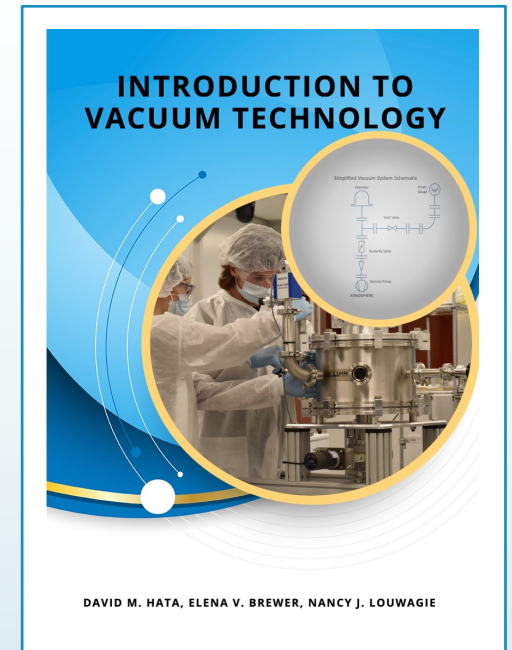


Development of Free Electronic Educational Resources for Technician Education in Vacuum Technology

Elena Brewer, SUNY Erie Community College
Nancy Louwagie, Normandale Community College
David Hata, Portland Community College (retired)

Link to Presentation Recording: <https://youtu.be/ciAqNzXFGvM>



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Developing an E-book and Other Interactive Instructional Materials for Technician Education in Vacuum Technology

NSF New-to-ATE Project #2000454, \$300K Budget

- ▶ PI – **Elena Brewer**, Assoc. Professor, Electrical Engineering Technology and Nanotechnology, SUNY Erie Community College, Williamsville, NY
brewer@ecc.edu
- ▶ Co-PI – **Nancy Louwagie**, Chair, Engineering Technology Programs, Vacuum Technology Department, Normandale Community College, Bloomington, MN
Nancy.Louwagie@normandale.edu
- ▶ Consultant - **David Hata**, Primary Author of *Introduction to Vacuum Technology* textbook, Portland, OR
- ▶ External Evaluator - **Bob Bailey**, Outcomes Consulting Services, Lynchburg, VA



This work is supported by the National Science Foundation under grant number 2000454. Any opinions, findings, and conclusions or recommendations expressed in this e-book are those of the authors and do not necessarily reflect the views of the National Science Foundation.



The Need

- ▶ The **semiconductor companies** need technicians and other personnel to work in their factories as:
 - **maintenance technicians**
 - **process technicians**
 - **equipment managers** who understand vacuum systems, what each system includes and what process does it support
- ▶ **Legislation** to grow the semiconductor industry is introduced:
 - CHIPS for America Act
 - FABS Act
- ▶ New factories are being built:
Example: **Intel Corporation** building new factories in Columbus, OH
(Image Credit: Intel Corporation)



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The Need (Continued)

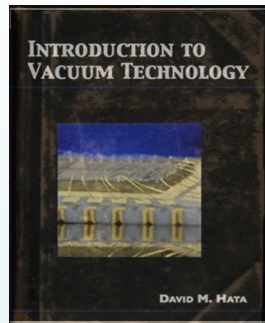
- A key part of a **semiconductor maintenance technician's skill set** is a working knowledge of vacuum technology.
- A **curriculum** for training technicians in vacuum technology requires:
 - **instructional materials**, such as textbooks and laboratory instruction manuals,
 - **training facilities**, such as teaching laboratories with industry-standard vacuum equipment,
 - qualified **instructors** with working knowledge of vacuum systems.



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Current Situation: Instructional Materials



- ▶ **No technician-level textbooks** are currently being published since *Introduction to Vacuum Technology* by David Hata went out-of-print.
- ▶ Many excellent **reference** or resource **books** are available, but there are no textbooks suitable for technician's education. Examples are:
 - *A User's Guide to Vacuum Technology*, John O'Hanlon
 - *Modern Vacuum Practices*, 3rd ed., Nigel Harris
 - *Vacuum Technology: A Beginning*, Harland G. Tompkins
 - *Overview of Vacuum Technology*, Tim Gessert.



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Current Situation: Vacuum Technology Programs / Courses

There are few **vacuum technology programs and/or courses** offered by **community colleges** for training technicians in the US. The following community colleges already have programs/courses in vacuum and have teaching laboratories with vacuum equipment:

- Normandale Community College (with telepresence for remote instruction):
 - Vacuum and Thin Film Technology AAS Program**,
 - Vacuum Maintenance Technician Certificate** (28-29 credits),
 - Vacuum Technology Certificate** (9 credits)
- SUNY Erie Community College:
 - Electrical Engineering Technology AAS Program** (with set of 3 vacuum technical elective courses)
 - Nanotechnology AAS Program** (currently under revision, will contain 3 vacuum courses, which also available for EET students)
 - Vacuum Technology micro-credential** (under development, will cover the same scope as Vacuum Technology Certificate from Normandale CC, 9-11 credits)



Vacuum Lab at SUNY Erie CC



Vacuum Lab at Normandale CC



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Current Situation: Vacuum Technology Programs / Courses

- ▶ Hudson Valley Community College (NY)
Electrical Technology: Semiconductor Manufacturing Technology AAS Program, Semiconductor Technology Certificate (25 credits)
 - ▶ Mohawk Valley Community College (NY)
Semiconductor Manufacturing Technology AAS Program
 - ▶ Penn State University (PA)
Nanofabrication Manufacturing Technology capstone semester (19 credits)
 - ▶ Portland Community College (OR)
Microelectronics Technology 2-year Associates Program
 - ▶ Rio-Salado College (AZ) –
Nanotechnology AAS Program
Nanotechnology Certificate (9 credits)
Nanotechnology and Manufacturing Certificate (19 credits)
- and others ...



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Current Situation: Vacuum Technology Instruction

- Most community colleges have **small departments** and face **scarcity of qualified teaching faculty** with the necessary technical expertise in vacuum technology.
- This creates a **barrier to the development of the curriculum** in vacuum technology (or infusing vacuum topics into existing curriculum).
- Another barrier to entry into teaching vacuum curriculum is a **cost of vacuum equipment** and **knowledge of what equipment is necessary** for laboratory experience.



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Turning Lack into Opportunity

The project team decided that the lack of suitable instructional materials in vacuum technology is a great opportunity to develop:

- ▶ An **e-book** adaptation of Hata's textbook with more resources that **support different student learning styles** beyond just reading text (interactive content, videos, animations, simulations) and support non-traditional students.
- ▶ **Ancillary materials:** Student Laboratory Manual and Instructor's Guide
- ▶ Published through **Milne Publishing, SUNY Geneseo.**



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Current and Follow-up ATE Projects

- Current ATE Project (DUE #2000454) focuses on **Rough Vacuum Systems** and covers only four chapters.

[TOC](#) and
Learning
Objectives

[Animation
Examples](#)

[Simulation
Example](#)

[Quiz
Example](#)

[Video
Example](#)

[Video / Animation
Example](#)



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Current and Follow-up ATE Projects

- ▶ Proposed Follow-on ATE Project will focus on **High Vacuum Systems** and **Advanced Topics**:
 - We will submit the follow-up project in October 2022.
 - Current project is a New-to ATE project and does not provide enough funding and time to do both rough and high vacuum systems.



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Lessons Learned: Choosing Publishing Platform

Criteria for choosing the on-line publishing platform:

- ▶ Required **functionality**:
 - formulas engine,
 - embedded videos, animations, and simulations,
 - self-generated table of contents,
 - embedded interactive quiz questions, and
 - ability to publish in different formats (PDF, HTML, EPUB).
- ▶ **Sustainability** requirement: free or low-cost housing of the resource after grant ends. **Milne Publishing** offers free and indefinite housing of the e-book and related ancillary materials on their platform.
- ▶ **Learning curve** for the team that is does not have prior e-publishing experience.



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Lessons Learned: Choosing Publishing Platform

- ▶ **Milne Publishing**, at **SUNY Geneseo** offers:
 - free publishing with incredible free personal support (through SUNY Geneseo library staff),
 - indefinite placing of OER resources on their platform,
 - all the required functionality,
 - very manageable learning curve with live help from SUNY Geneseo Milne Library staff.
- ▶ Some of the other publishing platforms evaluated, but not selected, were OpenStax (developed by Rice University) and LibreTexts (developed by University of California).



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Lessons Learned: Animations Development

- Involve **student-artists** to create still graphics for animation's sequences.
- Combine still graphics into **GIF file** using free on-line GIF generators (such as "imgflip").
- **Embed** shorter GIF (Graphics Interchange Format) files directly in the e-book.
- **Record** longer GIF files **in MP4 format** and upload to **youtube**. The link to the youtube video can be embedded in the e-book.
Advice: create a dedicated youtube channel to house these videos and upload MP4 files as "Unlisted" if you do not want people to search them directly.



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Lessons Learned: Interactive Quizzes

- ▶ True/False and Multiple/Choice questions are straightforward to create.
- ▶ Make sure you build in feedback for correct and incorrect answers. If student answered question incorrectly, you may place reference to the e-book section where this material is covered.
- ▶ The immediate feedback is vary valuable for students in assessing their understanding of the material.

[INTERACTIVE QUIZ EXAMPLE](#)



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Lessons Learned: Cost Control in Video Materials Development

- ▶ **Professionally recorded videos** will take a substantial chunk of the project's budget (tens of thousands of dollars for several minutes of final video product).
- ▶ **Use “in-house” talent** – faculty, staff, or students who have experience creating and editing videos.
- ▶ Use educational discount when acquiring **video editing software** (Vegas Pro 19 with educational discount is only \$149, without educational pricing - \$359).
- ▶ **Cooperate with outside industry vendors** (examples: Busch Vacuum Solutions, Kurt J. Lesker CoP) to obtain permission (in-writing) to use their video materials and agreement on how materials should be cited/licensed.
- ▶ **Cooperate with** current or prior **ATE centers** (example: MATEC) to be able to use video materials they developed.



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Lesson Learned: Subject Matter Experts (SMEs) Review Process

- ▶ Make sure that SME board represents all of the **stakeholders**:
 - **industry** needs to make sure that future technicians are well prepared for their future employment;
 - **academia** (faculty) need to evaluate pedagogical value of the resource;
 - **professional societies and ATE Centers** are more familiar with overall industry trends and also may have expertise in teaching vacuum-related topics.
- ▶ **10 SMEs** reviewed four chapters of the developed e-book in Fall 2021. The SME review board members represent:
 - **industry**: Kurt J. Lesker Co, Advanced Materials Technology Group, PCB Piezotronics, Intel (retired), NREL (retired), IBM (retired)
 - **academia**: Erie CC, Normandale CC, Hudson Valley CC, University of New Mexico, Penn State University, University of Arizona (former)
 - **professional societies**: AVS (American Vacuum Society) and SVC (Society of Vacuum Coaters)
 - **ATE Centers**: Center for Nanotechnology Education and Utilization (CNEU)



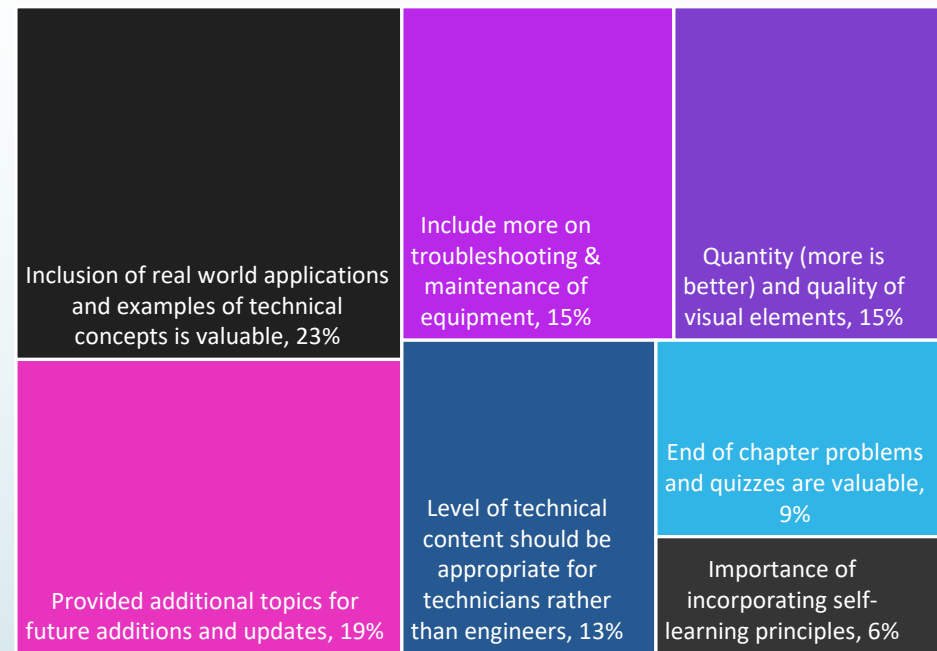
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Lesson Learned: Subject Matter Experts (SMEs) Review Process

Feedback from SMEs was positive and provided suggestions for improving e-book. However, it was a lot of concrete feedback leading to e-book revisions, which took longer than was originally planned.

Common Themes from Subject Matter Expert Review



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Lesson Learned: Student / Faculty Feedback from Using E-book

- ▶ Hands-on Learning Activities (labs) will be tested in Normandale CC and SUNY Erie CC classes during Fall 2022.
- ▶ If you **are interested in testing e-book or laboratory materials in your classes in Spring 2023**, please contact Project PI Elena Brewer at brewer@ecc.edu. \$600 stipend will be provided to compensate faculty for incorporating material into their courses and meeting reporting requirements.



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Lessons Learned: Dissemination

- **Project Website:** ATE Central provides the most straightforward way of creating project website for ATE Projects at <https://atecentral.net/microsites>.

PROs:

- simple and fast to create the project website,
- free,
- ATE Central is also an archiving agency for ATE Projects.

CONS:

- limited elements can be incorporated into the website / microsite



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Lessons to Be Learned: On-Site Hands-On Professional Development Workshop

- ▶ **WHO:** community college faculty, travel support is available
- ▶ **WHEN:**
 - May 23 or May 24, 2023 – Zoom workshop kick-off meeting ,
 - June 21-23, 2023 – on-site portion of the workshop.
- ▶ **WHERE:** Normandale Community College, Bloomington, MN
- ▶ **WHAT:** hands-on experience working with rough vacuum systems



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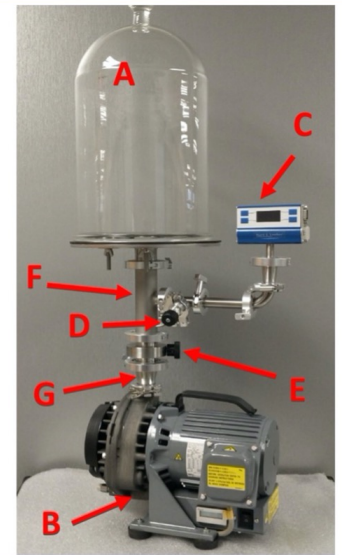
Lessons to Be Learned: On-Site Hands-On Professional Development Workshop



**Rough Vacuum System
Normandale Community College**

Rough Vacuum System

- A – Chamber 
- B – Vacuum Pump 
- C – Pirani Gauge 
- D – Vent Valve 
- E – Butterfly Valve 
- F – T-piece Pipeline with KF40 coupling 
- G – KF40 to KF16 Reducer Nipple 



Rough Vacuum System, SUNY Erie Community College



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Conclusion

- ▶ If you have any **questions** OR
- ▶ If you want to be involved in **class-room testing** of e-book and/or laboratory ancillary materials OR
- ▶ If you are interested in **attending Hands-On Professional Development Workshop** in Summer 2023

Please contact project PI, Elena Brewer, at
brewer@ecc.edu



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Thank You!



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