partners and employers.

Partnership

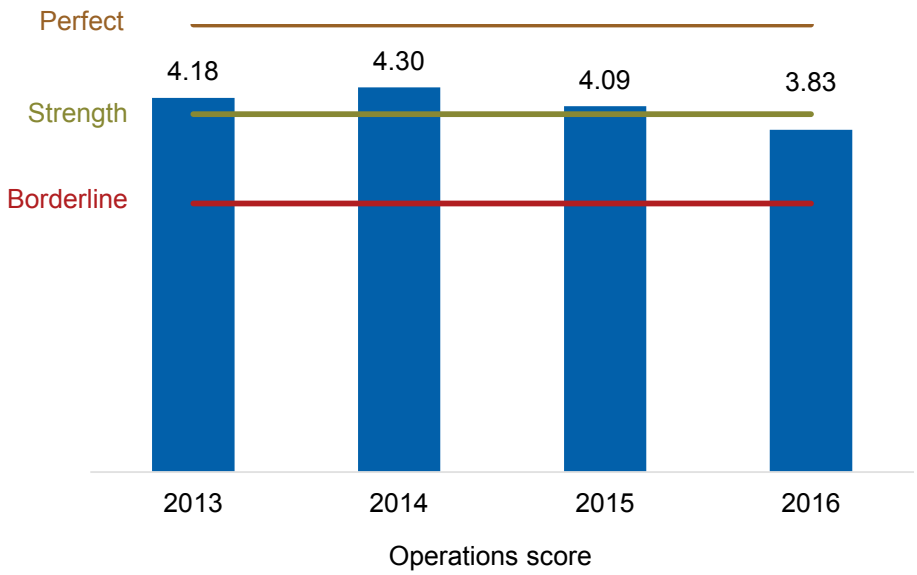
As part of Wilder's annual partner survey, respondents were asked a series of questions adapted from the Collaboration Factors Inventory[1]. These questions are intended to gauge the overall strength of the collaboration activities and structure from the perspective of those involved. Overall, respondents gave very favorable ratings to 360's collaboration and operations. A score of five is "perfect," higher than four indicates a "strength," a score of between three and four is "borderline," and a score of less than three indicates a "weakness." More information about how these scores are calculated and the questions that contribute to each are available in the Appendix.

Operations measure

Figure 5 shows the aggregated responses to the questions that focus on structural, organizational, and operational aspects of the 360 partnerships. These questions target factors that indicate successful operations, specifically related to having the right leadership strategies, adequate funding, and making appropriate progress toward its goals. The average operations score increased between 2013 and 2014, then decreased between 2014 and 2016 from 4.30 to 3.83. The most recent survey year, 2016, was the first time that the mean score dipped into the borderline range; however, 2016 results should be interpreted with caution due to the low response rate and small number of respondents (N=10).

[1] Mattessich, P., Murray-Close, M., & Monsey, B. (2001). *Wilder Collaboration Factors Inventory*. St. Paul, MN: Wilder Research.

5. Operations measure, Years 1-4



Across all four years of the survey, the two highest ranked operations questions have been "360 is doing work that would not otherwise be happening" (average score: 4.42) and "360 has the right leadership to succeed" (average score: 4.36). There was a slight decline in both measures during 2016; however, this is unsurprising, given the small number of survey responses (N=10) and 360's recent leadership transition, in which a new executive director was hired a few weeks prior to the survey.

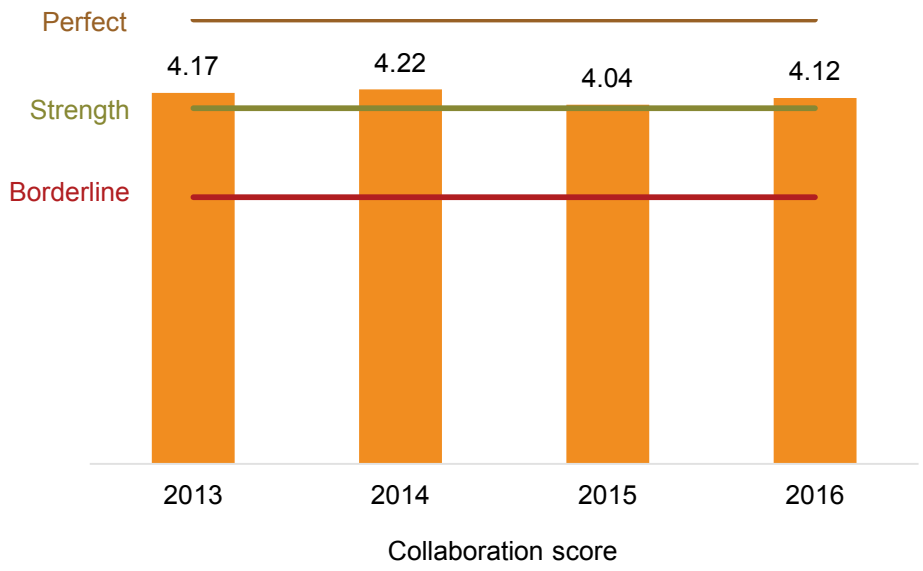
Across the four survey years, the three lowest-ranked operations questions have been "360 has taken on the right amount of work" (average score: 3.82), "360 has adequate funding to complete the work" (average score: 3.86), and "360 is progressing at the right pace" (average score: 3.99)—the only three questions with average scores under 4.00. Qualitative responses further illuminate some of these points. For example, partners suggest that 360 may be taking on too much work. In the 2015 survey, one partner said, "there are too many balls in the air, and not enough time to step back and manage effectively what is currently happening;" another suggested that 360 has struggled with remaining "focused on a few main goals, not spreading [themselves] too thin." With respect to funding, partners suggested that there was not adequate funding for the work, some specifically speaking to the relatively low salary level of staff.

Collaboration measure

Figure 6 shows the average score across the six collaboration questions for each of the four years of the partner survey. The collaboration measure consistently remained above score of 4.00 ("strength") across the four years of the evaluation. The pattern for average

collaboration score mirrors the pattern for operations score, though the average collaboration score increased slightly in 2016. Again, the 2016 results should be interpreted with caution due to the low response rate and small number of respondents (N=10).

6. Collaboration measure, Years 1-4



Over time, the strongest responses related to collaboration have typically been "discussions among 360 partners encourage sharing of diverse points of view" (average score: 4.28) and "I have a clear sense of what 360 is trying to accomplish" (average score: 4.23).

The only item in the collaboration set with an average score of less than 4.00 is "360 partners have a clear sense of their roles and responsibilities"; individual year ratings for this item never reached the "strength" level (average of 4.00 or greater), with averages ranging from a low of 3.75 (in 2015) to 3.90 in 2016.

Employers

In a survey of employers conducted in early 2016, respondents were asked about their familiarity with 360, as well as its affiliated programs and partner organizations. The majority of respondents said they were at least somewhat familiar with 360 (65%); although over one-third were not very or not at all familiar (Figure 7).

7. Familiarity with 360 and affiliated programs and partners, 2016 (N=52)

How familiar are you with the following entities?	Very familiar	Somewhat familiar	Not very familiar	Not at all familiar
The Statewide Tour of Manufacturing	40%	19%	17%	23%
Manufacturing and engineering programs at Minnesota State Colleges and Universities (MnSCU)	37%	46%	10%	8%
Dream It. Do It.	27%	15%	19%	39%
The 360 Manufacturing Center of Excellence	15%	50%	25%	10%
The VEX Robotics program	15%	23%	27%	35%
360 eTECH Online and Hands-on Manufacturing Education	6%	40%	23%	31%

Improved perceptions of manufacturing

Over the past four years, 360 has held a number of events to improve perceptions and increase the visibility of manufacturing careers among both children and adults. Most notable is the Minnesota Statewide Tour of Manufacturing. Every fall, 360 and its partners coordinate with manufacturing businesses across Minnesota to provide tours of their facilities for students, educators, job seekers, other manufacturers, and the general public. Through these tours, as well as its summer camps and the VEX Robotics competition, 360 hopes to improve awareness, perceptions, and interest in manufacturing and Science, Technology, Engineering, and Math (STEM).

After each event of these events, participants are asked to complete a survey to gauge the event's impact on participants' awareness, perceptions, and interest in manufacturing careers, as well as interest and confidence in STEM. Participants are asked to rate their familiarity or opinion of each of these both before and after the program. More information on the questions and response options is available in the Appendix.

Survey results across the four years suggest 360 has had a substantial impact on the visibility of manufacturing careers and STEM, particularly on the perceptions of manufacturing careers. For the measures selected:

- 360 has made the greatest impact on perceptions of manufacturing: 64 percent of youth and 78 percent of adults surveyed increased their perception of manufacturing.
- Among youth, 360 has made the least impact on interest in manufacturing careers: 46 percent of youth surveyed increased their interest in manufacturing careers.
- Among adults, 360 has made the least impact on interest in STEM: 31 percent of youth surveyed increased their interest in manufacturing careers.
- Youth events had a similar impact on perceptions among boys and girls, except for the STEM measures: a greater percentage of girls increased their interest and confidence in STEM compared to boys.

These outcomes are explored in greater detail below.

Improvement in perceptions of manufacturing

Figures 8 and 9 show the improvement in perceptions of manufacturing for each measure among youth and adult participants.

The in percentage reflects participants who were not already highly interested in the topic—that is, it omits those who said they were highly engaged in the measure (e.g., very aware of manufacturing careers) both before and after the program.

Figure 8 shows the impact of 360 camps, VEX, and the Tour of Manufacturing among *youth* participants. Among all youth participants surveyed, 360 had the most influence on the perception of manufacturing careers (64% increased), followed by awareness of manufacturing careers (57% increased) and confidence in STEM (57% increased). Impact was somewhat lower with respect to interest in STEM (50% increased) and interest in manufacturing careers (46% increased).

8. Percent of youth participants who reported increased visibility, 2013-2016

	2013 (N=130-179)	2014 (N=116-211)	2015 (N=141-230)	2016 (N=40-72)	All (N=459-692)	Total youth who increased
Awareness of manufacturing careers	56%	49%	68%	49%	57%	366
Perception of manufacturing careers	68%	61%	69%	53%	64%	350
Interest in manufacturing careers	50%	36%	55%	39%	46%	319
Interest in science, technology, engineering, and math (STEM)	56%	40%	51%	65%	50%	236
Confidence in science, technology, engineering, and math (STEM)	56%	53%	60%	57%	57%	261

Notes. The total number of youth who reported an increase is a minimum, based on the number of respondents surveyed. This table represents the combined responses of youth participating in the Tour of Manufacturing, VEX, and Summer Camps surveys. Denominator for percentage omits those that "remained high"—e.g., those who were interested in STEM "a lot" both before and after the program. More information available in the Appendix.

Figure 9 shows a similar pattern among adults, though the percentage increases were notably lower than for youth. This could be because adult events are less intensive than youth events, spend less time on topics that would increase interest in manufacturing careers or STEM, or because adults are less likely to change their mind about manufacturing careers or STEM. Note that about two-thirds of the adults surveyed (67%) participated in a Tour of Manufacturing event, a one-day tour of a manufacturing facility designed by manufacturing employers, which could have a limited impact compared to the more intensive, 360-directed youth activities (e.g., a multi-day camp). The remaining adults supported youth in the VEX Robotics Tournament, either as coaches or parents.

The greatest impact on adults was in the perception of manufacturing careers (78% increased), followed by the impact on the awareness of manufacturing careers (49% increased). Compared to youth, adult participants were less likely to demonstrate increases in interest in manufacturing careers and STEM (31 and 36%, respectively).

9. Percent of adult participants who increased visibility, 2013-2016

	2013 (N=11-130)	2014 (N=104-192)	2015 (N=69-109)	All (N=253-314)	Total adults who increased
Awareness of manufacturing careers	73%	47%	50%	49%	144
Perception of manufacturing careers	77%	75%	86%	78%	244
Interest in manufacturing careers	38%	33%	41%	36%	114
Interest in science, technology, engineering, and math (STEM)	18%	31%	34%	31%	79

Notes. The total number of adults who reported an increase is a minimum, based on the number of respondents surveyed. This table represents the combine responses for adults responding to the Tour of Manufacturing and VEX surveys. Denominator for percentage omits those that "remained high"—e.g., those who were interested in STEM "a lot" both before and after the program. More information available in the Appendix.

Youth events had similar impact on boys and girls, except for STEM measures

Figure 10 shows the percentage of youth participants that increased their awareness, perception, interest, or confidence in manufacturing or STEM out of those who were not highly engaged prior to camp, broken down by gender.

There was no substantial gender difference between boys and girls with respect to their awareness, perception, or interest in manufacturing careers. Of these three measures, both boys and girls most frequently improved their perceptions of manufacturing (65-66%), demonstrating slightly lower increases in awareness (57-58%) and interest in manufacturing careers (45-50%).

However, girls were more likely to increase their interest and confidence in STEM than boys (57% vs. 47% and 64% vs. 53%, respectively).

10. Percent of youth participants who increased visibility, by gender, 2013-2016

Measure	Boys (N=289-478)	Girls (N=152-201)	Total (N=446-679)
Awareness of manufacturing careers	57%	58%	57%
Perception of manufacturing careers	65%	66%	65%
Interest in manufacturing careers	45%	50%	46%
Interest in science, technology, engineering, and math (STEM)	47%	57%	50%
Confidence in science, technology, engineering, and math (STEM)	53%	64%	57%

Note. Denominator for percentage omits those who "remained high"—e.g., those who were interested in STEM "a lot" both before and after the program. More information available in the Appendix.

Enhanced pipeline

As described earlier, 360 has increased interest in manufacturing among K-12 participants in its events, and the number of graduates in manufacturing-related programs at 360 partner schools has increased. Ultimately, enhancing the pipeline for manufacturing workers is all about the things that happen in between these two touch points. An enhanced pipeline ensures that students inspired to pursue manufacturing are able to move easily and efficiently from *interested* in a manufacturing career to *graduating* with a degree in manufacturing.

Many of the aspects of 360 that are addressed in other sections of this report—such as refined curricula and improved perceptions of manufacturing—are integral to this goal. Understanding how 360 has impacted the pipeline for manufacturing workers requires us to understand how graduates' cumulative education- and employment-related experiences contributed to their degree in manufacturing.

Ideally, measuring this pipeline would involve tracking participants in 360 events and programs over time, from K-12 through employment. However, this type of tracking is very time and labor-intensive in practice, likely requiring alignment of multiple data systems, written consent from parents and students, and substantial analytical work. In lieu of this approach, Wilder attempted to complete a survey of students in 360 courses to better understand the experiences that led them to pursue a field related to manufacturing.

In 2016, 360 staff sent a survey link to a selection of professors, requesting that they share the link with students. However, only 32 students completed the survey. This is a very low response rate, considering that 360 identified approximately 1,500 majors at its core partner schools for the year 2014. Wilder and 360 hope to develop strategies to reach a greater number of students in the future. Given the low response rate, results should be interpreted with caution.

Despite the low response rate, there was some variety in respondent demographics and educational experiences. The majority of respondents were studying Electronics, Robotics, Automation, Mechatronics, and/or Industrial Maintenance (47%), with smaller proportions studying Machine Tool Technology (22%), Welding and Fabrication (22%), or a different subject area (9%). Most students were nearly finished with their programs (59%), while 35 percent of students were about halfway through, and 7 percent had just started. Respondents came from six different partner schools: Hennepin County Technical College (35%), Pine Technical and Community College (23%), South Central College (23%), Central Lakes College (13%); two students (6%) said they came from other partner schools. Though all respondents were male and most were white (96%), many

different age groups were represented: 38 percent were age 18 to 25, 41 percent were age 26 to 45, and 21 percent were age 46 or older.

Very few survey respondents specifically identified participation in 360-affiliated K-12 programs (e.g., summer camps, VEX, etc.), so an accurate assessment of 360's K-12 outreach impact on the pipeline is limited. This is unsurprising, because only eleven respondents identified themselves as age 18 to 25—the group that would have been most likely to access 360 outreach programs. Two respondents had participated in a robotics tournament or competition; of those, one specifically noted participation in VEX.

Respondents were positive about the impact of manufacturing tours. Most respondents (90%) had attended a tour of a manufacturing facility. Though none said they attended the Statewide Tour of Manufacturing, 85 percent attended a tour organized by their local college, 11 percent participated in a tour sponsored by their high school, and 15 percent had participated in a different kind of tour. In general, these tours had a substantial impact on respondents: 62 percent said the tours impacted their decision to pursue their current program or career "a fair amount" (46%) or "a lot" (15%). Even if this impact cannot be directly attributed to 360, it does indicate that the Tour of Manufacturing strategy is effective in building a pipeline of students.

While the positive findings from the youth outreach surveys cannot be directly tied to the increased enrollment and graduate numbers, we are hopeful that continued attention to youth outreach efforts and increasing the visibility of manufacturing careers, through such efforts as the popular Statewide Tour of Manufacturing, will continue to help build the pipeline of manufacturing workers.

Refined curricula

In addition to increasing the visibility of manufacturing careers and enhancing the pipeline of students to workers, 360 worked with industry leaders to refine manufacturing-related curricula. Two examples of this work are the creation of a guide for K-12 teachers and 26 Career Success Skills modules.

Teacher guide survey

In 2014, 360 sponsored the production and dissemination of a toolkit for teachers, called *Your Future is Made in Manufacturing*. This guide was created to help K-12 teachers introduce manufacturing careers to their students. To help understand how teachers used the toolkit and how the materials might be improved, Wilder sent a survey link to a list of 46 educators who had downloaded a toolkit online. In total, 22 individuals accessed the survey. However, only five respondents had used the toolkit with students, so survey data are not particularly helpful in illustrating the impact of the teacher guide.

Five educators had used the toolkit with students, reaching an estimated 118 students in 10th, 11th, and 12th grades. Those who had not used it said that they were planning to use it in the future, had passed it on to other staff, or had not yet had time for the packet. The toolkit seemed to have a positive impact on student and teacher perceptions of manufacturing. Four out of five educators said that "some" or "many" of their students expressed new interest in manufacturing careers after working with the toolkit. All five educators said they were more likely to recommend manufacturing careers to their students after using the toolkit.

The survey was administered again in 2015, but with a very low response rate. A survey was emailed to 147 addresses that had requested the guide, now called *An Introduction to Manufacturing in Minnesota Teacher Guide*. Only 18 recipients (12%) responded to the first question of the survey. Nearly three-quarters of respondents (73%) said they had either already used or planned to use the teacher guide with students or employees. At the time of the survey, approximately 100 students or employees had already been taught using the Teacher Guide. Those who had not yet used the guide expected to teach approximately 1,800 students or employees with the guide during the upcoming year.

Again, because of the low response rate and small number of teachers using the guide, it is difficult to comment on the exact impact of the materials developed.

Career Success Skills survey

In order to provide educators and industry with more resources to help students and employees develop their professional skills, 360 created 26 Career Success Skills learning modules. These modules were developed with industry and faculty feedback to improve the abilities of employees, and include topics such as: verbal communication, reliability, having a positive attitude, responsibility and accountability, problem solving, continuous learning, and critical thinking. Two types of groups can utilize the modules:

- Intermediaries – the teachers, faculty, industry professionals, and others who access the modules and then use them with students, employees, or others
- End Users – the students, employees, or others with whom the Intermediaries share the modules

Wilder sent a survey to each group to understand how both groups used the 360 Career Success Skills learning modules, how the modules can be improved, and the possible impact the modules are having on students and employees. It should be noted that the response rate for both surveys was quite low (see Appendix for detailed methodology).

Intermediaries

The majority of respondents (81%) felt that the 360 Career Success Skills learning modules were easy to access online, and the same percentage (81%) had already recommended the modules to their colleagues. Over half (57%) of respondents had used the modules with End Users, who were most often students (67%). Respondents were asked about the effectiveness of the modules in helping End Users improve their skills in specific areas. Respondents were most likely to say that the modules were at least somewhat effective in helping End Users with the following skills: problem solving (91% very or somewhat effective), verbal communication (91%), critical thinking (82%), having a positive attitude (82%), and responsibility (82%).

Several respondents had suggestions for how the modules could be improved, including ways to track if students have completed the quizzes or watched the videos; having a more polished presentation of the modules, with correct grammar, spelling, and uniformity; and more interactive elements, such as assessments and role playing.

End Users

Nine of the ten End Users who completed the survey were employed full time, while the remaining respondent was unemployed. All respondents felt that the Career Success Skills learning modules were effective. Respondents were asked about the effectiveness

of the modules in helping End Users improve their skills (the same set of skills listed in the Intermediary survey). End Users were most likely to say that the modules were at least somewhat effective in helping them improve their skills in the following areas (9 respondents each): continuous learning, critical thinking, verbal communication, and flexibility. When asked which skill they were most interested in improving, the majority said verbal communication (78%), followed by continuous learning (67%).

Conclusion

With respect to its primary goals, 360 has demonstrated substantial success, particularly with respect to the quantity and diversity of graduates and collaboration among partners.

Strengths

- **The quantity of workers has increased**. The number of graduates in 360-affiliated majors from 360's ten original partner institutions as increased 33 percent over the baseline average, compared to an increase of 20 percent from other schools.
- **The diversity of workers has increased**. The number of diverse graduates—diverse in terms of race, gender, age, and first generation student status—has grown more at 360's ten original partner institutions than at other Minnesota State programs.
- **Collaboration among 360 partners remains highly rated**. Only one of the six collaboration measures received an average rating lower than 4.00, which is the threshold for a "strength."
- **Manufacturing employers are familiar with 360**. In a survey of 52 regional manufacturing employers, nearly two-thirds (65%) were at least somewhat familiar with 360.
- **360 has improved perceptions of manufacturing in many of its youth and adult participants**. Perceptions of manufacturing increased in 64 percent of youth and 78 percent of adults surveyed after participating in one of 360's youth and community outreach programs (the Tour of Manufacturing, VEX, and summer camps).

For additional consideration

- Partners' average rating of 360's structural, organizational, and operational processes has declined slightly over time. Three out of eight measures had an average score in the "borderline" level across the four years of the survey: "360 has taken on the right amount of work," "360 has adequate funding to complete the work," and "360 is progressing at the right pace."
- The quality of workers has been difficult to measure. Employers struggle to differentiate workers, so it is difficult to determine 360's impact on graduate quality.
- Surveying students in 360 programs at partner institutions has been challenging, primarily due to a variety of logistical concerns.

- Surveys designed to assess 360's goal of refined curricula (the Teacher Guide and Career Success Skills surveys) had relatively low response rates, so it is difficult to assess the impact of curriculum. However, most of those who had used the tools felt that they were at least somewhat effective.

Appendix

Manufacturing and Applied Engineering
ATE REGIONAL CENTER OF EXCELLENCE

LOGIC MODEL

VISION:
A 21st Century education system that prepares individuals to participate fully in rewarding careers in manufacturing and which completely meets the needs of the region's manufacturing employers.

INPUTS

ISSUES

- Lack of coordination in systems
- Current curricula does not meet industry needs for career ready employees
- Lack of diverse student populations in manufacturing programs
- Not enough graduates to meet manufacturing industry needs
- Manufacturing industry suffers from a negative image which is impacting the number of individuals considering manufacturing careers

RESOURCES

ORGANIZATIONS
- University and college members
- College associates
- K-12 school system
- MnSCU System Office
- Manufacturing businesses
- Associations and foundations

PEOPLE
- Incumbent workers
- Potential students
- Public
- Youth
- Students

RESOURCES
- ATE
- College members
- Dream !t Do !t (DIDI)
- Associations and foundations
- MnSCU System Office
- University
- eTECH

ACTIVITIES

COLLABORATION

REPORTING / FEEDBACK

EVALUATION TEAM

DREAM !T DO !T STATEWIDE COMMITTEE

YOUTH OUTREACH TEAM

SEAMLESS CAREER PATHWAYS TEAM

COMMUNITY OF PRACTICE

LEADERSHIP COUNCIL [guidance]

EXEC TEAM

STRATEGY COUNCIL [implementation]

NATIONAL VISITING COMMITTEE

TECHNOLOGY TEAM

CURRICULUM TEAM

IMPLEMENTATION

EVALUATION/ASSESSMENT
Map industry certifications and identify gaps
Survey employers
Track students/graduates
Measure progress on goals
Balanced Scorecard/Baldrige
Identify successes and challenges

CHANGING PERCEPTIONS
Statewide Dream !t Do !t implementation
Regional Dream !t Do !t implementation
Tour of Manufacturing
Teacher Toolkit and Adopt-a-School

YOUTH OUTREACH
STEM camps and events
STEM competitions
Girl-targeted activities

PATHWAYS
High school articulation
Seamless pathways
Credit for prior learning
Articulation agreements for veterans

TOOLS

TECHNOLOGY
Web 2.0
Smart phone and tablet experiments
Simulation learning
Social media marketing
Web-based learning management

CURRICULUM
Stackable – Modular coursework
Customized lab structure
Workplace readiness/success skills
Next generation tech and business practices
Problem-based and inquiry learning

RESULTS

MEASURES

STUDENTS AND GRADUATES
# of graduates -- all manufacturing programs statewide
# of graduates -- 360° college members manufacturing programs
# of students in eTECH
# of graduates in eTECH
# of students -- Bemidji Training Institute
Demographics (age, gender, race/ethnicity, and if first generation)
Increased wages/salaries
Satisfaction measures

INCREASED VISIBILITY
ENHANCED PIPELINE
INDUSTRY-DRIVEN CURRICULUM

CHANGING PERCEPTIONS
# of participants in Tour of Manufacturing (TOM)
# of participants more positive towards mfg. careers
# of businesses hosting tours at the TOM
# of people joining talent communities
# of partnerships/people collaborating who haven't before
# of interactions between schools and businesses
# of schools engaged in the Dream !t Do !t (DIDI) program
joining social media/talent communities/participation
of referrals (web traffic) to DIDI from businesses/schools
# of blogs/guest posts
# of times logo is downloaded from DIDI site
# of times QR code is used
# of views for online video
# of website visitors going to college websites
# of toolkits provided to employers
# of employers who deliver toolkits to schools and "Adopt-a-School"
# of teachers who receive toolkits
# of teachers and employer reps trained
# of students exposed to toolkits
# of times app is downloaded

YOUTH OUTREACH
# of K-12 events and camps/# geared towards girls
# of attendees at events/# of girls participating
# of youth more positive towards STEM
# of youth more confident in STEM
# of youth more positive towards manufacturing careers
# of youth more aware of manufacturing careers
# of adults more positive towards manufacturing careers

IMPACT

VISIBILITY
Improved image of manufacturing **careers**
Improved image of manufacturing **sector**

CURRICULUM
Increased **quality** of students and graduates

100s MORE TECHNICIANS GAINFULLY EMPLOYED

PIPELINE
Increased **quantity** of students and graduates
Increased **diversity** of students and graduates

CURRICULUM
# of students taking modules/non-credit training
# of hours in non-credit training
# of students in Career Success Skills curriculum
# of colleges/programs using Career Success Skills
# of people attending forums
# of students in problem-based learning (PBL)
# of faculty receiving professional development in PBL
# of college programs implementing PBL
# of courses impacted by curriculum improvements
# of documents added to new management system
# of faculty using new management system

PATHWAYS
# of students articulating to BSU
# of high schools offering eTECH courses
# of credits received by high school students
# of high school students taking eTECH courses
# of workers receiving credit for prior learning
# of credits received by credit for prior learning
# of veterans using VETS system/awarded credit for service experience/placed in 360 program

Developed with the assistance of
Wilder Research
June 2013

Quality, quantity, and diversity

Figure A1 summarizes the quantity, quality, and diversity questions from the 2016 employer survey.

A1. Overall impact of 360, 2016 (N=50)

What impact do you think the 360 Manufacturing Center of Excellence has had on the following…	A big impact	Some impact	Little impact	No impact	Don't know
The **quantity** of graduates from 360-affiliated manufacturing and engineering programs	2%	42%	12%	6%	38%
The **quality** of graduates from 360-affiliated manufacturing and engineering programs	10%	44%	2%	4%	40%
The **diversity** of graduates from 360-affiliated manufacturing and engineering programs	2%	30%	14%	8%	46%

***Source**: 2016 Employer Survey*

Perceptions of manufacturing

Table A2 outlines the source data for the perceptions of manufacturing data, which includes measures related to awareness, perceptions, and interest in manufacturing careers. Surveys from 2012 were not included, as consistent questions to measure interest, confidence, and awareness had not yet been finalized.

A2. Youth and adult visibility measures, sources, and years

Measure	Measure specification	Camp surveys (youth only)	VEX (youth and adults)	TOM (youth and adults)
Youth measures				
Youth awareness of manufacturing careers	# of youth more aware of manufacturing careers	2013-2015	2013-2016	2013-2015
Youth perceptions of manufacturing careers	# of youth more positive towards manufacturing careers	2013-2015	2013-2016	2013-2015
Youth interest in manufacturing careers	# of youth more interested in manufacturing careers	2013-2015	2013-2016	2013-2015
Youth interest in STEM	# of youth more interested in STEM	2013-2015	2013-2016	2013-2015
Youth confidence in STEM	# of youth more confident in STEM	2013-2015	2013-2016	2013-2015
Adult measures				
Adult awareness of manufacturing careers	# of adults more aware of manufacturing careers	NA	NA	2013-2015
Adult perceptions of manufacturing careers	# of adults more positive towards manufacturing careers	NA	2013-2016	2013-2015
Adult interest in manufacturing careers	# of adults more interested in manufacturing careers	NA	NA	2013-2015
Adult interest in STEM	# of adults more interested in STEM	NA	NA	2013-2015

The questions and response options for each measure are outlined in Figure A3.

A3. Youth and adult visibility questions

Measure	Question text	Valid response options
Youth/adult awareness of manufacturing careers	Think about BEFORE [the event]/ NOW, after [the event]. How much were you/are you... Aware of careers in manufacturing?	A lot Some Very little Not at all
Youth/adult perceptions of manufacturing careers	How did you feel about manufacturing careers BEFORE the camp? How do you feel about manufacturing careers NOW?	I thought they were good I thought they were just ok I didn't think they were good I didn't think about them
Youth/adult interest in manufacturing careers	Think about BEFORE [the event]/ NOW, after [the event]. How much were you/are you... Interested in manufacturing careers?	A lot Some Very little Not at all
Youth/adult interest in STEM	Think about BEFORE [the event]/ NOW, after [the event]. How much were you/are you... Interested in science, technology, engineering, or math?	A lot Some Very little Not at all
Youth confidence in STEM (not measured for adults)	Think about BEFORE [the event]/ NOW, after [the event]. How much were you/are you... Confident in your ability to do science, technology, engineering, or math?	A lot Some Very little Not at all

The following tables outline the complete, year-by-year outcomes for each of these measures. The main body of the report examines the percent of respondents who increased their interest out of the total number of respondents who did not begin and end camp with the highest level of interest, which shows the extent to which 360 was able to impact those who were not already highly interested in manufacturing careers and STEM.

An alternate way to look at success for these surveys is to count those who maintained the highest response as an equally positive outcome as increasing interest in less-engaged respondents. This alternate measure does not just measure improvement, but also rewards 360 for attracting and maintaining highly-engaged participants.

With this approach, all responses can be grouped into positive and neutral/negative outcomes. In this section, individuals with positive outcomes either increased or maintained a high level of engagement, while those with neutral or negative outcomes remained at the same level of engagement (that was lower than the highest level) or demonstrated a decrease in engagement. From this perspective, across all 360 events:

- 68 percent of youth and 68 percent of adult respondents increased or maintained a high level of **awareness** of manufacturing careers
- 76 percent of youth and 91 percent of adult respondents improved their **perception** or maintained a high opinion of manufacturing careers
- 58 percent of youth and 55 percent of adult respondents increased or maintained a high level of **interest in manufacturing careers**
- 74 percent of youth and 63 percent of adult respondents increased or maintained a high level of **interest in science, technology, engineering, and math (STEM)**

Figures A4 through A12 show these breakdowns over time. "No change" refers to those who maintained a lower level of engagement before and after the event (e.g., some, very little, not at all).

Awareness of manufacturing careers

A4. Awareness of manufacturing careers among youth, 2013-2016

	2013 (N=230)	2014 (N=263)	2015 (N=291)	2016 (N=100)	All (N=884)
Increase in awareness	41%	37%	48%	34%	41%
Maintained high awareness	26%	24%	30%	31%	27%
No change in awareness	27%	35%	19%	32%	27%
Decrease in awareness	6%	4%	3%	3%	4%

A5. Awareness of manufacturing careers among adults, 2013-2015

	2013 (N=23)	2014 (N=262)	2015 (N=168)	All (N=453)
Increase in awareness	35%	32%	32%	32%
Maintained high awareness	52%	33%	37%	36%
No change in awareness	4%	31%	29%	29%
Decrease in awareness	9%	4%	2%	4%

Perceptions of manufacturing careers

A6. Perceptions of manufacturing careers among youth, 2013-2016

	2013 (N=195)	2014 (N=242)	2015 (N=262)	2016 (N=94)	All (N=793)
Improvement in perception	45%	40%	49%	39%	44%
Maintained positive perception	33%	35%	29%	26%	32%
No change in perception	21%	23%	21%	35%	23%
Worse perception	1%	2%	0%	0%	1%

A7. Perceptions of manufacturing careers among adults, 2013-2016

	2013 (N=21)	2014 (N=313)	2015 (N=247)	2016 (N=143)	All (N=724)
Improvement in perception	33%	32%	32%	41%	34%
Maintained positive perception	48%	58%	58%	52%	57%
No change in perception	14%	8%	11%	7%	9%
Worse perception	5%	1%	0%	0%	1%

Interest in manufacturing careers

A8. Interest in manufacturing careers among youth, 2013-2016

	2013 (N=232)	2014 (N=264)	2015 (N=292)	2016 (N=100)	All (N=888)
Increase in interest	38%	29%	43%	28%	36%
Maintained high interest	23%	20%	21%	28%	22%
No change in interest	32%	48%	33%	41%	38%
Decrease in interest	7%	3%	3%	3%	4%

A9. Interest in manufacturing careers among adults, 2013-2015

	2013 (N=23)	2014 (N=257)	2015 (N=164)	All (N=444)
Increase in interest	22%	25%	27%	26%
Maintained high interest	43%	25%	34%	29%
No change in interest	26%	46%	37%	41%
Decrease in interest	9%	4%	2%	4%

Interest in science, technology, engineering, and math (STEM)

A10. Interest in STEM among youth, 2013-2016

	2013 (N=238)	2014 (N=268)	2015 (N=294)	2016 (N=105)	All (N=905)
Increase in interest	32%	23%	24%	25%	26%
Maintained high interest	43%	42%	52%	62%	48%
No change in interest	21%	31%	19%	13%	22%
Decrease in interest	4%	4%	4%	0%	4%

A11. Interest in STEM among adults, 2013-2015

	2013 (N=23)	2014 (N=279)	2015 (N=171)	All (N=470)
Increase in interest	9%	18%	15%	17%
Maintained high interest	52%	40%	55%	46%
No change in interest	26%	37%	27%	33%
Decrease in interest	13%	4%	2%	4%

Confidence in science, technology, engineering, and math (STEM)

This question is only included on youth surveys, so no adult data are available.

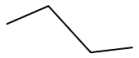
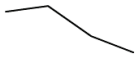
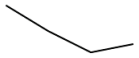
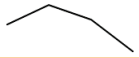
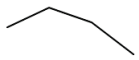
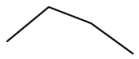
A12. Confidence in STEM among youth, 2013-2016

	2013 (N=235)	2014 (N=187)	2015 (N=258)	2016 (N=103)	All (N=783)
Increase in confidence	34%	33%	36%	26%	33%
Maintained high confidence	39%	38%	41%	54%	41%
No change in confidence	23%	25%	21%	17%	22%
Decrease in confidence	4%	4%	3%	3%	3%

Perceptions of stakeholders about 360

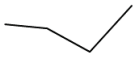
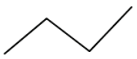
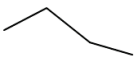
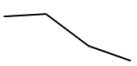
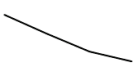
This section includes more detailed descriptions of the measures included in the "operations" and "collaboration" measures tracked by 360.

A12. Operations questions, Years 1-4

	2013 (N=25)	2014 (N=28-29)	2015 (N=20)	2016 (N=10)	Graph
Has adequate funding to complete the work.	4.00	4.00	3.75	3.70	
Has the right partners involved in the work.	4.24	4.41	3.95	4.00	
Has taken on the right amount of work.	4.00	4.07	3.70	3.50	
Has the right governance structures to succeed.	4.32	4.17	4.05	4.10	
Has the right leadership to succeed.	4.60	4.68	4.55	3.60	
Is progressing at the right pace.	3.92	4.14	4.10	3.80	
Is implementing the right strategies to ensure success.	4.04	4.28	4.10	3.70	
Is doing work that would not otherwise be happening.	4.32	4.66	4.50	4.20	

Note. Mean scores based on responses to individual items; items were assigned the following values: "strongly agree"=5, "agree"=4, "neither agree nor disagree/neutral/no opinion"=3, "disagree"=2, "strongly disagree"=1.

A13. Collaboration questions, Years 1-4

	2013 (N=25)	2014 (N=28-29)	2015 (N=20)	2016 (N=10)	Graph
The level of commitment among 360 partners is high.	4.28	4.21	4.05	4.30	
360 partners have a clear sense of their roles and responsibilities.	3.84	3.83	3.75	3.90	
I have a clear sense of what 360 is trying to accomplish.	4.08	4.32	4.10	4.40	
I am confident 360 will achieve its goals and purpose.	4.20	4.38	4.10	4.00	
Discussions among 360 partners encourage sharing of diverse points of view.	4.40	4.41	4.20	4.10	
Information is effectively shared with those who need it.	4.24	4.14	4.05	4.00	

Note. Mean scores based on responses to individual items; items were assigned the following values: "strongly agree"=5, "agree"=4, "neither agree nor disagree/neutral/no opinion"=3, "disagree"=2, "strongly disagree"=1.

Evaluation activities and methodology

Over the course of the four-year grant period, the following evaluation activities (and corresponding methodologies) were completed:

- **Program logic model:** Together with 360 staff, Wilder Research developed a logic model to capture the resources, activities, and projected outputs and outcomes of 360's grant activities.

- **Partner feedback:** Wilder Research has conducted four partner surveys with 360 partners. In the first year of the grant (February 2013) Wilder administered a web survey to 40 program partners identified by 360 staff; 30 people completed the survey, for a response rate of 75%. The first survey focused on partners' expectations and understanding of the goals for the grant. In 2014, Wilder changed the methodology to get more in-depth feedback from partners, conducting 30 telephone interviews. The second survey asked partners to discuss whether their expectations had been met so far, the value the Center had created, their perspectives on the structure and partnerships of the Center, and any successes and challenges they have viewed to date. For the 2015 and 2016 surveys, Wilder returned to the web survey method. The 2015 survey was shared with 40 partners; 21 completed the survey, for a response rate of 53 percent. The 2016 survey was shared with 39 partners; 10 completed the survey, for a response rate of 26 percent. While the questions related to collaboration and operations remained mostly the same across all surveys, much of the final survey focused on perspectives related to the work over the entire four years of the grant.

- **Summer camp participant surveys:** One important aspect of the 360 mission is to expose K-12 students to, and increase enthusiasm for, science, technology, engineering, and math (STEM) and manufacturing careers. Therefore, each year, 360 and its partners hold summer camps for youth. In order to evaluate the success of these camps in meeting their goals, 360 staff have distributed self-administrated questionnaires, designed by Wilder, to youth participants at the end of each camp. The completed surveys are then sent back to Wilder for analysis and reporting. The table below illustrates the number of respondents (and distinct camps that respondents attended) by year.

A17. Youth survey respondents and camps

	Number of youth survey respondents	Number of distinct camps respondents attended
Year 1 (2012)	59	3
Year 2 (2013)	244	11
Year 3 (2014)	184	9
Year 4 (2015)	197	11

- **VEX Robotics youth and adult surveys:** Like the summer camps, the VEX Robotics program is intended to build awareness and interest in STEM and manufacturing careers, as well as grow the pipeline of manufacturing students and workers in Minnesota. Teams of youth work together to build robots from kits and then compete with other teams at scrimmages and tournaments. Across most years of the grant, Wilder administered a web survey to youth participants of the VEX Robotics program, as well as the adults who were involved (i.e., parents, teachers, and coaches). The purpose of the survey was to gauge the success of the VEX Robotics program as well as the satisfaction of participating youth and adults. To reach youth, evaluators sent the youth survey link to the e-mail addresses of parents. Parents were asked to forward the link to their children, and both groups were instructed to forward the survey to other adults or youth who may have been involved. In years three and four of the grant, Wilder and 360 develop a consent form that adults could distribute prior to each tournament. Parents could either write their own email address or provide the email address of their child. 360 staff collected all completed consent forms and sent them to Wilder. Parents and coaches were also sent the youth survey link (when they received their own survey) to share with their students or children. This methodology, of using consent forms and sending the youth survey link to adults, is likely responsible for the increased number of respondents in the later years of the grant.

A18. VEX survey respondents, youth and adults

	Number of youth survey respondents	Number of adult survey respondents
Year 1 (2012)	n/a	n/a
Year 2 (April 2013)	33	32
Year 2 (February 2014)	23	55
Year 3 (February 2015)	74	76
Year 4 (February 2016)	112	161

- **Youth outreach event tracking:** In addition to the surveys administered to event participants, in year two, Wilder created and sent a "youth outreach event tracking form" via Survey Monkey to each school that hosted an event to track logistical information, such as how many youth participated, the age, gender, and race/ethnicity of participants, and other important information used in reporting to funders. While this was not in the original work plan, it has been useful to 360 over the past three years in tracking specific information about their youth outreach efforts.

- **Tour of Manufacturing participant and host surveys:** Every fall, 360 and its partners coordinate manufacturing businesses across Minnesota to provide tours of their facilities for students, educators, job seekers, other manufacturers, and the general public. This event is called the Dream It. Do It. Minnesota Statewide Tour of Manufacturing. For the past four years, to help understand the impact of the tours, Wilder has administered a survey to both Tour participants and the businesses that hosted the tours. In the first two years of the grant, Wilder administered both surveys via SurveyMonkey, and Tour participants were directed to the online survey through a flyer distributed at each site. However, to address the large decrease in responses during year two, Wilder changed the methodology so that staff from each host business distributed hard copies of the survey (as a self-administered questionnaire) to participants. Hosts then returned completed surveys to Wilder Research in a pre-addressed envelope.

A19. Tour of Manufacturing survey respondents, participants and hosts

	Number of participant respondents	Number of host respondents
Year 1 (2012)	117	21
Year 2 (2013)	28	35
Year 3 (2014)	391	34
Year 4 (2015)	239	58

- **Tour of Manufacturing coordination survey:** In years two through four of the grant, in addition to the host and participant surveys, Wilder also conducted a brief survey with local Tour of Manufacturing coordinators to help gauge the amount of resources that organizations contributed to their local Tour of Manufacturing effort. This was a web-based survey sent only to six to eight people, depending on the year.

- **Longitudinal "perceptions" questions:** In year two of the grant, to consistently track perceptions of manufacturing and STEM over time, the evaluation team developed a series of questions to be used across all event surveys, such as the Tour of Manufacturing, summer camp, and VEX Robotics surveys. The questions were first used in the 2013 summer camp survey.

- **Analysis of administrative data from Integrated Statewide Record System (ISRS):** Over the course of the four-year grant period, Wilder worked with 360 and Minnesota State, formerly MnSCU, to pull administrative data for the students and graduates of 360-related programs.

- **Analysis of wage data from the Minnesota Department of Employment and Economic Development (DEED):** During year three, Wilder received data on 360 program graduate employment rates and wage information for the baseline years (2010-12) and first year of implementation (2013). These data will continue to be collected during the new grant period.

- **Balanced Scorecard.** In the third year of the grant, Wilder worked with 360 to design a Balanced Scorecard dashboard to align the program's activities to its vision and strategy and to monitor performance. Staff selected the most important measures from an extensive list compiled over the first two years of the evaluation that fit in four distinct organizational perspectives – customer, financial, internal processes, and learning and growth.

- **Teacher guide survey:** In 2014, 360 sponsored the production and dissemination of a toolkit for teachers, called *Your Future is Made in Manufacturing*. To help understand how teachers used the toolkit and how the materials might be improved, Wilder sent a survey link to a list of 46 educators who had downloaded a toolkit online. In total, 22 individuals accessed the survey. The survey was administered again in 2015, but with a very low response rate. A survey was emailed to 147 addresses that had requested the guide, now called *An Introduction to Manufacturing in Minnesota Teacher Guide*. Only 18 recipients (12%) responded to the first question of the survey.

- **Employer survey:** In the spring of 2016, just as the grant was ending, Wilder and 360 sent a web-based survey to employers to hear about their experiences hiring graduates from manufacturing and engineering programs, and specifically about the qualities that are important to them in hiring recent graduates, and the preparedness of recent graduates who enter the workforce. A survey link was sent to 139 employers and 59 responded, for a response rate of 42 percent.

- **Career Success Skills survey:** 360 created 26 Career Success Skills learning modules to provide educators and industry with more resources to help students and employees develop their professional skills. To understand how people used the learning modules, Wilder sent a survey to Intermediaries – the faculty and professionals who access the learning modules to use with students and employees – and End Users – the students, employees, or others with whom the Intermediaries share the modules. A web survey was emailed to 75 End Users and 197 Intermediaries; 10 End Users and 21 Intermediaries responded.

Graduation and majors data

Wilder Research receives graduate data from Minnesota State's ISRS data system. This analysis compares outcomes for 360's ten original partner institutions—referred to in this report as "360 Core" schools—to graduates in the same 360-affiliated programs (roughly, manufacturing-related programs) at other Minnesota State schools. Those ten original partner schools are identified in Figure A6. Of the original ten partner institutions, 360 reports the number of majors for nine, all but Bemidji State.

Gradually, 360 welcomed five new partners to the collaboration: Anoka-Ramsey Community College, Century College, Hennepin Technical College, Ridgewater College, and South Central College. For the purpose of this report, these new partners are grouped with "other Minnesota State schools," as 360 has had less time to impact these partners.

A20. College partners included in administrative data

	"360 Core" schools	Majors data
Anoka-Ramsey Community College	No	No
Bemidji State University	Yes	No
Central Lakes College	Yes	Yes
Century College	No	No
Hennepin Technical College	No	No
Lake Superior College	Yes	Yes
Minneapolis Community and Technical College	Yes	Yes
Northland Community and Technical College	Yes	Yes
Northwest Technical College (Bemidji)	Yes	Yes
Pine Technical College	Yes	Yes
Ridgewater College	No	No
Riverland Community College	Yes	Yes
Saint Cloud Technical and Community College	Yes	Yes
Saint Paul College	Yes	Yes
South Central College	No	No