Integration of Art and Engineering: Creating Connections between Engineering Curricula and an Art Museum's Collection

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Within STEM education, a movement called STEAM (Science, Technology, Engineering, Art, and Mathematics) is gathering momentum. Yet, while articles abound with ideas for incorporating STEAM concepts into K-12 classrooms, the literature on STEAM education at the university level is scant. Complicating matters is the fact that the "A" in STEAM does not always stand for "Art"; for example, in one recent ASEE paper that contains the words "STEAM curricula" in its title, the "A" stands for "Agriculture" [1].

However, reflections on STEAM at the university level can be found in a few papers presented at the 2013 ASEE convention. One, "Faculty reflections on a STEAM-inspired interdisciplinary studio course," offers insights on the opportunities and drawbacks of STEAM as it is currently understood (i.e., inserting the arts into the STEM curriculum as a way to make students more creative [2]. Another, "Turning STEM into STEAM," discusses the role of images in scientific communication and argues that "teaching the foundational concepts of Art, with disciplinary rigor and engineering context, would help improve critical and creative thinking, guide and encourage innovative engineering and visual art; fostering more effective direct and conceptual communication of scientific ideas and advancements" [3].

The thesis of this paper is that an art museum and its collection can function as a central location, both physically and conceptually, for STEAM on a college campus. The paper's authors—a mechanical engineering professor, a liberal arts professor, and an art museum director—bring truly multidisciplinary perspectives to the STEAM challenge of coherently integrating art and engineering education. The paper describes a unique relationship that has developed between one university's engineering curricula and the collection of an art museum on its campus. The paper presents a longitudinal study of engineering students at this institution who engaged with art as part of their curriculum at both the freshman and junior levels.

Among our findings:

- Students liked the flexibility and freedom, the self-guided discovery that using art as a starting point afforded. No students were put off by the art.
- The decision to integrate art into freshman-level humanities course and a junior-level technical course allowed students to make connections with what they learned earlier in their college careers.
- Not insignificant is the fact that this interdisciplinary project brought together three people from very different academic areas to exchange ideas.

The Museum - Contributions to the Synthesis of Art and Engineering

While the seeds may have been planted much earlier, the synthesis of art and engineering at Milwaukee School of Engineering formally began in 2001 with the gift of the Eckhart G. Grohmann *Man at Work* collection to the University. Dr. Eckhart Grohmann, successful Milwaukee businessman and member of the MSOE Board of Regents, began collecting art

depicting working scenes in 1968 with the acquisition of a small Dutch painting of the interior of a blacksmith's forge. This began a parallel career in collecting alongside his work in operating a successful aluminum foundry.

Approaching the turn of the 21st century, as business and art acquisitions came and went, with Dr. Grohmann divesting himself of various enterprises he held over the course of his career, he found himself with a growing collection and limited space to house and care for the works. He considered donating the collection to the Milwaukee Art Museum or a similar institution, but feared that doing so would not serve the purpose he envisioned; that the collection be used as an educational tool through which viewers would gain a better understanding of past ways of works, industrial and engineering principles, and over 400 years of human achievement.

As a result of his connection with MSOE and admiration for the school and its programs, Dr. Grohmann ultimately decided that it was the best venue for fully exploring the potential of his art collection. So, in 2001, he made the initial gift of nearly 500 works to the school with the initial plan being to display the works on campus while researching individual works, artists, and subject matter. In making this gift, the ultimate goal was to establish a venue that would be a permanent home for the housing, care, and display of the collection.

The use of the Grohmann Collection began with a major display (some 80+paintings and bronzes) of selected work in the MSOE Alumni Partnership Center. This exhibition, coupled with research into the collection, led to the establishment of a docent program whereby students and members of the community received formal training in the collection, its themes, and subject matter. The display of the collection, in addition with smaller displays in other campus buildings, helped to cement the mission and purpose of the collection: that it be first and foremost a tool for education in art and engineering and second a marketing component for MSOE and its programs.

The success of this initial foray into art and engineering at MSOE led to the further development of finding a permanent home for the collection. A number of properties and options were explored before MSOE (with the funding of Dr. Grohmann) decided on the purchase of the vacant Milwaukee Branch of the Chicago Federal Reserve Bank, on the corner of Broadway and State Sts. in the heart of the MSOE campus. The building was purchased on 2005 and work began soon thereafter to transform the space into the Grohmann Museum.

As the collection was already in use in a number of campus curricula, the building committee, led by Dr. Hermann Viets, MSOE President, decided to more fully integrate the missions of MSOE and the Grohmann Collection. The first step was creating three classrooms in the Museum where a variety of general studies and engineering classes would be held. Next, it was decided that the Museum project would also furnish new office space for the General Studies Department. As a result, the Museum was to become a dynamic space; a laboratory for learning and a venue for the synthesis of art and engineering.

Following two years of intensive planning and effort, the Grohmann Museum opened in October of 2007 as the newest and arguably the finest Museum in Milwaukee, in addition to being to only Museum of its type in the world. Nowhere else will one find as comprehensive a collection

surrounding the themes of art, engineering, and occupation. Subjects included in the permanent collection displays include iron and steel production, mining, construction, agriculture, quarrying, craftsmen, and intellectual trades. The Museum also hosts a number of feature exhibitions exploring many more themes around the central subject of work.

Over the course of the past six years the collection has doubled in size due to Dr. Grohmann's continued generosity. Also, the Museum's mission has been further explored and reinforced through the use of the collection to enhance a number of campus courses and programs. Examples include:

- The continued opportunities provided students in the Museum's docent training program; educating Museum tour guides and encouraging student involvement.

- Integration of the Museum collection in the HU100 curriculum—the majority of professors teaching Humanities 100 (a requirement for all engineering students) have created a collection component in their coursework, in which students explore an artwork or group of works and write a corresponding essay detailing their research.

- Use of the collection in a variety of classes including Physics, Architecture, Construction Management, Computer Engineering, Business, and Nursing. The collection has proven useful in courses dealing with ergonomics studies, aesthetic interpretation, OSHA studies and ME processes.

- Feature exhibitions that develop synergy with campus programs. For example, a tour of the photography exhibition *Bridges: The Spans of North America* prompted a group of Graduate Students in Civil Engineering and Bridge Design to write research papers on the bridges included in the photos. The papers were then included as supplementary didactics in the display.

- Currently, the Museum Director is adjunct professor in Technical Communications, and TC321 Visual Design Techniques engages engineering students in visual design and interpretation. The course culminates in a Museum exhibition of the student design work created over the previous quarter.

- Tours provided to every program and major on campus. Also, the Museum and its collection has extensive international reach via our web galleries, the loan of the collection for exhibitions both nationally and internationally, and our 1500 volume research library, which is available through our Walter Schroeder Library at MSOE.

- The Museum has also become the host venue for a number of professional conferences and symposia, including those organized by: The Society for Industrial Archeology, American Society of Mechanical Engineers, Fluid Power Institute, American Society of Civil Engineers, American Foundry Society, Association for Corporate Growth, Society for Technical Communications, Thunderbird School of Global Management, Institute for Urban Agriculture, Association of General Contractors, and many others. The Museum also supports a number of campus and student organizations.

The Museum has five levels, with a rooftop garden, three classrooms, and a lounge area in the lower level. Students have found the lounge area to be a quiet study spot, and benches throughout the gallery spaces are frequently occupied by students waiting for class or discussing team projects.

Longitudinal Study

In this case study, a cohort of students engaged with the Museum's collection during the freshman and junior years. Surveys have been administered to collect feedback from these students about their experiences with art in a freshman-level humanities seminar and a junior-level manufacturing processes course. Both courses are honors courses, and their art components are serving as pilots for possible replication among the general student population. The freshman seminar has now run four times; the junior course will have run twice by the time this paper is presented. (That data will be incorporated into this paper's conference presentation.)

Freshman-year honors humanities seminar

The GS 1010H Honors Seminar I is subtitled "Reading the City." In this course engineering students explore the concept of "City" as a social construct. Students study cultural understandings of what "City" means by "reading" its portrayal in different kinds of "texts" (music, art, literature, history, myths, film, assumptions/stereotypes, "urban legends") as well as from a variety of perspectives (literary, philosophical, historical, and aesthetic, for example).

Art is an important component of this seminar. First comes a basic grounding in art principles. Students spend a couple of classroom sessions learning art terminology and practicing their new vocabulary by discussing slides of city-themed artwork in class. Second, following this introduction, students spend three class periods in the Museum analyzing the collection's sculpture and paintings. In the first class period, the entire class visits 3-4 artworks and participates at each stop in analysis of works as a whole group. Each student then selects a work of art to analyze and, in the next two class periods, gives an individual analytical presentation of his or her piece to the rest of the class.

The third and final art-related portion of the course requires each student to produce an original work of art that is displayed in a public exhibit at the Museum. The exhibit's theme is "The City" (the topic of the seminar). It opens with an end-of-term reception organized by students in the class and runs for three weeks. Shortly after students return to campus, the exhibit is struck and the students' artwork is returned to them.

For this longitudinal study, a link to a SurveyMonkey survey eliciting feedback on the art experience was emailed to all students who have taken the freshman humanities seminar. Of those 51 students, 35 students chose to participate in the survey—a response rate of 69%.

Student reflections on their experiences with the art component of this freshman-level course were favorable.

Every single student recalled creating a work of art for display in the Museum; 88.6% said they "strongly remember" and 11.4% "somewhat remember." In addition, a strong majority (77%) of students agreed that the experience of creating their artwork was largely positive. Over half of

the students said they felt “happy” and “proud” of their artwork, while one in five went so far as to say they felt “excited.”

A majority (54%) of students felt that their technical knowledge enhanced their ability to appreciate, interpret and create art. Likewise, 54% of students said that exposure to the Museum’s collection gave them a different view of technology. Interestingly, their comments revealed that the art helped broaden and contextualize their understanding of the *history* of technology:

> “In particular, viewing the artwork describing the progression of medical technology gave me a much deeper appreciation for how far we've come in such a little amount of time.”
>
> “It allowed a good look at past technologies and safety precautions.”
>
> “I actually was curious how people managed to produce such quality products with the older tools and social structures. The art doesn't say MUCH about it, but gives an impression of work environments of earlier times.”

A question aimed at teasing out whether the art component helps to achieve ABET Criterion 3 (a-k) outcomes revealed only moderate success. Although 40% of students agreed that the art component of GS 1010 “increased my understanding of the impact of engineering solutions in a global, economic, environmental, and/or societal context,” another 40% said they were merely “neutral” regarding this claim. No one “strongly agreed” with the statement—and 20% either “disagreed” or “strongly disagreed” that the art had helped them see engineering impacts in a global or societal context.

However, a student who said that the art *had* helped them understand engineering in a broader societal context added this comment: “Especially with environmental effects/considerations.” One of the Museum website’s regularly updated features is a quarterly “sustainability” blog written by the chair of the Department of Civil, Architectural Engineering, and Construction Management. It is possible that this engineering/museum blog has contributed to heightened awareness among students.

Two of the 35 students (6%) did not enjoy the art experience. One of these two students sounded frustrated in his comments about the slippery definition of “quality” in art:

> “Art always has potential, but it can't be taken seriously or people will be unfairly penalized, and it will never be worth anything if taken lightly. Anybody can write a sentance [*sic*] about how their shoelace position is 'artistic' and who is the teacher to object? It has to be acknowledged as a small, side, relaxing project.”

Both students were dissatisfied with their artwork. Neither felt he had received adequate instruction and background to produce a piece of art to take pride in. They both expressed an all-or-nothing view of the course’s art component—either that it should not have been included as part of the humanities seminar at all or it should have been made a central focus of the course.

Yet one of these students did say that the art component had enhanced his aesthetic judgment and his ability to learn independently, which provides some evidence of achieving ABET's Criterion 3 (i). Working on the art project, this student said, "definitely forced me to realize how inadequate my instruction and practice in visual arts had been, and spurred me to study the subject further on my own. I have achieved a much better understanding as a result of my independent exploration."

Overall 82% of students agreed or strongly agreed that the art component should continue to be included in the freshman-level humanities seminar.

Junior-year manufacturing processes course

In the junior level Mechanical engineering class in manufacturing processes, the art collection was used as the starting point for the students to investigate a particular aspect of manufacturing processes or practices. The class is required in the ME program and a special section was created for the scholars program and has the designation of ME 323H. The scholars program has one class per term that is designated as the H section in the junior and senior year for the students. The inclusion of a class in manufacturing processes (ME 323H) as a junior level class in the University Scholar's program was a good opportunity to formally make use of the art collection as part of the course. The class is the main exposure in the curriculum to manufacturing processes and typically covers casting, deformation (bulk and sheet metal), powder processes, machining, joining, an overview of plastic and composite processes and an introduction to Statistical Process Control. The class has a lab component with a project in which the student's design, model, simulate and ultimately produce a cast part. Other lab activities include an SPC activity, machining, design of experiments and surface roughness, with at least one open week.
The class provides an overview of many processes, with a focus on process description and characteristics, terminology, and design aspects. The coverage of many processes has the drawback of limited depth in those processes. Most instructors have an assignment or project that allows the students to explore a particular process or aspect of a process in-depth. In ME 323H, the instructor used the art collection as a starting point to provide an opportunity for the students to explore the relationship between engineering solutions and society in addition to gaining in-depth knowledge on an aspect of manufacturing.

The specific assignment given to the students was to select a piece of art-work from the collection as the starting point for an in-depth study of an aspect of manufacturing processes or practices that related to the art work. The students were given a week to select a piece of artwork and submit a paper topic. The instructor was rather flexible in how closely tied the paper topic was to the artwork. In some cases, the paper topic was the process depicted in the art, in other cases, it was a product illustrated in the art, or the environmental or safety practices shown in the art. (see Appendix for examples) The students were encouraged to learn and describe the piece of art they chose, but the main focus was on an aspect of manufacturing processes. A lab period was used to take the students to the museum in which the museum director gave a guided tour to the students (and the instructor) of the collection, including what is available on-line and in books. The deliverables from the assignment included a paper due at the end of the term along with a presentation to the class given during class in the last week of the term. A small portion of the final exam (12%) covered material from the presentations. The students were asked to

submit a possible question for the final exam based on each presentation, which allowed the instructor to gain insight into what the students found useful and interesting and also encourages the students to pay attention and mentally process the information from the presentations.

The museum director giving the initial tour of the art collection was especially useful in providing a different perspective on the pieces in the collection compared to the instructor of the course who is an engineer. The museum director gave insight into the meaning of the work, some history and context related to the art work and also the difference between art and an exact representation. This allowed the students to more deeply appreciate the art itself and understand why they might have a particular connection to a piece of artwork. The instructor also found the different perspective to be interesting, very useful and thought provoking. The students appeared to be actively engaged in viewing the art during the tour and made use of the knowledge and perspective of the museum director. Several students noted the different perspective in this class, which is technical, compared to the earlier humanities class.

A survey (6 questions plus comments) was given in class at the end of the term requesting feedback from the student perspective on the project. The entire class of 15 students was present and all provided feedback. (see Appendix for the survey questions). Student reflections on their experience with the assignment were favorable with "neutral" being the lowest rating given.

The students were very positive in their reflection on the assignment with the majority of students in the "agree" or "strongly agree" category on the survey questions.

A majority (60%) of the student felt exposure to the art collection gave them a different view of technology and 87% of the students felt the assignment increased their understanding of the impact of engineering solutions in a global, economic, environmental and/or societal context. The students who were "neutral" on exposure to the art collection giving them a different view of technology all felt the assignment increased their understanding of the impact of engineering solutions.

The students felt (87%) exploring the art collection increased their interest in manufacturing processes and all the students felt their technical knowledge enhanced their ability to appreciate and interpret the art.

While 67% of the students enjoyed learning about the art and using artwork as a starting point for the manufacturing process paper, 93 % of the students recommended the assignment be used in the future

The majority of the student comments were mainly positive as well, with the suggestion to have the introduction to the paper and the tour later in the term than the first week. The students who commented indicated a desire to have more knowledge of the manufacturing processes before making a topic selection. The main positive comments were about the flexibility of choosing a topic and the opportunity to learn about an aspect of manufacturing in more depth. A few students noted this could be done without the tie to the artwork and were neutral on learning more about the artwork and using the collection as a starting point. The initial tour by the museum director was also considered a plus along with presentations to the class.

The instructor's perspective was the project was a success and will be repeated in the spring 2014 term in ME 323H. The timing of the initial tour of the museum will be modified to be later in the term as suggested. One potential downside is there are processes that are not depicted in the artwork and some students may find that limiting for the paper. The instructor noted that 2 specific groups of students really liked the connection to art and were very excited to have the opportunity to enhance their knowledge and to see the connection between some of the processes used in art with manufacturing processes. The specific topics were glass blowing/manufacturing and pattern making/casting. Overall, the Men at Work art collection provides a wonderful opportunity to make the connection between an engineering class and the humanities and help the students explore the impact of engineering in a global, economic, environmental and societal context.

Conclusion

The STEAM movement in engineering education is fairly new. Limited scholarship exists to date regarding how art may be most effectively integrated into engineering curricula at the university level. Our institution is a small engineering school and the piloted courses were part of the university's honors program. However, we believe the art components of these courses could easily work in non-honors course sections. One major difference between honors and non-honors sections would be the number of students per class; the honors sections are 50-75% the size of regular classes. Managing the museum tour and discussions/presentations of art might require splitting a class into two groups and taking different groups into the museum separately.

However, one unique feature of our successful mingling of art and engineering is the relationship the Museum has built with students and faculty. The freshman humanities courses (including non-honors courses) are often scheduled to meet in the building's classrooms, where teachers can easily take students into the galleries to view the art. A history professor whose office is in the building has begun writing a book about one of the collection's painters. The museum plays host to outside events and similarly offers its spaces for faculty meetings, student design presentations, speaking events, and the annual holiday party. The museum's physical location in the center of campus, its classrooms, and its attractive facilities beyond the collection itself make it a central destination. The museum's collection has been thoroughly integrated into the fabric of campus life—socially, physically, intellectually, even spiritually. One student commented in our survey: "I often wander through the museum in my off time to help clear my head and gain inspiration."

Cultivating a relationship between faculty, students, and museum staff has been greatly eased by the particular circumstances of our institution. Building something similar at a different school might be more labor-intensive, but with effort and outreach engineering faculty could establish relationships with art museums on other campuses or with local historical societies and industrial collections. Here in Milwaukee, for example, Harley-Davidson and Briggs & Stratton maintain museums documenting the history of their product lines within the larger historical and societal context. Additionally, the Internet makes it possible to access art work online, including the collections of most large museums.

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Appendix A
Campus Reactions to Tours of the Grohmann Museum Art Collection

Students are moved by the Grohmann Museum collection in a number of ways. When first established, it seemed it may have proven difficult to dovetail a fine art collection with engineering curricula, but soon it was discovered that the collection, when viewed through the lens of the student, is provocative, informative, and lends a great deal of historical perspective to their academic engagement.

Physics students have used the imagery of workers engaged in industrial activities as a springboard for ergonomics studies. Architectural Engineering, Mechanical Engineering and Construction Management students have delved into a variety of ESHA-related lines of inquiry pertaining to worker safety and mechanical apparatus. Civil Engineering students are able to view public works projects, construction sites, and engineering feats and synthesize an historical perspective on the work they are currently involved in. Comments arising from such student engagement surround a number of common themes:

"I can't believe they do that dressed like that!"
"That machine/operation doesn't appear very safe."
"Today, we would…"
"That machine/process has been replaced with…"
Etc.

It is in these reactions, the student exploration of the collection, and their personal 'dialogue' with the works on display that we regularly witness the impact of the art collection on the students of MSOE. A few of the most popular works include:

CHARLES CUNDALL, *The New Forth Road Bridge*, 1960, Oil on canvas, 25 5/8 x 40 in.

HANS DIETER TYLLE (After Menzel), *The Iron Rolling Mill*, Oil on canvas, 62 ½ x 100 ¼ in.

Appendix B
Discussion of art in GS 1010H Honors Seminar I

Engagement with art in this fall quarter freshman honors course begins with learning art-related vocabulary. Art works are accessed online and discussed in class, using art terminology to guide our "seeing."

Following the in-class discussions, students spend two class sessions in the Museum. In the first session we visit a few paintings as a group and analyze them, again using the art terminology learned in class. Students are then free to wander the Museum and select an artwork of their own to analyze and present to the class. In the second session the class walks through the Museum floor by floor, and students present the analyses of their selected works to each other. The quarter ends with a reception, to which the university community is invited, opening a month-long exhibit of students' original artworks.

Below is a list of art terms that students learn. Following that are a few brief representative art works selected by students in the Grohmann Museum, along with summaries of their analyses as illustration of the type of discussion students engage in during their museum visit.

Art Terms (painting):

- Color – hues (primary, secondary, tertiary), value/intensity/brightness, saturation
- Lines – linear, curvilinear, diagonal, zigzag, etc.
- Shapes/forms – biomorphic (living), geometric (nonliving)
- Focal point
- Texturization
- Representation – realistic or abstract
- Rule of thirds
- Light – source, quality (hard/soft)
- Chiaroscuro
- Composition
- Negative space
- Perspective
- Vanishing point
- Bokeh

UNKNOWN, *Blast Furnace at Böhler Steelworks, Austria*, ca.1920, Oil on canvas, 118 x 53 ½ in.

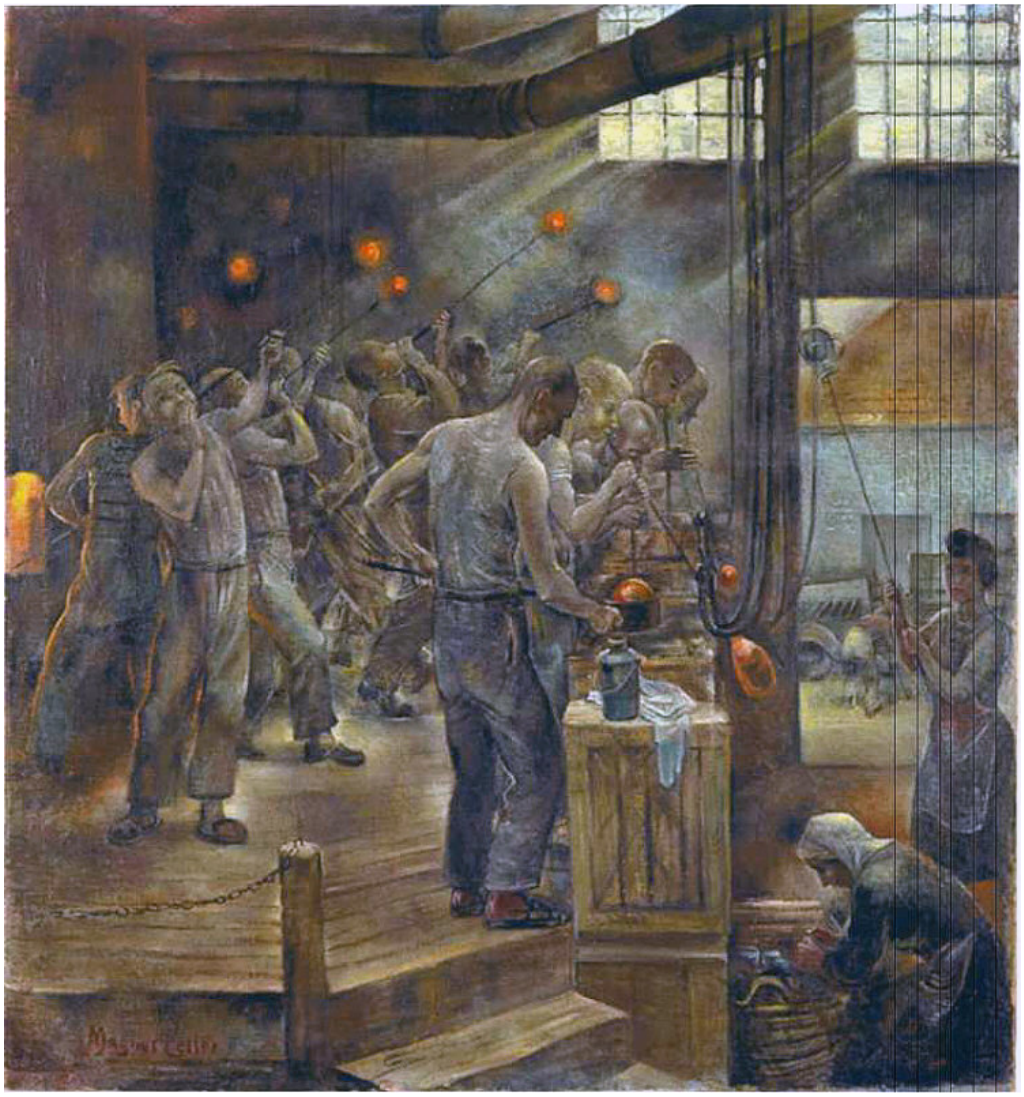
The dimensions of this painting and strongly vertical, slightly tapering lines cause the viewer's gaze to sweep upward. The result is a feeling of awe because the viewer is observing the subject from a low angle. The color of the blast furnace is a dark bluish-gray, a cool hue associated with non-living elements. Lines are straight; the forms are geometric. The light is natural and diffuse; the source appears to be directed from the upper right of the painting. The clouds appear threatening and reminded students of the clouds in El Greco's *View of Toledo* (below). Yet behind the blast furnace, the sky is strangely pink, creating a "halo" effect that makes the blast furnace appear even more heroic.

EL GRECO, *View of Toledo,* ca.1600, Oil on canvas, 47.8 in × 42.8 in.

FELIX SENGER, *Surface Soft Coal Mining with Electric Power Plant and Industry*, 1939, Oil on canvas, 35 ¾ x 55 ½ in.

The composition of this painting draws the eye to the industrial complex at the center. The open-pit coal-mining operation is lower and darker, with light cliffs rising to the plain where the factories lie in the distance. The railroad track in the foreground is curved, and a series of lines radiate inward from the circle of that track, like spokes of a wheel, within the pit (and ascending the cliff walls to the plain) to further draw the eye toward the center of the painting. The light is natural and very diffuse, but the best-lit spot appears to be the light-colored cliff walls and the expanse of plain leading to the smokestacks in the very center of the painting. An extremely small train can be seen on the plain, trailing a thin line of steam; the addition of this feature helps to emphasize the vast scale of the landscape.

MAGNUS ZELLER, *Interior of Glass Works*, ca.1945, Oil on canvas, 39 ¼ x 36 ¼ in.



These glass blowers resemble musicians performing on a stage. They are standing on a raised platform, and their posture and arm positions make it look like they are playing some sort of horn instrument, like a trombone. The shafts of sunlight streaming in diagonally from the windows at the upper right resemble a spotlight, to carry the theatrical metaphor a bit further. The light is natural and soft. Colors are blue-gray and cool hued, plus the tan color of wood. Even the outside light and scenery have a cool blue-green appearance. The only warmth is found in the orange glowing balls of glass at the end of the pipes.

FREIDRICH NERLY, the Elder, *Transporting Marble to the Sculptor Thorwaldsen in Rome*, Oil on canvas, 30 ¾ x 42 ¾ in.

Students noted the how the rule of thirds in this painting helps to emphasize the piece of marble and the drama of the approaching storm. At center is the marble, the brightest spot in the painting. The man sitting atop the block of rock is white-bearded, dressed in white, and holding a staff equipped with a bayonet-type point, presumably for prodding the oxen. Students noted that he looks like an Old Testament version of God, or maybe Zeus looking down from Mount Olympus.

The oxen are straining to the point of almost being crazed. Their eyes are wild and bulging, and their mouths are open, apparently bellowing. The middle pair of oxen has stumbled to their knees, and the pair closest to the cart paw the road so violently that dust rises from their hooves. In the right-center area of the painting another cloud of dust rises, illuminated by sunlight, to highlight a second team of oxen hauling another piece of marble.

In the background at center and right are rocky cliffs, which contrast with the narrow strip of sea at left. Dark storm clouds dominate the sky, and rain can be seen falling over the sea, made visible against the pink-orange sky in the far distance. The light source is the sun, almost directly overhead, and the light is hard, casting clear shadows. This contrast of glare and shadow adds to the impression of tension in the painting.

Appendix C
Art as a starting point in ME 323H Manufacturing Processes

ME 323H
Paper Assignment
Spring 2013
Dr. C. Barnicki

Assignment:

A portion of the Homework/Lab grade for ME 323 will be a paper and short presentation (5 -8 minutes) on a work of art related to manufacturing process from the Grohmann Museum collection. The work of art will serve as a starting point for the paper/presentation. The focus of the paper should be related to manufacturing; the specific process illustrated in the work of art, the environmental and/or safety aspects of the manufacturing process(s) illustrated in the work of art, the production methods used to produce a particular product, or how a particular work of art was produced. If the work of art illustrates a process from the past, a perspective on how the process (or environmental/safety considerations) have changed to the present is expected with more weight on the present.

Timeline:
Initial choice for topic/work of art: due Monday, March 18th. If multiple students/groups have the same choice, an alternative selection may be needed.

Preliminary topics (short description of the focus of the paper with the title/artist of the work of art and a minimum of 2 references outside the textbook) are due on Monday April 15th.

Final papers are due no later than the end of class on Thursday, May 16th.

Paper:

A minimum of 4 pages and should include flow diagrams and illustrations if possible. The artwork is a starting point for the paper, with the focus of the paper on the process (or safety/environmental) as it is today rather than at the time of the historical artwork. An evolution of process changes with a compare/contrast with the historical process depicted in the art would be encouraged if appropriate to the topic.

The paper should include a brief description of the work of art, with title, artist, date, location and subject required along with some insight into why this work of art was chosen. There should also be a description of the process, which would include steps, materials, equipment along with the important variables in controlling the process, the relative advantages and disadvantages of the process along with characteristics of the process (or parts produced by the process).

Note: Questions from the presentations will likely be on the final exam. An overview/summary should be prepared (1 page) to distribute to the class.

ME-323H Spring 2013 Survey

A. Please answer the following questions about the paper assignment which includes the presentations:

1. Exploring the ***Men at Work*** art collection increased my interest in manufacturing processes.

Strongly disagree Disagree Neutral (2) Agree (10) Strongly agree (3)

2. I enjoyed learning about art and using artwork as a starting point for the manufacturing process paper.

Strongly disagree Disagree Neutral (5) Agree (8) Strongly agree (2)

3. My technical knowledge enhanced my ability to appreciate and interpret the art

Strongly disagree Disagree Neutral Agree (11) Strongly agree (4)

4. Exposure to the ***Men at Work*** art collection gave me a different view of technology

Strongly disagree Disagree Neutral (6) Agree (7) Strongly agree (2)

5. The assignment increased my understanding of the impact of engineering solutions in a global, economic, environmental and/or societal context.

Strongly disagree Disagree Neutral (2) Agree (9) Strongly agree (4)

6. I would recommend that this assignment be used in the future.

Strongly disagree Disagree Neutral (1) Agree (10) Strongly agree (4)

7. I have used the ***Men at Work*** art collection in a previous class.

Yes (14) No (1)

8. Please comment on what you liked, did not like, and would suggest to change in regard to this assignment.

Suggestions for improvement: Mainly to start later in the term so the students have some exposure to manufacturing processes

Positive aspects of the assignment: Overall the students enjoyed the flexibility of choosing an aspect of manufacturing processes to explore in more detail and to learn about what the other students explored in the presentations at the end of the term. The tie to the art collection was not considered to be as important as the ability of the students to choose their own topic and to have the presentations in class and the material part of the final exam. The participation of the museum director in giving the initial tour was considered to be a positive with a different perspective from the instructor.

Art work and student paper topics (paintings included for two, as illustration):

The Wheelwright, Walter D. Sadler: Wheel Making

The Perfumier/Herbalist Production of Perfume Bottles

Additional art works and student papers:

The Glass Blowers in Incheville, Marie F. Firmin-Girard	Glass Blowing
Blast Furnace, Erich Mercker:	Blast Furnace Process in the Production of Steel
Industrial Plant, Behrens:	Safety and Environmental Concerns
The Hop Pickers, C. H. Hart:	Making of Steel Blades
Drop Forging, Friedrich von Keller:	Forging
Foundry worker with Ladle, G.A. Janensch	Casting Processes and Mold Making
Worker and Boss, G. Oppel:	Manufacturing of Porcelain Floor Tiles
Man in Workshop with Armor, E. K. G. Zimmerman	Brass Instrument Building Processes