

## **AC 2008-1465: ADDING LEAN AND SIX SIGMA TO INDUSTRIAL ENGINEERING TECHNOLOGY PROGRAMS: DOES THIS CONSTITUTE A CHANGE IN CURRICULUM?**

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## **Adding Lean and Six Sigma to Industrial Engineering Technology programs: Does this constitute a change in curriculum?**

### **Abstract**

This paper will focus on changes that have been made to Industrial Engineering Technology (IET) and Industrial Technology (IT) programs to incorporate popularized 'Lean Six Sigma' terms into existing curriculum without making any drastic impacts to the topics taught within the programs. Included will be a discussion of how IET and IT faculty at Purdue University and its regional campuses have capitalized on Lean Six Sigma training for non-manufacturing industries to broaden their curriculum. By having faculty utilize their expertise in the non-manufacturing arena, they are able to translate experiences back into classroom discussions as well as document the experiences in other teaching materials. Additionally, new courses have been developed and alternate educational opportunities such as certificates at both undergraduate and graduate levels have been developed to meet this expanding need for IET and IT principles in non-manufacturing industries under the guise of 'Lean Six Sigma.' Emerging opportunities such as these at various academic institutions will be discussed.

### **Introduction**

The profession of Industrial Engineering has been evolving since its conception in the 1880's when Frederick Taylor and Frank and Lillian Gilbreth first began to develop the rules and techniques of methods improvement<sup>1</sup>. Since then the term Industrial Engineer has been associated with a variety of organizational functions and methodologies that stem from this one central concept of helping enterprises to drive down costs and improve organizational efficiency. Topics associated with this over the years have included quality, engineering economics, human factors, facility layout, scheduling, logistics, design and manufacturing of products, simulation, and most recently, Lean and Six Sigma methodologies. When we discuss the topics of Lean and Six Sigma we find that all of the core concepts are already being taught within most IET and IT programs as many educators will eagerly argue. This results in little curriculum changes required to incorporate these 'new' Industrial Engineering topics.

Possibly a more important change to IET and IT curriculum that can capitalize on the natural incorporation of Lean and Six Sigma is addressing the issue that the practice of industrial engineering (which shares many of the same core concepts as IET and IT programs) has broadened beyond the traditional manufacturing setting to areas such as transportation, banking, retailing, lodging, healthcare, telecommunications, government, service and other non-manufacturing organizations. To potential students the name "industrial" can be a deterrent to pursuing this course of study and potential employers in service industries may be unaware of the usefulness of IET and IT graduates within their organizations. To this point, the Institute of Industrial Engineers (IIE) reported findings from a study presented in the Engineering Workforce Commission newsletter that showed Industrial engineers would enjoy a 12.8 percent overall increase in jobs in 2008 compared to 1998 but this increase shows only modest increases in IE jobs among manufacturers (6.5 percent), while it projected a whopping 34.4 percent job growth in

non-manufacturing segments other than government<sup>2</sup>. IET and IT graduates can therefore benefit from the Lean Six Sigma terminology change that is now prevalent across all industries. Healthcare providers, financial institutions and others know of Lean Six Sigma methods and can relate the benefits of using these methods within their particular organizations whereas they are often less apt to identify how an ‘industrial engineer’ may help them.

### **Lean Six Sigma – A Historical Perspective**

The term Lean was introduced by Krafcik and the famous book, *The Machine That Changed the World*<sup>3,4</sup>. These publications present the results of a major MIT study to identify systematically best practices of Japanese and other automobile manufacturers worldwide. The techniques highlighted in these publications are techniques that have been taught (using some alternative terminology) in traditional IET and IT courses such as Facility Layout and Methods Improvement as well as many others. The focus of Lean is waste reduction for process improvement.

Six Sigma was first started at Motorola, Inc. and was then developed into what we know today at General Electric. The main thrust of Six Sigma requires an organization to follow a prescribed process to reduce variation in order to improve customer satisfaction. It is a structured process that is designed to deliver almost perfect products or services on a consistent basis and improving bottom line performance by finding and eliminating the causes of defects in business processes. A wide range of companies have been successful in implementing the Six Sigma philosophy and various definitions have been proposed, but all contain the same central themes which, like Lean concepts, are found throughout most IET and IT Curriculum. Some of these themes include use of teams, training in “statistical thinking,” emphasis on a systematic problem solving method, and a management philosophy that focuses on supporting these initiatives as a business strategy.<sup>5</sup> So the focus of Six Sigma can be summarized as a management philosophy whereby statistical methods are used to systematically reduce variation in processes.

Both Lean and Six Sigma emerged as business improvement philosophies in the late 1980’s early 1990’s and at that time many practitioners were set on differentiating one methodology from the other. Today, most practitioners will agree that the two methodologies compliment one another and when the statistical approach is used in conjunction with waste elimination techniques, the improvement philosophy is more versatile and complete. Hence, today many publications refer to the philosophy as ‘Lean Six Sigma.’

### **Lean and Six Sigma get noticed in the Educational arena**

The question that therefore should be posed is: “Are universities changing their curriculum to include Lean and Six Sigma as a result of the latest workforce trends?” A decade ago, Lean and Six Sigma were just beginning to be recognized as potentially important terms in higher education in engineering and engineering technology programs. One reference that highlights this point well is the number of papers presented annually at the National American Society for Engineering Education (ASEE) conferences that mention the terms Lean or Six Sigma (See Table 1). In 1998 only eleven (11) academics

found the term Lean important enough to mention in their academic research papers and zero (0) mentioned Six Sigma. In 1999 nine (9) mentioned Lean and one (1) Six Sigma. The number of papers mentioning these terms were slow to increase for the next five years with a dramatic jump in interest showing in 2004 with thirty-seven (37) papers mentioning Lean and twenty-one (21) mentioning Six Sigma and by 2007 the topic had shown to be one of great interest with Lean showing up in sixty-three (63) papers and Six Sigma in thirty-two (32). With this type of interest, it would be expected that some changes may be seen in IET and IT curriculum themselves to highlight these ‘new found’ topics, however contrary to the surge in using these terms, research shows that relatively few programs have incorporated these terms into their curriculum.

| Number of ASEE national conference papers mentioning the terms Lean or Six Sigma |      |      |      |      |      |      |      |      |      |      |
|--|------|------|------|------|------|------|------|------|------|------|
|  | 2007 | 2006 | 2005 | 2004 | 2003 | 2002 | 2001 | 2000 | 1999 | 1998 |
| Lean   | 63   | 64   | 36   | 37   | 20   | 24   | 10   | 11   | 9    | 11   |
| Six Sigma  | 32   | 28   | 11   | 21   | 8    | 8    | 3    | 2    | 1    | 0    |
| Lean or Six Sigma  | 79   | 74   | 41   | 47   | 26   | 30   | 12   | 12   | 10   | 11   |

**Table 1**

### **Changes to IET and IT curriculum incorporating Lean Six Sigma**

Before highlighting the results found from an evaluation the authors conducted of curriculum that incorporate Lean and Six Sigma, it should be noted that several ASEE national conference papers do highlight that certification courses for Lean and Six Sigma have been integrated into engineering technology programs as part of their curriculum such as two papers presented at the 2004 national conference<sup>6,7</sup>. However, the focus of this paper has been limited to ABET and NAIT accredited IET and IT programs. So whereas the actual number of programs incorporating these topics and actually changing their curriculum to meet constituent needs extends well beyond accredited programs, this paper excludes these programs in its findings. A comparison of the changes in accredited versus non-accredited programs and its drivers is topic for another paper.

Changes to highlight Lean and Six Sigma may occur at various levels in the curriculum. The first level of changes may occur at the program name level. Whereas it was not expected that program names would be changed to incorporate the terms Lean or Six Sigma, it was expected that other changes may have occurred to highlight the profession shift to include the “non-industrial” sector. This shift has been happening in the ABET accredited Industrial Engineering programs and can be seen by viewing the list of programs on the ABET website at <http://www.abet.org>. As of December 2007, 14% of the ABET accredited IE programs are now named ‘Industrial and Systems Engineering.’ V. E. Unger, professor and head of the department at Auburn University states, "We believe the new name will better convey to prospective students and employers the changing nature of industrial engineering and the role of industrial engineers in many organizations. Although the name change will not result in any new degree programs, it should help us attract more students into the program and expand employment opportunities for our graduates.”<sup>8</sup>

Of the 13 ABET accredited IET programs (see Appendix A) it was found that only one program did facilitate a recent name change, but rather than follow the IE programs' lead, they took their own path and renamed their program 'Operations Technology.' This program then highlighted Lean and Six Sigma with changes to course names as well. This institution and three others were the only IET undergraduate curriculums (31%) to change course names to highlight these topics. Of the remaining nine accredited programs one offers a quality certificate that mentions Lean and Six Sigma in the description and two institutions offer continuing education opportunities outside of the IET curriculum. Overall, 54% of the accredited IET programs' institution web sites at least mention the terms Lean or Six Sigma.

Of the 72 NAIT accredited IT programs (see Appendix B), 15% offer courses that have been renamed to include Lean or Six Sigma with 47% of the accredited IT programs' institution web sites at least mentioning the terms Lean or Six Sigma.

### **Purdue University faculty bring LSS into the Classroom**

The strong points of IET and IT faculty are in their application of these principles and their often required industry experience prior to working in academia. Unfortunately, since a majority of IET and IT educators began their careers more than 10-20 years ago, this has resulted in many of them having their experience grounded in the manufacturing industries. IET and IT curriculum, including texts and educational materials as well as plans of study, must change to incorporate non-manufacturing focuses so that the students and employers of non-manufacturing industries can benefit.

In order to accomplish this, faculty must engage in the community and the new 'non-industrial' markets to gain experience. This is what Purdue University faculty did in order to begin the transformation of their curriculum. Much of this transformation started with the development of a curriculum for healthcare Lean Six Sigma training, and the use of this curriculum through a \$1.2M training grant with a local health care system. Faculty were able to begin bringing the real life project experience into the class room expanding their IET and IT student experiences beyond the world of manufacturing. The training opportunities have continued into transactional service organizations as well with the anticipation of continuing so as to round out faculty experience with Lean Six Sigma application in manufacturing, service and healthcare organizations. To date, the programs in which faculty teach have made significant changes to continue to attract the 'non-industrial' sector. The changes noted here focus on three particular Purdue campuses; Purdue University Calumet (PUC), Indiana University Purdue University Indianapolis (IUPUI) and Purdue University West Lafayette (WL).

At Purdue University Calumet (PUC), a traditional 2 plus 2 IET program offering both an A.S. degree and a B.S. degree has existed since the early 1970's. Changes to incorporate concepts such as Lean and Six Sigma into the curriculum were initiated starting in 2004 with all changes being reviewed and approved by the program's industrial advisory board prior to official action being taken. Changes to the curriculum have been as basic as changes to the course names to highlight Lean and Six Sigma terminology, to changes more in-depth such as creating a new course to focus specifically on Lean and Six Sigma

methodology as well as bundling together a package of courses to create a Certificate in Lean Six Sigma. In addition to the undergraduate IET program curriculum, courses toward a M.S. in Technology with a specialization in Industrial Technology began to be offered at PUC starting in 2006 opening yet another opportunity to develop graduate level courses with Lean Six Sigma focus. The following specific changes have been made at PUC as of January 2008:

1. Course name change
  - IET 264 Fundamentals of Work Design was changed to Fundamentals of Lean Work Design. The same content is taught, the text has one chapter entirely focused on Lean. This change simply highlights the topic of Lean.
2. Undergraduate and graduate course development
  - IET 411 Applications of Lean Six Sigma was created utilizing the basic research and examples developed for the training curriculum that faculty used in their healthcare training experiences.
  - TECH 581 Advanced Quality Techniques was taught as an experimental graduate level course during the Fall 2007 semester. This course focused students as a capstone course for other quality education they had received. One of the course requirements was to take the American Society for Quality (ASQ) Certified Six Sigma Green Belt (CSSGB) exam. The body of knowledge for this exam was reviewed throughout the semester and the student pass rate on this professional nationally recognized exam was 80%.
  - 'Healthcare Quality Applications' is currently under development as an interdisciplinary course focusing on Lean Six Sigma techniques used in the healthcare industry to improve patient safety and quality. The course development is a joint effort between the PUC nursing faculty and IET faculty through an internal curriculum innovation development grant. The course will be used for both M.S. in Technology curriculum and for M.S. Clinical Nurse Specialist curriculum.
3. Undergraduate certificate creation
  - An Undergraduate Certificate in Lean Six Sigma was created utilizing 5 courses of which 4 are IET courses; Statistics, Project Management, SPC, TQM, Lean Work Methods, Applications of Lean Six Sigma.
4. PUC has become an ASQ certification testing site
  - The University has worked to partner with the local chapter of the American Society for Quality (ASQ) to become an official testing site for all certification exams including Certified Six Sigma Green Belt (CSSGB) and Black Belt (CSSBB). This has further helped to market the IET program at PUC.

At Purdue University's main campus in West Lafayette, an Industrial Technology B.S. program is offered as well as an M.S. This program has also incorporated many changes that highlight Lean and Six Sigma including changing of course names and creating new undergraduate courses with a focus on Lean and Six Sigma as well as offering graduate level courses on a trial basis. The following specific changes have been made at Purdue University West Lafayette as of January 2008:

1. Course name and description changes
  - IT 342 Introduction to Statistical Quality. The term "control" was dropped from the course title following the philosophy of the American Society for Quality when the organization dropped "control" from its own title to adopt a broader spectrum of quality management and improvement. The course has added discussion of Six Sigma methodology and concepts as well.
  - IT 483 Facilities Design for Lean Manufacturing. This course title was changed to incorporate the term 'Lean' to reflect the importance of this systematic approach to facility design and its effect on reducing or eliminating waste such as excessive inventory, material handling, backtracking, over and underproduction, and ineffective use of resources. The course contents emphasize a systematic approach to designing a facility which integrates principles of a lean production system.
2. Course replacement in IT curriculum
  - IT 214 Introduction to Lean Manufacturing. This course replaced IT 114 Problem-solving in manufacturing in order to introduce students to the concepts of waste identification and elimination in manufacturing and industrial processes. The course emphasizes a systematic approach to eliminating non-value added activities throughout a production system. The students develop an appreciation for how lean manufacturing leads to superior product quality, shorter delivery time, and lower production costs.
3. Undergraduate and graduate course development
  - IT 446 Six Sigma Quality. This course is a study of the six sigma quality and process improvement methodology using the define, measure, analyze, improve, and control (DMAIC) process. The course addresses advanced topics in statistical quality as they pertain to the six sigma methodology and provides preparation for the Green Belt Certification exam.
  - IT 581 Introduction to Six Sigma and Lean Manufacturing has been taught as an experimental graduate level course.

At Indiana University Purdue University Indianapolis (IUPUI), while no specific IET degree program exists, a full array of IET courses as well as certificates with IET focus are offered through the Mechanical Engineering Technology undergraduate degree programs. In addition to the undergraduate degree programs, MET faculty at IUPUI also focus their efforts on teaching the M.S. in Technology graduate curriculum. Curriculum



at both the undergraduate and graduate levels have been directly affected by the faculty working in non-manufacturing industries that specifically request the topics of Lean and Six Sigma. The following specific changes have been made at IUPUI as of January 2008:

1. Course description changes have been made
  - IET 474 Quality Improvement of Products and Processes course description has been amended to include Six Sigma in the narrative. The focus of the course is on experimental techniques used to improve products and processes such as Design of Experiments and ANOVA. The course also explains how these experimental techniques are embedded within quality improvement tools/methodologies such as QFD, FEMQ, and LSS.
2. Undergraduate and graduate certificates in quality have been created
  - Undergraduate Quality Control Certificate – 6 courses – Marketed to address the increasing demand for training relevant to LSS – the content in the courses also covers the American Society for Quality (ASQ) LSS Certified Six Sigma Green Belt (CSSGB) body of knowledge and students are encouraged to sit for the exam at the completion of the certificate program.
  - Graduate Certificate for Quality in Healthcare and Technology – 4 courses – Measurement and Evaluation, Quality and Productivity in Industry and Technology, Health Information Technology, and Directed Project.
3. Special courses and curriculum geared toward application of quality improvement initiatives (especially LSS) for healthcare have been created.
  - As catalyst for the above mentioned graduate certificate, one local Indianapolis hospital proposed the creation of special courses and curriculum to fill needed gaps in the skill set of key hospital employees in the areas of qualitative/quantitative design, measurement and analysis, Lean Six Sigma, health information technology, and a directed project culminating their academic experience. While any IUPUI student can take courses in the graduate certificate, separate sections of the courses are being modified for delivery on site at the hospital while enabling students to focus on applications specific to relevant healthcare interests.
4. Graduate courses have been created.
  - Diffusion of quality and reliability science that has been apparent in manufacturing industries has slowly been making its way into external areas. Through team teaching efforts and contacts created through the healthcare research partnerships, a new graduate course was developed focused on Patient Safety and Outcomes. The course combines graduate students from Public Health, Health Administration, and

Clinical Nurse Specialist programs at IUPUI and is taught by a team consisting of a doctoral nursing researcher and faculty, the Director of the Indiana Patient Safety Coalition who is also a healthcare professional, and an engineering technology faculty with healthcare experience. From the engineering technology perspective, the course presents healthcare professionals with a set of tools they can use to improve the safety of patients by improving the processes and systems in which patient care is given. Translated for healthcare, these are many of the same tools that traditional manufacturing students are taught.

5. Continuing Education Opportunities arose.
  - Partnership in the creation of training materials for application in hospitals throughout the state of Indiana within the Healthcare Technical Assistance Program at Purdue West Lafayette. As news of the statewide LSS in Healthcare program spread and successes of the applications became published, the creator of the program was solicited by Purdue West Lafayette to assist them with the development of their own program and training materials
6. Interdisciplinary opportunities arose for MET faculty to work with other University programs.
  - Other areas (especially healthcare) are taking note. The 2001 IOM report: *Crossing the Quality Chasm: A New Health System for the 21<sup>st</sup> Century*<sup>1</sup> has brought significant attention to the potential benefits of incorporating quality methodologies and tools from industries outside of healthcare. As a result of this, additional opportunities for interdisciplinary collaboration have emerged with the schools of nursing and medicine. One recent opportunity that arose was a collaborative effort focused on the reduction of nosocomial MRSA infections within Indianapolis hospitals. A portion of this grant combined health services researchers, engineering technology faculty, and hospital healthcare professionals to examine the systems and processes surrounding the primary MRSA reduction protocol bundle. Engineering technology faculty provided Lean training to each participating unit/facility (11) and assisted with improvement strategies and implementation at each location. All major Indianapolis hospital systems are participating in the 18 month study – an accomplishment in itself.

## **Conclusion**

In addition to changes noted above, the non-manufacturing experiences that faculty at Purdue University have engaged in have highlighted that the traditional curriculum for IET and IT students includes many required courses that may or may not be relevant in non-manufacturing industries. With ABET requirements now focused on student outcomes and NAIT requirements heading in the same direction, the purpose of requiring

all IET or IT students to take a course such as manufacturing processes becomes questionable. Ideas such as this will need further evaluation before any changes are made, but are next on the list of curriculum changes to be analyzed for Purdue University and its regional campuses.

Whereas PUC, IUPUI and Purdue University West Lafayette have made significant changes to their programs to accommodate the non-manufacturing sector by adding topics such as Lean and Six Sigma, the faculty does not lose sight of the fact that the curriculums they are altering are IET and IT curriculums. And as stated in an Industrial Engineer magazine "Member Forum" Adedeji Badiru, cautioned:

*"The core of our profession should always be industrial engineering – not supply chain, not expert systems, not lean initiatives, not TQM, and not any other exploratory offshoot. Buzzwords come and go. If we remain consistent with our name and core mission, the profession will survive with a clear and recognizable identity. But if we dabble in fad based names that have no historical roots, we will be swept around as the sentiments change."* <sup>10</sup>

This statement has much merit, but as the industrial engineering profession branches out to "non-industrial" environments, educators can not ignore that constituents with their limited understanding of the profession require that alternative terminology be presented for this expanding market. Adding courses and changing names of courses without affecting the content of our curriculum does add value to IET and IT programs and expands the current limited base of prospective students that do not identify with the "industrial engineer".

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**Appendix A**  
**ABET accredited IET programs institutional web site search results**

| University Name  | Program Name  | Lean or Six Sigma results from institutional web site search - no mention, courses exist, outreach, cetificates, other | Courses with LSS in the Name   |
|--|---|--|--|
| University of Dayton   | Industrial Engineering Technology (BS)  | courses in IET and ISE, CE courses   | IET 400 Six Sigma, ISE 499 SP: Lean Vis Wkplace  |
| Gaston College   | Industrial Engineering Technology (AAS)                                       | corporate training   |  |
| Indiana University-Purdue University Fort Wayne                    | Industrial Engineering Technology (AS and BS)                                 | outreach courses only  |  |
| State University of New York Institute of Technology at Utica/Rome | Industrial Engineering Technology (BS/BT)                                     | No mention   |  |
| Northwestern State University of Louisiana                         | Industrial Engineering Technology (BS)  | No mention   |  |
| Pellissippi State Technical Community College                      | Mechanical Engineering Technology - Quality Control Option (AAS)              | No mention   |  |
| Purdue University Calumet  | Industrial Engineering Technology (AS and BS)                                 | courses in IET, certificate program, corporate training  | IET 264 - Fundamentals of Lean Work Design, IET 411 - Applications of Lean Six Sigma Methodologies |
| Purdue University North Central                                    | Industrial Engineering Technology (AS)  | certificate  |  |
| Sinclair Community College   | Industrial Engineering Technology (AAS) - new name is 'Operations Technology' | courses in IET/OPT, industry training programs   | OPT 130 Lean Manufacturing, OPT 240 Six Sigma  |
| South Carolina State University                                    | Industrial Engineering Technology (BS)  | No mention   |  |
| University of Southern Mississippi                                 | Industrial Engineering Technology (BS)  | No mention   |  |
| Southern Polytechnic State University                              | Industrial Engineering Technology (BS)  | courses in IET, certificates, continuing ed  | IET 3407 - Six Sigma concepts  |
| Southwest Tennessee Community College                              | Industrial Engineering Technology (AS)  | No mention   |  |

**Appendix B**  
**NAIT Accredited IT program institutional web site search results**

| University Name                          | Program Name                           | Lean or Six Sigma results from institutional web site search - no mention, courses exist, outreach, certificates, other | Courses with LSS in the Name                                   |
|--|--|---|--|
| Alcorn state university                  | B.S in Industrial Tehnology            | No mention  |  |
| Arizona State universirt east            | B.S in Industrial Tehnology Management | No mention  |  |
| Bemidji State univesrity                 | B.S, M.S in Industrial technology      | No mention  |  |
| Buffalo state university                 | B.S,M.S in Industrial technology       | No mention  |  |
| California polytechnic state university  | B.S,M.S in Industrial technology       | No mention  |  |
| California state university CHICO        | B.S in manufacturing technology        | Continuing Education  |  |
| California University of Pennsylvania    | A.S, B.S in Industrial technology      | course topic  |  |
| Central connecticut state univesrity     | B.S in Industrial technology           | courses   | IT 464 Intro to Six sigma quality, MFG 496 Lean manufacturing  |
| Cleveland state community college        | A.S in Industrial technology           | No mention  |  |
| East carolina university                 | B.S,M.S in Industrial technology       | Graduate courses, certificate   | ITEC 6002Lean Manufacturing, ITEC 6003Advanced Lean Techniques |
| Eastern illinois university              | B.S,M.S in Industrial technology       | No mention  |  |
| Eastern Kentucky university              | B.S,M.S in Industrial technology       | No mention  |  |
| Eastern Michigan university              | B.S,M.S in Industrial technology       | No mention  |  |
| Georgia southern state university        | B.S in Industrial Tehnology            | No mention  |  |
| Idaho state university                   | A.S in Industrial technology           | No mention  |  |
| Illinois state university                | B.S in Industrial Tehnology            | No mention  |  |
| Indiana state university                 | B.S,M.S in Industrial technology       | No mention  |  |
| iowa state university                    | B.S,M.S in Industrial technology       | No mention  |  |
| Ivy tech community college- bloomington  | A.S in Industrial technology           | Continuing Education  |  |
| Ivy tech community college- evansville   | A.S in Industrial technology           | Continuing Education  |  |
| Ivy tech community college- fort wayne   | A.S in Industrial technology           | Continuing Education  |  |
| Ivy tech community college- indianapolis | A.S in Industrial technology           | Continuing Education  |  |
| Ivy tech community college- kokomo       | A.S in Industrial technology           | Continuing Education  |  |

**Appendix B: Continued**  
**NAIT Accredited IT program institutional web site search results**

| University Name                              | Program Name                     | Lean or Six Sigma results from institutional web site search - no mention, courses exist, outreach, cetificates, other | Courses with LSS in the Name  |
|--|----------------------------------|--|---|
| Ivy tech community college- Lafayette        | A.S in Industrial technology     | Continuing Education   |   |
| Ivy tech community college- Muncie           | A.S in Industrial technology     | Continuing Education   |   |
| Ivy tech community college- Richmond         | A.S in Industrial technology     | Continuing Education   |   |
| Ivy tech community college- Sellersburg      | A.S in Industrial technology     | Continuing Education   |   |
| Ivy tech community college- South bend       | A.S in Industrial technology     | Continuing Education   |   |
| Ivy tech community college- Terre haute      | A.S in Industrial technology     | Continuing Education   |   |
| jackson state community college              | A.S in Industrial technology     | No mention   |   |
| Jackson state university                     | B.S in Industrial Tehnology      | No mention   |   |
| Jacksonville state university                | B.S,M.S in Industrial technology | courses  |   |
| kean university                              | B.S in Industrial Tehnology      | No mention   |   |
| kent state university                        | B.S,M.S in Industrial technology | courses offered but not through the IT program   |   |
| l e fletcher technical community college     | A.S in Industrial technology     | No mention   |   |
| linn state technical college                 | A.S in Industrial technology     | No mention   |   |
| Midde tennessee state university             | B.S in Industrial Tehnology      | No mention   |   |
| millersville university of pennsylvania      | B.S in Industrial Tehnology      | Continuing Education   |   |
| Minnesota state university                   | B.S in Industrial Tehnology      | No mention   |   |
| Missouri state university                    | B.S in Industrial management     | Certificates   |   |
| Morehead state university                    | B.S,M.S in Industrial technology | courses  | IET 317 - Just in Time and Lean Systems   |
| North east state community technical college | B.S in Industrial Tehnology      | No mention   |   |
| Nothern illinois university                  | B.S,M.S in Industrial technology | No mention   |   |
| Nunez community college                      | A.S in Industrial technology     | No mention   |   |
| Ohio northern university                     | B.S in Industrial Tehnology      | course topic   |   |
| ohio university                              | B.S,M.S in Industrial technology | Certificates   |   |
| Owens community college                      | A.S in Industrial technology     | No mention   |   |
| Purdue university                            | B.S,M.S in Industrial technology | courses  | IT 581R, Six Sigma and Lean Manufacturing, IT 214 Introduction to Lean Manufacturing,IT 483, Facility Design for Lean Manufacturing |
| San jose state university                    | B.S,M.S in Industrial technology | courses  | Tech 146 lean manufacturing   |

**Appendix B: Continued**  
**NAIT Accredited IT program institutional web site search results**

| University Name                               | Program Name                     | Lean or Six Sigma results from institutional web site search - no mention, courses exist, outreach, certificates, other | Courses with LSS in the Name  |
|---|----------------------------------|---|---|
| South east missouri state university          | B.S in Industrial Tehnology      | certification   |   |
| southeastern louisiana university             | B.S in Industrial Tehnology      | No mention  |   |
| Southern illinois state university carbondale | B.S,M.S in Industrial technology | courses, certificate  | IT 465 Lean Manufacturing, IT 470a Six Sigma Green Belt I, IT 470b Six Sigma Green Belt II, IT 480 Six Sigma Black Belt |
| Southern university at shreveport             | A.S in Industrial technology     | No mention  |   |
| Southwestern oklahoma state university        | B.S,M.S in Industrial technology | No mention  |   |
| state fair community college                  | A.S in Industrial technology     | No mention  |   |
| Tennesse state university                     | B.S in Industrial Tehnology      | No mention  |   |
| Tennesse technological university             | B.S in Industrial Tehnology      | courses   | ISE 4650. Lean Production Systems,  |
| Texas A&M commerce                            | B.S,M.S in Industrial technology | courses   | Lean manufacturing  |
| Texas A&M kingsville                          | B.S,M.S in Industrial technology | courses   | 5334. Lean Manufacturing  |
| Texas southern university                     | B.S in Industrial Tehnology      | No mention  |   |
| university of arkansas pine bluff             | B.S in Industrial Tehnology      | No mention  |   |
| central missouri university                   | B.S in Industrial Tehnology      | No mention  |   |
| University of lousiana                        | B.S in Industrial Tehnology      | Continuing Education  |   |
| University of nebraska kearne                 | B.S in Industrial Tehnology      | No mention  |   |
| university of north dakota                    | B.S,M.S in Industrial technology | courses   | Lean: Ideas and Practice. (IT555)   |
| University of northern iowa                   | B.S,M.S in Industrial technology | Continuing Education  |   |
| University of southern maine                  | B.S in Industrial Tehnology      | No mention  |   |
| University of texas at tyler                  | B.S,M.S in Industrial technology | courses   | TECH 5310 Six Sigma Quality, TECH 5335 Lean manufacturing   |
| university of wisconsin platteville           | B.S in Industrial Tehnology      | No mention  |   |
| university of wisconsin stout                 | B.S in Industrial Tehnology      | No mention  |   |
| Walters state community college               | B.S in Industrial Tehnology      | No mention  |   |
| Western kentucky university                   | B.S,M.S in Industrial technology | Continuing Education  |   |