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Fall 2020

IE 203-001: Applications of Computer Graphics in Industrial Engineering

Paul Ranky

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Welcome to Study Guide of Application of Computer Graphics in Industrial Engineering ...

for Sustainable Lean & Green Visual Factory Management, Computer Networking, Object-oriented Thinking & Programming, Programming Computer Controlled Machines, Industrial Internet of Things (IoT), Data Analytics, Human-Computer Interaction, Customer Experience & Presentation Skills, and with a strong focus on integration of system!

Dear Students, Parents, Teachers, Mentors, Coaches, Friends, Please read it carefully. This is a long, but on the other hand you find all essential course information here.

Please read this entire document first! Many of your questions are answered in this document. Use the outlines below to find "Ctrl" (Mac or Linux: Command) in the document and type in the text of these sections, unless the outlines change during the semester.

Please use the Discussion Board in Canvas for questions. Use Canvas Email only for personal questions. Email and phone calls are extreme special exceptions. We are also going to discuss some very new methods and technologies, such as Computer Vision, Artificial Intelligence, Internet of Things (IoT), Data Analytics, Human-Computer Interaction, Customer Experience and Presentation Skills, and with a strong focus on integration of system!

Our Canvas Discussion Board is for all students to share their questions and answers. Please read it carefully. This is a long, but on the other hand you find all essential course information here.

Please read the entire document first! Many of your questions are answered in this document. Use the outlines below to find "Ctrl" (Mac or Linux: Command) in the document and type in the text of these sections, unless the outlines change during the semester.

Attentions in this class is comparison and between the SLIP Security and student body accepted VR education rules. These rules will be strictly enforced, therefore remove or missing classes is not permitted.

According to SLIP regulations, if the very physical or mental condition of a student is not suitable for the VR education, the student will be asked to leave the class and will be marked as absent. Please note, if you feel sick, please contact Dr. Yu immediately!

Please use the phone provided through your student mailbox office hours together and not each individual cell phone!

A few words about this: **ASQ** (American Society for Quality) Student Chapter at NIT ASQ is the largest quality society in the world. Join us, see how, and network with professionals! We have our own NIT ASQ Student Chapter. Our NIT ASQ Student Chapter is the largest student chapter in the world. Our NIT ASQ Student Chapter is the only one in the world, which is supported by a professional chapter

Prepare this 1-page format for a training presentation, or on your screen or Word, in PowerPoint, but as soon as you have your well page up on the internet, just in up to Assignment 1 (You can add images, text, video clips, etc. after this is done or later)

Assignment 1 (10% Deadline: by Division 1, 16): webpage and My Computer's Digital Factory Network Model "Be the way to 3D document and knowledge manager by IT assignments, using Computer Graphics & 3D software and Internet/Intranet/Extranet

Assignment 1 (continued)

Make a 1-page presentation in the webpage design:

Part 1 in the design and documentation of your use in the 3D company's digital factory networking model:

In more detail, Part 1 - the web page design:

do you need at this stage a unique and striking webpage architecture for your presentation. (You can extend it later.) The instructor will help you, nevertheless you have the freedom to develop the webpage the way YOU want it.

This will be used for documenting your work, and also for learning a lot about object-oriented thinking and design. Furthermore, when you are applying for a job, that web page will be a great ambassador for you, promoting your wonderful achievements (i.e., your professionally documented work)!

Focus on your goals, on your audience. Our impressions you want to communicate about your company, on structuring your data, and preparing your data objects for the future. This is a very important start, even if at a later stage you may want to use a professional web-page design company to do the final touches, or to do it all for you.

We focus here on data structures and core structures, graphics and such (layout, look and)

Find out objects, shapes, use .html files (you can convert text from Word files) and .htm(l), for images .jpg files (your smart phone takes these type of images), for video clips you can use .mov, .m4v, .m4a, .avi formats, and .mp4 formats.

We also learn about content thinking, analysis, design and management. It pays to be creative and also have some basic graphic and web-page design skills.

As part of this assignment, we also learn together how to take effective, good quality images with our smartphones, and also how to shoot simple video with our smartphones, that can be used as data objects for our web-page. We also learn how to edit such video, and how to use such video.

Make sure that you find a way to analyze our digital factory, even after you graduate, you may, like many others, find a job that requires this. An independent assignment, your own photo you like if can easily remember you! Very IMPORTANT!!!, and take a bit of time to the background pages in this class.

Assignment 1 (continued) Use the information in the attached pdf file, and the information and (to your own thing, as long as it satisfies NJIT requirements and regulations. Please understand, that it is extremely important for you to develop knowledge/skills and the skills, and this is the skills that are needed.

In more detail, Part 2 this is the design and documentation of your part in the 3D company's **digital factory networking model**. To complete the part of the assignment, please take notes during the lecture, as well as during the discussion. Use the attached pdf file, and the information in Assignment 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40,

Handle Scroll		When you press **[HANDLE SCROLL]**, the jog handle scrolls through the text.

Name	Icon	Meaning
Low Air (Warning)		The air pressure to the machine is too low to reliably operate pneumatic systems. Correct this condition to prevent damage to or incorrect operation of pneumatic systems.
High Air (Alarm)		The air pressure to the machine is too high to operate pneumatic systems. The machine will not operate until the condition is corrected. You may need to install a regulator at the machine's air input.
E-Stop		**[EMERGENCY STOP]** on the pendant has been pressed. This icon disappears when **[EMERGENCY STOP]** is released.
E-Stop		**[EMERGENCY STOP]** on an auxiliary device has been pressed. This icon disappears when **[EMERGENCY STOP]** is released.

You can find an electronic copy of this manual and other useful information on our website in the "Resource Center". Join Haas owners online and be a part of the greater CNC community at these sites:

diy.haascnc.com
The Haas Resource Center: DIY Documentation and Procedures

haasparts.com
Your Source for Genuine Haas Parts

www.facebook.com/HaasAutomationInc
Haas Automation on Facebook

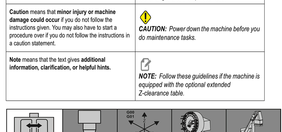
www.twitter.com/Haas_Automation
Follow us on Twitter

www.linkedin.com/company/haas-automation
Haas Automation on LinkedIn

www.youtube.com/user/haasautomation
Product videos and information

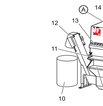
www.flickr.com/photos/haasautomation
Product photos and information

Description	Example
Danger means that there is a condition or situation that **will cause death or severe injury** if you do not follow the instructions given.	*DANGER: No step. Risk of electrocution, bodily injury, or machine damage. Do not climb or stand on this area.*
Warning means that there is a condition or situation that **will cause moderate injury** if you do not follow the instructions given.	*WARNING: Never put your hands between the tool changer and the spindle head.*
Caution means that **minor injury or machine damage could occur** if you do not follow the instructions given. You may also have to start a procedure over if you do not follow the instructions in a caution statement.	*CAUTION: Power down the machine before you do maintenance tasks.*
Note means that the text gives **additional information, clarification, or helpful hints.**	*NOTE: Follow these guidelines if the machine is equipped with the optional extended Z-clearance table.*

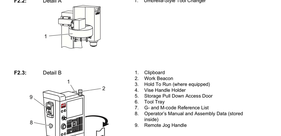


	There are high voltage components on the machine that can cause electrical shock. Always use care around high voltage components.
	Long tools are dangerous, especially at spindle speeds higher than 5000 RPM. The tools can break and eject from the machine. Remember that machine enclosures are intended to stop coolant and chips. Enclosures may not stop broken tools or thrown parts. Always check your setup and tooling before you start machining.
	Machining operations can create hazardous chips, dust or mist. This is function of the materials being cut, the metalworking fluid and cutting tools used and the machining speeds/feeds. It is up to the owner/operator of the machine to determine if personal protective equipment such as safety goggles or a respirator is required and also if a mist extraction system is needed. All enclosed models have a provision for connecting a mist extraction system. Always read and understand the Safety Data Sheets (SDS) for the workpiece material, the cutting tools and the metalworking fluid.

T1.4: Prohibited Action Symbols – Red Circles with Slash-Through

Symbol	Description
	Do not enter the machine enclosure when the machine is capable of automatic motion. When you must enter the enclosure to complete tasks, press **[EMERGENCY STOP]** or power off the machine. Put a safety tag on the control pendant to alert other people that you are inside the machine, and that they must not turn on or operate the machine.
	Do not machine ceramics.
	Do not attempt to load tools with the spindle drags misaligned with the cutouts in the toolholder V-Flange.
	Do not machine flammable materials. Do not use flammable coolants. Flammable materials in particulate or vapor form can become explosive. The machine enclosure is not designed to contain explosions or extinguish fire.

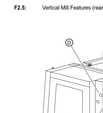
F2.1: Vertical Mill Features (front view)



1. Side Mount Tool Changer (optional)
2. Servo Auto Door (optional)
3. Spindle Assembly
4. Electrical Control Box
5. Work Light (2X)
6. Operator Controls
7. Storage Tray
8. Air Gun
9. Front Work Table
10. Chip Container
11. Tool Holding Vise
12. Chip Conveyor (optional)
13. Tool Tower
14. High Intensity Lights (2X) (optional)

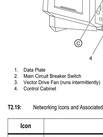
A. Umbrella Tool Changer (not shown)
B. Control Pendant
C. Spindle Head Assembly

F2.2: Detail A



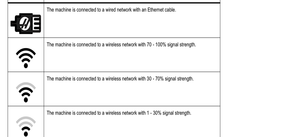
1. Umbrella-Style Tool Changer

F2.3: Detail B



1. Clipboard
2. Work Beacon
3. Hold To Run (where equipped)
4. Vise Handle Holder
5. Tool Release Up/Down Access Door
6. Tool Tray
7. G- and M-code Reference List
8. Operator's Manual and Assembly Data (stored inside)
9. Remote Jog Handle

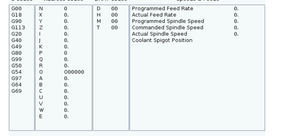
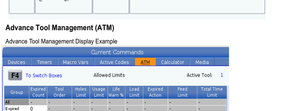
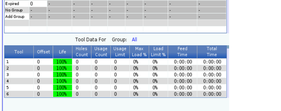
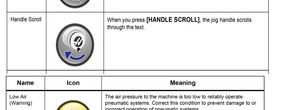
F2.5: Vertical Mill Features (rear view)



1. Data Plate
2. Main Circuit Breaker Switch
3. Vector Drive Fan (runs intermittently)
4. Control Cabinet

A. Electrical Connectors
B. Coolant Tank Assembly (movable)
C. Electrical Control Cabinet Side Panel
D. Consolidated Air Lubrication Module (CALM)

T2.19: Networking Icons and Associated Network Status

Icon	Network Status
	The machine is connected to a wired network with an Ethernet cable.
	The machine is connected to a wireless network with 70 - 100% signal strength.
	The machine is connected to a wireless network with 30 - 70% signal strength.
	The machine is connected to a wireless network with 1 - 30% signal strength.
	The machine is connected to a wireless network, but it is not receiving data packets.
	The machine is successfully registered with HaasConnect and is communicating with the server.

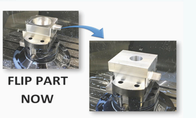
F2.17: Active Codes Display Example

Advance Tool Management (ATM)

Advance Tool Management Display Example

Advanced Tool Management -This page contains information the control uses to predict tool life. Here is where you create and manage tool groups, and where you enter the maximum tool load percentage expected for each tool.

Media Display Example - Work Instruction during a Program



Name	Icon	Meaning
Setup		Setup mode is locked; the control is in Run mode. Most machine functions are disabled or limited while the machine doors are open.
Setup		Setup mode is unlocked; the control is in Setup mode. Most machine functions are available, but may be limited while the machine doors are open.
Cycle Door		The door must be cycled at least once to ensure that the door sensor is working. This icon appears after **[POWER UP]** if the user has not yet cycled the door.
Door Open		Warning, door is open.

Name	Icon	Meaning
Door Hold		Machine motion has stopped because of door rules.
Jog Lock		Jog lock is active. If you press an axis key, that axis moves at the current jog rate until you press **[JOG LOCK]** again, or the axis reaches its limit.
Remote Jog		The optional remote jog handle is active.
Vector Jog		For five-axis machines, the tool will jog along the vector defined by the rotary positions.

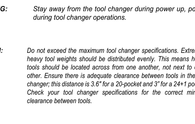
Name	Icon	Meaning
Brake		A rotary axis brake, or a combination of rotary axis brakes, is unclamped.
Brake		A rotary axis brake, or a combination of rotary axis brakes, is clamped.
Spindle Fan Failed		This icon appears when the spindle fan stops operating.
Transformer Overhead (Warning)		This icon appears when the transformer is detected to be overheated for more than 1 second.

Name	Icon	Meaning
Low Voltage (Warning)	LOW VOLTAGE	The PFDM detects low incoming voltage. If the condition continues, the machine cannot continue operation.
Low Voltage (Alarm)	LOW VOLTAGE	The Power Fault Detect Module (PDFM) detects incoming voltage that is too low to operate. The machine will not operate until the condition is corrected.
High Voltage (Warning)	HIGH VOLTAGE	The PFDM detects incoming voltage above a set limit, but still within operating parameters. Correct the condition to prevent damage to machine components.
High Voltage (Alarm)	HIGH VOLTAGE	The PFDM detects incoming voltage that is too high to operate and could cause damage to the machine. The machine will not operate until the condition is corrected.

Tool Holder Care

1. Make sure that tool holders and pull studs are in good condition and tightened together securely or they may stick in the spindle.

Tool Holder Assembly, 40-Taper CT Example: [1] Pull Stud, [2] Tool (Endmill).



2. Clean the tool holder taper body (the part that goes into the spindle) with a lightly oiled rag to leave a film, which helps prevent rusting.

4.8.1 Loading the Tool Changer

CAUTION: *Do not exceed the maximum tool changer specifications. Extremely heavy tool weights should be distributed evenly. This means heavy tools should be located across from one another, not next to each other. Ensure there is adequate clearance between tools in the tool changer; this distance is 3.6" for a 20-pocket and 3" for a 24+1 pocket. Check your tool changer specifications for the correct minimal clearance between tools.*

NOTE: *Low air pressure or insufficient volume reduces the pressure applied to the tool release piston and will slow down tool change time or will not release the tool.*

WARNING: *Stay away from the tool changer during power up, power down, and during tool changer operations.*

CAUTION: *Do not exceed the maximum tool changer specifications. Extremely heavy tool weights should be distributed evenly. This means heavy tools should be located across from one another, not next to each other. Ensure there is adequate clearance between tools in the tool changer; this distance is 3.6" for a 20-pocket and 3" for a 24+1 pocket. Check your tool changer specifications for the correct minimal clearance between tools.*

NOTE: *Low air pressure or insufficient volume reduces the pressure applied to the tool release piston and will slow down tool change time or will not release the tool.*

WARNING: *Stay away from the tool changer during power up, power down, and during tool changer operations.*

A Large and Heavy Tool (left), and a Heavy (not Large) Tool (right)

F5.19: Subprogram Pattern

eLearning Pack Resources for this session: Use the videos in your eLearning Pack, as well as the ones shown in class.

C Class, ELIT Week 11: Semiconductor, evaluation and case-based learning and reviewing selected application of silicon Microsoft, Adobe, Apple, Siemens, etc. and web authoring software packages. Spreadsheets and Microsoft Excel and Microsoft Access. Introduction to Microsoft Visual Basic and Microsoft Visual Basic for Applications. Introduction to Microsoft Visual Basic and Microsoft Visual Basic for Applications. Pick, Pick Basic and Microsoft Access. Pick, Pick Basic and Microsoft Access.

D Class ELIT Week 11: Introduction to Microsoft Visual Basic and Microsoft Visual Basic for Applications. Introduction to Microsoft Visual Basic and Microsoft Visual Basic for Applications. Pick, Pick Basic and Microsoft Access. Pick, Pick Basic and Microsoft Access. Introduction to Microsoft Visual Basic and Microsoft Visual Basic for Applications. Introduction to Microsoft Visual Basic and Microsoft Visual Basic for Applications. Pick, Pick Basic and Microsoft Access. Pick, Pick Basic and Microsoft Access.

eLearning Pack Resources for this session: Use the videos.

C Class, ELIT Week 11: Communication, Computer Networking, **CASTLEMATH** computer graphics. Communication methods. Computer networking basics. Integration methods and issues. Interactive multimedia. Introduction to computer graphics and image processing. Introduction to computer graphics and image processing. Introduction to computer graphics and image processing

Some more student laboratory activity and AISS event pictures in this live class include the following:

Computer Controlled Machine Programming, Based on Object-oriented Principles - VMC laboratory preparation information:
Please explore this site for some useful information on our computer controlled CNC machines and related object oriented machine programming methods, tools and technologies. Isaac Automation Inc. USA is tools and technology provider for our laboratory. Our laboratory is equipped with two CNC machines, one CNC lathe and one CNC milling machine. Our laboratory is also equipped with 17 Maintenance workbench, stationary machines. This modern facility enables us to learn more about object-oriented programming, testing, validation and exact quality control, with a strong focus on the integration of systems.

Our machines are similar to what you will see here:

http://www.haas.co.uk/milling-another-world/

Also, there is some useful info. on CNC programming and software here:

http://www.mecsoft.com/cncmachining.aspx

http://www.mecsoft.com/products/visualmill_product?c=visualmill_product&ref=mecsoft&CLP=1%3B+been+what+was+been+%5B4dim_parameter+2%5D+%5Ftitle+

EXPLORE and enjoy!

Computer Controlled Machine Programming and Computer Graphics, Based on Object-oriented Principles. CNC laboratory preparation information in the NJIT Makerspace (his class setting)

The NJIT Makerspace is a wonderful computer controlled (CC) 21st century advanced manufacture resource for students, faculty and industry.

In this class we have access to the amazing tool, self-over ride, explore and **learn more about object-oriented computer controlled machine programming**, including having our programs on advanced computers, controlling machines in the Makerspace. We will be using the Makerspace machines and computers, and also using our own laptops. We will be using the Makerspace machines, and also using our own laptops to write computer programs in C, Javascript, Nodejs, Coffeescript, Nodes, Jade, Jade, Stylus, Mongo, Express, Jade, Stylus, Mongo, Express, Angular, Bootstrap, and all those wonderful computer tools we learn in this class. We will also see some wonderful machines in the Makerspace.

The point here is not to learn technology, but the value of technology (that is a different class), but to use this amazing facility to **reinforce our object-oriented systems thinking approach, as well as use these machines to create and computer program with best practice code.**

Our goal is to learn how to use the Makerspace machines, and also to learn how to write computer programs in the Makerspace machines. Business Business Operations Management and the class uses are going to NJITlab. We don't just learn CC thinking and programming, but we in a 3-dimensional computer integrated machine, like a lathe and a 3-axis CNC milling machine, C-axis and a 5-axis CNC milling. It takes a lot of knowledge to be able to use these machines, and we will be using our own laptops to write computer programs to control the machines. We will be using our own laptops to write computer programs to control the machines. We will also use our own laptops to write computer programs and also install computer programming and graphics software on our own laptops.

In order to help our students to succeed in an advanced, global world, this is the time when we are introducing **two concepts of object-oriented case programming, and Python programming with example.** Students will be introduced to the concepts of object-oriented case programming, and Python programming with example, and students will be given the opportunity to use these concepts in their computer programs, including CC machines. The office is NJIT Bldg 101 and 101 Bldg, and all design and prototypes flow for other, like students, and others, where they benefit 21st century Group Design Process problem solving and creative, critical, analytical, and systems thinking.

Also note, that the facility is planning to offer **machine operator certifications** to NJIT students, so that they can program, and run their programs (and their programs on these advanced computer controlled machines safely.

Also there is a discussion on the class website, to explore how to take advantage of the wonderful capabilities of these tools. Note that the Haas Fac is a because **industry needs professional problem solving engineers,** and the Haas Fac is a great place to learn how to be a professional problem solving engineer, and also learn how to use these wonderful machines. Also note that the Haas Fac is a place where we can do the big picture thinking, as well as take a big deeper and understand the details too.... this is the concept of the 1st chapter professional, ... yes, see my notes earlier (The first of the slides is, that the more you learn about these tools, the more you realize you don't know.

Doing these **extra-participation focused labs** we encourage you to ask any questions you have and let us work up a plan, and we can answer problem based questions.

*(For your local information: I spent over 30 years actively designing and implementing advanced computer controlled jobs and systems (the tools, with computer programming, material handling, real time, computer controlled machine programming, and computer controlled machine programming, and computer controlled machine programming, and

1. Pre-assessment: The effective instructor-trainer tries to make contact with each student through the pre-assessment. As your instructor-trainer is based on the PowerPoint and minimally geared at the students.

2. Pre-Introduction: The effective instructor-trainer tries to make contact through the pre-introduction. The effective instructor-trainer tries to make contact through the pre-introduction.

3. Positive in the case: The effective instructor-trainer uses a PowerPoint slide and tries to make contact through the front of the room. Ask your instructor-trainer about behind a podium and use the desktop computer mouse to move through the slides.

4. Positive in the case: The effective instructor-trainer uses a PowerPoint slide and tries to make contact through the front of the room. Ask your instructor-trainer about behind a podium and use the desktop computer mouse to move through the slides.

5. Hand gestures: The effective instructor-trainer continually showed the palms of the hands facing upwards. Our pre-recorded instructor-trainer tell the students on the PowerPoint and minimally gestured at the students.

Note: Use cases are mostly generated as text or diagrams and are not to scale. Visit https://www.conceptdraw.com/ for more information.

eLearning Pack Resources for this session: Use the eBook. Also see the videos in the eLearning Pack.

10 min 30. Classification (Cost) Presentation

Pound Implementation: Information management and stakeholder quality control solution and student documentation. Continuous assignment project improvement assistance based on team and class feedback.

Final Assignment submission, including 40.2. Investor Invoicing (no £/£/£), statistical analysis graphs and graphics exercises, as well as your aligned-oriented progress.

DEVELOPMENT PROCESS: Follow this order for the best results.

Optionally (for some MSc) conduct a Stakeholders Interviews using SWOTM, or whatever other software, or 2-Pair. Everything you need to use (See more that week) **(**Or with one of your classmates and/or your tutor**)**. Use the Stakeholders Interviews to identify the stakeholders' Strengths, Weaknesses, Opportunities and Threats (SWOTM) and/or other relevant information and discussed the stakeholder at Minimum. Then, complete the same process using:

1. What are the purpose of the video conferencing sessions? (Note: that the business as essential skill in the course 40.4.)
2. What are the purpose of the video conferencing sessions? (Note: that the business as essential skill in the course 40.4.)
3. Use the Stakeholders Interviews to identify the stakeholders' Strengths, Weaknesses, Opportunities and Threats (SWOTM) and/or other relevant information.

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2. What are the purpose of the video conferencing sessions? (Note: that the business as essential skill in the course 40.4.)
3. Use the Stakeholders Interviews to identify the stakeholders' Strengths, Weaknesses, Opportunities and Threats (SWOTM) and/or other relevant information.

Final Assignment submission, including 40.2. Investor Invoicing (no £/£/£), statistical analysis graphs and graphics exercises, as well as your aligned-oriented progress.

DEVELOPMENT PROCESS: Follow this order for the best results.

Optionally (for some MSc) conduct a Stakeholders Interviews using SWOTM, or whatever other software, or 2-Pair. Everything you need to use (See more that week) **(**Or with one of your classmates and/or your tutor**)**. Use the Stakeholders Interviews to identify the stakeholders' Strengths, Weaknesses, Opportunities and Threats (SWOTM) and/or other relevant information and discussed the stakeholder at Minimum. Then, complete the same process using:

1. What are the purpose of the video conferencing sessions? (Note: that the business as essential skill in the course 40.4.)
2. What are the purpose of the video conferencing sessions? (Note: that the business as essential skill in the course 40.4.)
3. Use the Stakeholders Interviews to identify the stakeholders' Strengths, Weaknesses, Opportunities and Threats (SWOTM) and/or other relevant information.

eLearning Pack Resources for this session: Use the eLearning Pack and the eBook where available to help.

Oral Presentation Rubric

	4 - Excellent	3 - Good	2 - Fair	1 - Needs Improvement
Delivery (Score: ___)	• Holds attention of the entire audience with use of direct eye contact, emotion and energy • Speaks with authority on the topic and can easily maintain audience interest with no distractions	• Consistent use of direct eye contact with audience, but still retains some focus on notes • Speaks with knowledge and can maintain audience interest with few distractions	• Displays minimal eye contact with audience, while reading mostly from notes • Speaks in uneven volume with little or no inflection	• Holds no eye contact with audience, as entire report is read from notes • Speaks with no inflection and/or mechanical tone, which causes audience to lose focus
Content/Organization (Score: ___)	• Demonstrates full knowledge by answering all class questions with confidence and elaboration • Provides clear purpose and relevance of topic, supports it with facts, and/or personal examples, supports conclusions/ideas with evidence	• Is at ease with knowledge of topic, but is not able to elaborate on the topic • Provides clear purpose and relevance of topic, but does not support the subject, conclusions/ideas are not well-supported	• Is uncomfortable with information and is able to answer only some of the question work cited • Attempts to define purpose and relevance of subject, vague examples, and/or unsupported conclusions/ideas	• Does not clearly define purpose of the report or provides weak or no support of subject, gives no relevance of the subject or conclusions
Enthusiasm/ Audience Interaction (Score: ___)	• Demonstrates strong enthusiasm about topic during entire presentation • Involves and interacts with audience (understanding and knowledge of topic, continuous eye contact, and/or asking and fielding questions)	• Demonstrates strong enthusiasm about topic during most of presentation • Relies some on audience interaction and awareness of mood points	• Displays minimal enthusiasm about topic, but seems uninterested in audience • Is able to answer questions with little or no elaboration	• Shows no interest in topic presented • Fails to increase audience awareness or knowledge of topic

eLearning Pack Resources for this session: Use the eLearning Pack and the eBook where available to help.

11.55 pm, December 10, 2020 = ABSOLUTELY THE LAST DAY TO SUBMIT any assignments! All submissions MUST be electronic + by email (+ in a web URL) !!!

Assignment Requirements & Assessment Criteria:

(These notes are that you understand the assessment criteria. When completing the assignments the course guide for continuous assessment on the following questions please use your **teacher-student** email.

Generic Assignment Architectural Requirements:

Based on class and team discussions, interactive multimedia (CD-Rom, DVD video, tutorials, traditional published papers and web articles, pre-recorded lectures, etc) assignments in an electronic format (one file only), with both a professional and a personal section, are required for this course.

Pre-Assessment Assignment: The teacher is known as a great communicator or practice in the content because they someone and complete graphics in 30. Then pass them to set up your virtual company and collaborate with the e-Learning Pack companion study of website. As a reminder, the process mapping assessment is about creating a Student Model and Design Organical Thinking or Design Thinking Process Model. Use the Student Model to identify the student's Strengths, Weaknesses, Opportunities and Threats (SWOTM) and/or other relevant information. Use the Design Thinking Process Model to identify the organizing theory and the Value Based Pricing. Use the Value Based Pricing to determine the cost(s) for all assignments.

Use the Student Model and the Design Thinking Process Model to identify the student's Strengths, Weaknesses, Opportunities and Threats (SWOTM) and/or other relevant information. Use the Student Model and the Design Thinking Process Model to identify the student's Strengths, Weaknesses, Opportunities and Threats (SWOTM) and/or other relevant information.

Because the problem is managed, the root cause remains unsolved. The additional labor and inventory for these makeshift repairs increase the cost. When these problems are made obvious because of labor reduction process, it is a chance to improve.

Supervisors and technicians must return the defective products to their respective departments. They should visit the preceding process to pursue the root causes behind these defects, and solve them starting with understanding the root cause.

This can be compared to taking pain medication for chronic appendicitis, instead you decide to get surgery and fully recover.

This concept also applies to solving the defects caused by machines, equipment, molds, and jigs, which we have described earlier. If we find that the equipment is causing a defect, it is important that we stop the line immediately and to identify and eliminate the root cause.

If we end up doing in-process readjustments on our own just because the maintenance department wouldn't respond after we contact them, we may start to fix the problem within our own production process, and this imperceptibly becomes a part of the regular process.

We shouldn't stop with a single written request or a single phone call. We must keep taking measures patiently until we get a product of perfect quality.

Defects and Inspection - Let's think about why sending out a defective product is unacceptable. If the assembly line which is the final process of production, sends out defective products, then it is highly possibility that a defective product might reach the customer.

This is unacceptable, because this affects the trustworthiness of the company and the credibility of the product, more than anything else. Normally, defects are discovered by inspection and reworked before they are sold to the customer. The more the company is determined not to put a defective product on the market, the stricter their inspection becomes, and thus the more frequent rework needed. This only increases your cost.

The extra inspections done is work that does not result in any value being added to the product. Manufacturing can build gauges into their jigs and fixtures an automatic inspection process that reduces the possibility defective products being used (this is called poka-yoke). This is done to ensure that every single product is of good quality.

We believe that the readjustment should be regarded as work that should not have existed from the beginning. The more people you need for inspection and rework outside of the process, the lower value-added ratio in the plant becomes, and the more the costs will increase.

You cannot say, "This product is expensive because we test it 10 times". This will not be accepted in the market. Work that does not add value is just an unnecessary activity. It is something that should be eliminated from the beginning.

Even if you omit the unnecessary activity within the direct work process and achieve some labor reduction, if you produce defective products, then inspection and rework increase the labor requirements. If you consider this from the point of view of cost reduction, the result may come out even, or even a loss; this result is far from the original purpose.

For this reason, we think in the following manner:
The inspections outside the process as well as rework are both unnecessary activity. We want to eliminate them as much as possible. Inspection should be the minimum necessary, and no rework required. And you inevitably reduce labor.

It is important to be aware that large labor reductions are possible by eliminating inspection and rework operations, as you strive for improvements.

The in-process inspection should be considered as follows:
It is necessary for the people to check the quality of products they made, namely the 100% in-process inspection. We regard the subsequent production process as the customer, so not a single bad product should be released.

It's important to be creative with all the various aspects of inspection methods. In addition to visual inspection or gauge inspection, "Poka-yoke (error-proofing)" must also be considered.

As for tot production such as that using high-speed automoated presses, we accumulate say 50 or 100 pieces over the chute, and inspect the first and last piece. If they are both good, they go ahead and get transferred to the plant. If there is a defect with the last piece, examine the piece the failure occurred, get rid of them, and you must take measures to prevent such defects from happening in the future.
This is a type of total inspection. Even in a fast, quick production process, you should not think that you can conduct only sampling inspections. It is important to build in the quality within the production process.

The Goal of the Inspector - Let's approach the concept of "inspections performed by an inspector."

The job of an inspector is the determination of whether a product is defective. They sometimes think that is enough to just pass the results back to the previous step.

This is not enough. The inspector should be responsible for doing on-site analysis why the failure occurred, and as much as possible, for determining the cause, and stop the reoccurrence of this problem.

They should not merely be an inspector who performs a of pass or fail test. Instead, inspector must be a teacher who explains what was wrong and teach you so as not to repeat the same mistake.

For example, if a matter that came up was a mistake during parts assembly, the cause might not be just as simple as "I was careless".

There might have been many various causes, for example: the parts were not lined up in their assembly order, the line stop button, or the call button was too far away, or the work instruction information was difficult to read.

Without identifying these causes and taking the appropriate action, failures will not be reduced. The purpose of the inspector's work is not to toss out the defective product but to reduce them to zero. Their work is evaluated on fulfilling this task.

Poka-Yoke (error-proofing) - During a production process, to build in high quality, we must think about which points the people need to check, which places do they have to measure, or when do need to replace cutting tools.

Devise ways of using jigs and fixtures so that products sent from the previous step are checked spontaneously. This means that you incorporate poka-yoke (error-proofing) within the production process to discover defects.

It is important to standardize poka-yoke to make sure that even if people are replaced, stable quality is produced.

Even the most careful people sometimes can make inadvertently mistakes, especially when they measure while performing other tasks, or doing the check by following a checklist.

That's why it's important to devise a mechanism that spontaneously eliminates defective products, operational errors, injuries or any other problems, even without a person paying attention to everything. The automatic discovery of any shortcomings, that is "poka-yoke."
To explain the mechanism of "poka-yoke" a little more specifically,
• A mechanism where products cannot be mounted in jigs when there is an operational error.
• A mechanism where the machine will not start when there is a problem with the product
• A mechanism where the machine will not start when there is an operational error.
• A mechanism to automatically correct operational errors before proceeding with production.
• A mechanism to detect problems made in the preceding process.
• If some work is left incomplete, the next step will not start.

Mechanisms other than these can also be considered.

The following can be thought of as poka-yoke methods.
1. Signs, ... visualize the fault with lamps and color coding to make it easier to be discovered.
2. Jigs, ... devise a jig so that it won't accept different products, or it doesn't operate when there is a mounting mistake, etc.
3. Automoration... to stop the machine when a problem happens during manufacturing.
This is sometimes not counted as "poka-yoke."

Poka-yoke is an extremely important part of building in quality during the production processes. The aim is reducing problems to zero. To achieve this aim, it's important to think of methods like those mentioned above, and to devise jigs that are easiest to grasp, as well as those with minimum loss, when establishing "poka-yoke."

In order to 'close the loop', we demonstrate the above concepts, methods and even some tools and machines in our advanced NJIT Makerspace, also during the CNC lab, in the ME lab., during the disassembly and service labs in almost every class by means of real-world factory tour videos, that we discuss in detail, in an interactive fashion. This way students learn these concepts and can develop an active design experience too, that they can document in their assignments. This is a semester-long activity, effecting every assignment. (Note, that some of this concepts are very new to most students, therefore they initially resist, and then gradually accept, understand, learn and actively apply and the best even develop further these methods and ideas as part of their 'own' (i.e. the 5th company) activities...)

USA (ANSI) and International Standards (ISO) and how these standards can be used in this class

In this class we also put a lot of emphasis on USA and international standards, that help us and guide our IE design, VFM and operation control decisions. In almost all cases these well researched and well written standards help us in our visual factory management / computer graphics in IE efforts too.

Please try to incorporate what you have learned from at least one of these standards into your assignments. (Please note, that the NJIT Library has a massive collection of standards if you want to read the full text.)

This is a good sample of standards, that are very useful for all of us to learn (please note, that if a link does not work, pls. search the key terminology as indicated, on the web.):

ANSI Safety Standards

BS OHSAS 18001 / BS OHSAS 18002 Occupational Health and Safety Package (British Standard) ...

Environment, Health, and Safety Management System Standards

Environment, health, and safety (EHS) standards play a key role in the overall standards environment, protecting employees and employers alike.

ISO 45001: Occupational Health and Safety Standard (More: https://www.nqa.com/en-us/certification/standards/iso-45001) ISO 45001 is the world's international standard for occupational health and safety, issued to protect employees and visitors from work-related accidents and diseases. ISO 45001 certification was developed to mitigate any factors that can cause employees and businesses irreparable harm. Its standards are the result of great effort by a committee of health and safety management experts who looked closely at a number of other approaches to system management — including ISO 9001 and ISO 14001. In addition, ISO 45001 was designed to take other existing occupational health and safety standards, such as OHSAS 18001, into account — as well as the ILO's labor standards, conventions and safety guidelines. Especially geared toward senior management, ISO 45001 has the ultimate goal of helping businesses provide a healthy and safe working environment for their employees and everyone else who visits the workplace. This goal can be achieved by controlling factors that could potentially lead to injury, illness and — in extreme situations — even death. As a result, ISO 45001 is concerned with mitigating any factors that are harmful or that pose a danger to workers' physical and/or mental well-being.

ISO to Develop New Global Occupational Health and Safety Standard

Jul 24, 2013 ... ISO to Develop New Global Occupational Health and Safety Standard. ANSI and ASSE seeking U.S. stakeholders to support the standard's ...

Environment, Health, and Safety Management System Standards

Environment, health, and safety (EHS) standards play a key role in the overall standards environment, providing a backbone for many other industry specific ...

Workplace Safety Standards Home

With welding's potential effects on health and safety, and given the large amounts of energy necessarily involved in welding, welding safety standards are vital in multiple engineering jobs IEs get involved with.

Workplace Safety Standards

Workplace safety standards represent a selection of programs, equipment, ... Code for power press operation: Health, safety, and safeguarding requirements ...

ANSI Members Support Children's Eye Health and Safety Month ...

Aug 1, 2016 ... August marks Children's Eye Health and Safety Month, a time to pay closer ... members that have developed standards related to eye safety.

ANSI to Sponsor International Consumer Product Health and Safety ...

Apr 13, 2006 ... The American National Standards Institute (ANSI) has announced its intention to sponsor the 13th annual meeting and training symposium of ...

ISO 9000 FAMILY - QUALITY MANAGEMENT
Standards Popular standards ISO 9000 family – Quality management ISO 9000 family - Quality management The ISO 9000 family addresses various aspects of quality management and contains some of ISO's best known ...

ISO 14001 ENVIRONMENTAL MANAGEMENT
Standards Popular standards ISO 14001 Environmental management ISO 14000 family - Environmental management The ISO 14000 family of standards provides practical tools for companies and organizations of all kinds looking to manage ...

Please note, that our Diassembly Exercises in this class give us a good opportunity to think more "sustainable green / non-toxic" too. This standard is a good example for medical devices: ISO 10993-17:2002: Biological Evaluation Of Medical Devices - Part 17: Establishment Of Allowable Limits For Leachable Substances. ISO 10993-17:2002 specifies the determination of allowable limits for substances leachable from medical devices. It is intended for use in deriving standards and establishing allowable limits where standards do not exist. It describes a systematic process through which identified risks arising from toxicologically hazardous substances present in medical devices can be quantified. ISO 10993-17:2002 is not applicable to devices that have no patient contact (e.g. in vitro diagnostic devices). Exposure to a particular chemical substance may arise from sources other than the device, such as food, water or air. ISO 10993-17:2002 does not address the potential for exposure from such sources.

As an example, in 2000 we started to use the ISO 9000 family of ISO standards. Since then, we have introduced new standards, as above, as part of the engineering thinking process, dealing with guidelines, opportunities, as well as constraints. The Diassembly Exercise offers us also a good opportunity to look into the sustainable green / toxic aspects of parts / processes of devices we diassemble and perhaps plan to re-manufacture or recycle at some stage.

About Engineering Ethics and Morals...

Engineering ethics is a very important part of every assignment in this class. Engineering ethics is the field of system of moral principles that apply to the practice of engineering. The field examines and sets the obligations by engineers to society, to their clients, and to the profession.

More here: (ref.: https://www.tutorialspoint.com/engineering_ethics/engineering_ethics_introduction.htm)

Engineering is the process of developing an efficient mechanism (based on science) which quickens and eases the work using limited resources, with the help of technology. Ethics are the principles accepted by the society, which also equate to the moral standards of human beings. An engineer with ethics, can help the society in a better way.

Hence the study of Engineering ethics, where such ethics are implemented in engineering by the engineers, is necessary for the good of the society. Engineering Ethics is the study of decisions, policies and values that are morally desirable in engineering practice and research.

Engineering design **ethics concerns issues** that arise during the design of technological products, processes, systems, and services. This includes **issues** such as safety, sustainability, user autonomy, and privacy. **Ethical** concern with respect to technology has often focused on the user phase. (More here: https://www.encyclopedia.com/science/encyclopedias-almanacs-transcripts-and-maps/engineering-design-ethics)

Morals
The word "Morality" originates from the Latin word "mos" meaning "custom". Morals are the principles or habits with respect to right or wrong of one's own conduct. They are not imposed by anyone. Morals are what you think is good and bad personally.
Though morals are not imposed, they can be understood as the preaching of our inner self. Depending on a few factors, our mind filters things as good or bad. These are the ideas that help frame our personality so that we can distinguish between what is right and what is wrong.

A moral is the code of conduct that you develop over time and set for yourself to follow, just like
* Being good to everyone
* Speaking only the truth
* Going against what you know is wrong
* Avoid cheating
* Being a nice human being etc.

Morals are always defined by one's own personality. Morals can be changed according to one's beliefs as they are completely dependent on one's perception towards the ethical values.

Ethics
The word "Ethics" originates from the Greek word "ethos" meaning "character". Ethics are a set of rules or principles that are generally considered as standards or good and bad or right and wrong, which are usually imposed by a group or society or a profession or a profession or so. Ethics can be understood as the rules of conduct proposed by a society or recognized with respect to a particular class of human actions or a particular group or culture. Ethics are dependent on others definition. They may or may not vary from context to context.

More here: (ref.: https://www.tutorialspoint.com/engineering_ethics/engineering_ethics_introduction.htm)

As an example, in our assignments and presentations during the past 20+ years this course run, students learned about ethics and morals during their social networking assignments, when they set up their own companies and it's web page, when they are disassembling devices, when they have to review full length videos, during the NJIT Makerspace lab. visits (started in 2019), during the zero defect quality exercises (started in 2016 with ASQ support), during our digital factory networking discussions when we also talk about cybersecurity issues (IIoT, and Industry 4.0 aspects, started in 2017), when they are creating their 3D process models, and during their interactive class presentations. Engineering ethics and morals becomes this way an integrated part of this class.

More examples: IEEE (USA): Ref.: https://www.ieee.org/about/corporate/governance/p7-8.html

The following is from the IEEE Policies, Section 7 - Professional Activities (Part A - IEEE Policies), 7.8 IEEE Code of Ethics

We, the members of the IEEE, in recognition of the importance of our technologies in affecting the quality of life throughout the world, and in accepting a personal obligation to our profession, its members, and the communities we serve, do hereby commit ourselves to the highest ethical and professional conduct and agree:

1. to hold paramount the safety, health, and welfare of the public, to strive to comply with ethical design and sustainable development practices, and to disclose promptly factors that might endanger the public or the environment;

2. to avoid real or perceived conflicts of interest whenever possible, and to disclose them to affected parties when they do exist;

3. to be honest and realistic in stating claims or estimates based on available data;

4. to reject bribery in all its forms;

5. to improve the understanding by individuals and society of the capabilities and societal implications of conventional and emerging technologies, including intelligent systems;

6. to maintain and improve our technical competence and to undertake technological tasks for others only if qualified by training or experience, or after full disclosure of pertinent limitations;

7. to seek, accept, and offer honest criticism of technical work, to acknowledge and correct errors, and to credit properly the contributions of others;

8. to treat fairly all persons and to not engage in acts of discrimination based on race, religion, gender, disability, age, national origin, sexual orientation, gender identity, or gender expression;

9. to avoid injuring others, their property, reputation, or employment by false or malicious action;

10. to assist colleagues and co-workers in their professional development and to support them in following this code of ethics.

Changes to the IEEE Code of Ethics will be made only after the following conditions are met:

• Proposed changes shall have been published in THE INSTITUTE at least three (3) months in advance of final consideration by the Board of Directors, with a request for comment, and

• All IEEE Major Boards shall have the opportunity to discuss proposed changes prior to final action by the Board of Directors, and

• An affirmative vote of two-thirds of the votes of the members of the Board of Directors present at the time of the vote, provided a quorum is present, shall be required for changes to be made.

CODE OF ETHICS (ASQ): ref.: https://asq.org/about-asq/code-of-ethics

Introduction

The purpose of the American Society for Quality (ASQ) Code of Ethics is to establish global standards of conduct and behavior for its members, certification holders, and anyone else who may represent or be perceived to represent ASQ.

In addition to the code, all applicable ASQ policies and procedures should be followed. Violations to the Code of Ethics should be reported. Differences in work style or personalities should be first addressed directly with others before escalating to an ethics issue.

The ASQ Professional Ethics and Qualifications Committee, appointed annually by the ASQ Board of Directors, is responsible for interpreting this code and applying it to specific situations, which may or may not be specifically called out in the text.

Disciplinary actions will be commensurate with the seriousness of the offense and may include permanent revocation of certifications and/or expulsion from the society.

Fundamental Principles

- ASQ requires its representatives to be honest and transparent.
- Avoid conflicts of interest and plagiarism.
- Do not harm others.
- Treat them with respect, dignity, and fairness.
- Be professional and socially responsible.
- Advance the role and perception of the Quality professional.
- Expectations of a Quality Professional

Act with Integrity and Honesty

- Strive to uphold and advance the integrity, honor, and dignity of the Quality profession.
- Be truthful and transparent in all professional interactions and activities.
- Execute professional responsibilities and make decisions in an objective, factual, and fully informed manner.
- Accurately represent and do not mislead others regarding professional qualifications, including education, titles, affiliations, and certifications.
- Offer services, provide advice, and undertake assignments only in your areas of competence, expertise, and training.

Demonstrate Responsibility, Respect, and Fairness

- Hold paramount the safety, health, and welfare of individuals, the public, and the environment.
- Avoid conduct that unjustly harms or threatens the reputation of the Society, its members, or the Quality profession.
- Do not intentionally cause harm to others through words or deeds.
- Treat others fairly, courteously, with dignity, and without prejudice or discrimination.
- Act and conduct business in a professional and socially responsible manner.
- Allow diversity in the opinions and personal lives of others.

Safeguard Proprietary Information and Avoid Conflicts of Interest

- Ensure the protection and integrity of confidential information.
- Do not use confidential information for personal gain.
- Fully disclose and avoid any real or perceived conflicts of interest that could reasonably impair objectivity or independence in the service of clients, customers, employers, or the Society.
- Give credit where it is due.
- Do not plagiarize.
- Do not use the intellectual property of others without permission.
- Document the permission as it is obtained.

CODE OF ETHICS (ASQ); more here: https://asq.org/about-asq/code-of-ethics

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About Continuous Improvement in this Class...

Continuous / continual Improvement, or CI, is a very important part of every assignment in this class.

Continuous Improvement is an ongoing effort to improve your organization's products, services, and/or processes. ... Gradual – seek "incremental" improvement over time. "Breakthrough" improvement all at once.

In the ISO 9001 standard, the requirement for continual improvement (CI) is defined in clause 8.5.1 "Continual Improvement". Continual Improvement can be initiated through the use of quality policy, quality objective, audit results, analysis of data, corrective and preventive actions and management review.

(More here: http://www.isorequirements.com/iso_9001_8_principles_continual_improvement.html)

In the ISO 9001 standard, the requirement for continual improvement (CI) is defined in clause 8.5.1 "Continual Improvement". Continual Improvement can be initiated through the use of quality policy, quality objective, audit results, analysis of data, corrective and preventive actions and management review. This requirement covers both the reactive and proactive action of improvement.

The reactive action are those actions taken to address nonconformities of products, processes and systems such as the correction taken on nonconformity or a defect and the follow-up corrective action to remove the root causes of the nonconformity. This is referred to as problem solving or problem resolution process and is a reactive action.

Continual improvement, however, refers to actions taken to optimize a specific characteristic or a set of characteristics even though performance of the characteristics may be at the acceptable level to the customer or the organization. This is very important concept in management practices as it is a way to prevent an organization from becoming complacent when all outcomes are acceptable. Continual improvement drives the organization to continually address ways to reduce costs, improve organizational performance and customer satisfaction.

In process management, the basis for CI is in the managing of variation. Variation is the fluctuation of the output of a process, sometimes called noise. Every repeatable process exhibits variation. Improvement of any process is to reduce variation so that the process can consistently meet expectation of either the internal customers or external customers. Studying variation leads to managing it, as this will help to identify the source of a problem and to establish the action most likely to resolve it.

Understanding variation involves identifying whether the variation is due to common causes or special causes. Common cause variation is systemic, built into the process or system. The variation is random, with its average value and boundaries being predictable (i.e. the variation around the average level is call random). The causal factors of common cause variation are unknown, and therefore, reducing such variation requires fundamental changes to the process or system. Common cause variation requires a long term strategy of process management to identify, understand and reduce it. It provides opportunity for Continual Improvement initiative.

(More here: http://www.isorequirements.com/iso_9001_8_principles_continual_improvement.html)

As an example, in 2019 we have started to use the amazing new NJIT Makerspace facility / lab. complex to illustrate students the way an ideal digital smart factory / digital / networked factory could look like. In 2020 and beyond, this component of the class gradually increases. We also show and encourage students to get seriously involved with visual factory management / computer graphics applications in IE, computer controlled object-oriented machine programming, additive manufacturing devices, computer controlled quality control machines and devices, laser cutting machines, waterjet machines, and other real-time, feedback controlled systems. We also provide academic as well as technician support for our students to do the above during their tenure, including sometimes NSF funded UG research, at NJIT, in the Makerspace facility / lab.

About Strategic Implementation Plan on STEM Diversity in this Class...

November 2019 White House Release Strategic Implementation Plan on STEM Diversity. These concepts are widely communicated in this class: The Strategic Plan presents a vision for a future where all Americans will have lifelong access to high quality STEM education and the United States will be the global leader in STEM literacy, innovation, and employment.

It is intended to serve as a "North Star" for the broader STEM community as it collectively charts a course for the Nation's success and is responsive to the requirements of Section 101 of the America COMPETES Reauthorization Act of 2010.

These are the main goals, that are being actively pursued to support the Strategic Plan's overarching vision:

1. Build Strong Foundations for STEM Literacy by ensuring that every American has the opportunity to master basic STEM concepts and to become digitally literate.

2. Increase Diversity, Equity, and Inclusion in STEM and provide all Americans with lifelong access to high-quality STEM education, especially those historically underserved and underrepresented in STEM fields and employment.

3. Prepare the STEM Workforce for the Future—both college-educated STEM practitioners and those working in skilled trades that do not require a four-year degree—by creating authentic learning experiences that encourage and prepare learners to pursue STEM careers.

The Strategic Plan is organized around four pathways, representing a cross-cutting set of approaches to improve STEM education that will help fulfill its vision and achieve its three goals. These concepts are widely communicated in this class:

1. Develop and Enrich Strategic Partnerships – Strengthen relationships between educational institutions, industry, community organizations to leverage resources for the purpose of providing the student with meaningful learning opportunities.

2. Engage Students where Disciplines Converge – Draw on knowledge and methods across disciplines to solve complex, real world problems in STEM using innovation, creativity, and initiative.

3. Build Computational Literacy – Design integrated approaches to teaching and learning computational thinking and promote digital literacy and cyber safety.

4. Operate with Transparency and Accountability – Develop and apply metrics that assess progress in meaningful ways and disseminate them to external stakeholders.

In 2019 we have started to use the amazing new NJIT Makerspace facility / lab. complex to integrate the above concepts and requirements into this class. In 2020 and beyond we have the opportunity to integrate the above principles, concepts, methods, tools and technologies even more into our classes. This will offer 'loop closing' opportunities (i.e. feedback control loops), because students will be able to test ideas, principles, methods and others learned in this class in a real-life digital factory-like large laboratory. By using the NJIT Makerspace we can also offer students more opportunities to actively design systems for real-world applications.