Elizabethtown College, EGR/CS 434

Robotics, Automation, and Machine Intelligence

Fall 2023

Cutting-edge innovations in robotics, automation, and machine intelligence that result in the most environmentally friendly and humanity-sensitive use of technology and resources to manufacture products or aid humans. Various forms of machine intelligence including symbolic AI which uses programmed rules, heuristics, and forms of knowledge representation; and artificial neural networks which are connectionist computer architectures (hardware or software) where many computational nodes are connected to solve problems requiring rapid adaptation, or where governing equations are not known or cannot be easily computed. Mobile-robot and robotic-arm theory, applications, simulations, real-time control, and path-planning. Human Computer Interactions (HCI). Periodic creation of large mobile robots. **Prerequisite(s):* CS 121 and MA 121. Fall semester, odd-numbered years.

MEETING TIMES MW 2:00-3:30pm in E273

PROFESSOR

Joseph T Wunderlich PhD
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	Monday	Tuesday	Wednesday	Thursday	Friday
10:30	10:30-11:00 OFFICE				
11:00	11-12:20 **FYS100** in E273 Organic Architecture & Frank Lloyd Wright	11-12:20	11-11:50 FYS Peer Mentor	11-12:20	11-12:20 **FYS100** in E273 Organic Architecture & Frank Lloyd Wright
11:30					
12:00			OFFICE		
12:30	12:30-1:50 **CS170** in E273	12:30-1:50	12:30-1:50 **CS170** in E273	12:30-1:50	12:30-1:50 **CS170** in E273
1:00	WHEN ANNOUNCED	MEETING	Computer Game Design and Virtual Reality		Computer Game Design and Virtual Reality
1:30		PERIOD			
2:00	2-3:20 **EGR434** in E273 Robotics and Machine Intelligence	2-3:20	2-3:20 **EGR434** in E273 Robotics and Machine Intelligence	2:00-3:20	1:50-3:10 OFFICE
2:30					
3:00					
3:30	OFFICE	3:30-4:50	3:30-4:50	3:30-4:50	3:30-4:50
4:00	4-5:40 **EGR495** in E273 Architecture Design Studio I	MEETING		MEETING	
4:30		PERIOD		PERIOD	
5:00					
5:30					

EGR401 Senior Projects at Arranged Times

ACADEMIC HONESTY

ELIZABETHTOWN COLLEGE PLEDGE OF INTEGRITY: ***"Elizabethtown College is a community engaged in a living and learning experience, the foundation of which is mutual trust and respect. Therefore, we will strive to behave toward one another with respect for the rights of others, and we promise to represent as our work only that which is indeed our own, refraining from all forms of lying, plagiarizing, and cheating."***

See the 2016-17 Elizabethtown College Catalog, "Standards of Academic Integrity" http://catalog.etown.edu/content.php?catoid=10&navoid=507#Academic_Judicial_System
or Academic Integrity at Elizabethtown College, 11th ed. https://www.etown.edu/offices/dean-of-students/files/academic-integrity-handbook.pdf

ARTIFICIAL INTELLIGENCE USE

"In this course, students shall give credit to AI tools whenever used, even if only to generate ideas rather than usable text or illustrations. When using AI tools on assignments, add an appendix showing (a) the entire exchange, highlighting the most relevant sections; (b) a description of precisely which AI tools were used (e.g. ChatGPT private subscription version or DALL-E free version), (c) an explanation of how the AI tools were used (e.g. to generate ideas, turns of phrase, elements of text, long stretches of text, lines of argument, pieces of evidence, maps of the conceptual territory, illustrations of key concepts, etc.); (d) an account of why AI tools were used (e.g. to save time, to surmount writer's block, to stimulate thinking, to handle mounting stress, to clarify prose, to translate text, to experiment for fun, etc.). Students shall not use AI tools during in-class examinations, or assignments unless explicitly permitted and instructed. Overall, AI tools should be used wisely and reflectively with an aim to deepen understanding of subject matter."

Source: https://ctl.utexas.edu/chatgpt-and-generative-ai-tools-sample-syllabus-policy-statements

LEARNING OUTCOMES

- Mobile Robot Design
- Robotic Arm Design
- Machine Intelligence

GRADING *(due-dates announced, but typically every Monday)*

20% Attendance, Participation, Demonstrated understanding of required readings, and In-class activities (including quizzes)
25% Project #1 *(Proposal and final deliverables)*
25% Project #2 *(Proposal and final deliverables)*
30% Comprehensive Final Exam *(including questions on individual project contributions)*

Course Grade: (60-62)=D-, (63-67)=D, (68-69)=D+, (70-72)=C-, (73-77)=C, (78-79)=C+, (80-82)=B-, (83-87)=B, (88-89)=B+, (90-92)=A-, (93-100)=A
(with any fractional part rounded to the nearest integer)

TWO DESIGN or RESEARCH PROJECTS

Everything must be uploaded to Canvas *(and look there for due dates and additional submission details)*

- Pure research projects must be by only individuals.
- Individuals or groups may be formed, but complexity of project must scale with the number of people. **Both projects may be sequenced to create phases of a "super-project" – but then expectations will also be super-sized; and some creative fund-raising would be expected (e.g., Phoenix Contact USA or Germany, Etown Student Senate, Local businesses, Etown Senior Staff Discretionary funds, Grants or start-up funds of various professors, etc.**

Papers must be in two-column, single-spaced, 10-point font using IEEE formatting dictated by: https://www.ieee.org/conferences_events/conferences/publishing/templates.html

- 4 to 5 pages (not including appendices) and include:
  - An Abstract (one or two paragraphs)
  - A number of discussion sections
  - A Conclusions section
  - A bibliography – call it "References." Excessive use of Wikipedia and non-scholarly citations will be penalized. (use the library, and Google Scholar, instead of just Google). Many high-quality citations are expected for research papers – nothing if you build something and it fully functions.
  - Appendices for supporting materials (code, sketches, drawings, data collected, manufacturers literature, etc.)
- Design/Build papers should be 2 to 3 pages (not including appendices) and include:
  - An Abstract (one or two paragraphs)
  - Design specification (and talk about options considered and decisions made)
  - User manual
  - Optional bibliography – call it "References." Nothing is expected here if you if you build something and it fully functions.
  - Appendices for supporting materials (code, sketches, drawings, data collected, manufacturers literature, etc.)

5- minute (max) PowerPoint presentation, with embedded-Audio, or a YouTube video for both projects

- Up to 10 minutes allowed for projects with more than four people.
- Some possible topics for semester projects *(don't feel obliged to pick one of these and consult RMI Club President for support of build projects)*:
  - Details of Teslabot robotics & AI
  - Details of ChatGPT
  - Generative AI examples
  - Stopping deep fakes
  - Next-generation of e-bot's
  - Competitions (see report for last major international competitor)
  - Rover for a selected planet or moon (parallel the design process in class for the europa rover)
  - Rover for a remote earth environment (parallel the design process in class for the europa rover)
  - Environmental probes
  - Robot for post-disaster clean-up
  - Air pollution monitoring robot (and maybe control)
  - Sensor fusion for pose estimation (e.g, motion capture + vision + gps + more)
  - Robot swarms
  - High-tech smart-house design
  - High-tech green architectural materials
  - Automated agriculture
  - Ai for factory energy efficiency
  - Networked factory automaton
  - U.S. improvement in factory automation (compare to Japan and EU countries)
  - Intelligent railroads
  - Medical assistive devices
  - Assistive robot for a masonic homes resident
  - Intelligent energy generation, distribution, and load-shedding
  - Intelligent and safe control of sustainable energy sources (e.g., solar, wind, geothermal, nuclear, hydrogen fuel cells)
  - AI for controlling internet information (e.g., CYBERSECURITY, CREATING SAFE VIRTUAL WORLDS, MINIMIZING POLARIZATION OF CIVILIZATIONS, etc)

ATTENDANCE

Class participation is part of your course grade. Also, exams cover mostly material that is only presented in lecture.

SCHOOL CLOSURE / CLASS CANCELATION

Additional work assigned to cover any class cancelation

LECTURES & REQUIRED *(testable)* READINGS

Lectures made from teaching a variation of this course at Elizabethtown College since 2000, and once as a PhD course at The University of Trento in Ital. Lectures include examples from my research at IBM, A.I. Dupont Children's Hospital, and elsewhere before 1999 *(see the details on my CV),* and research by my students and I since then.

34 YEARS OF ROBOTICS & MACHINE INTELLIGENCE

1989-1999 1999- Etown Projects 2004 Etown Simulation Course RMI Lab Creation 2009 PhD Course Phoenix Contact USA &Germany (15 year relationship)	Penn State, U. Delaware, AI Dupont Hospital, IBM R&D, Purdue Univ., Elizabethtown 24 years of student symposiums (pre-dating Scholarship Day) 1st lab site, seven Wunderbots: charter, website, IGVC *(international competition)* Lab site now University of Trento, Trentino Alto, Italy 2017 Invited speaker at EDUNET conference, Vienna Austria *Twenty years of Elizabethtown College Robotics & Machine Intelligence*	CV

ROBOTICS

Lectures

Readings

(see Canvas for ones required)

ROVERS IN SPACE **- Solar System** PPT PDF **- Rovers In Space** PPT PDF **- Europa** PPT PDF	**Space Exploration: 1971** Lunar Rover; **1996** Mars Pathfinder Sojourner; **2004** Mars Rovers Spirit & Opportunity; **2011** Mars Science Lab; **2017** Mars ExoMars; **1977** *Voyager 1 & 2;* **1989** *Galileo;* **2020** Europa Jupiter "Clipper" Mission (wiki); **~2024** Europa Lander/Rover (wiki)	2 3 4 6 8 29 34 35
ROVER MECHANICS PPT PDF	Manned vs. unmanned, Biomimicry, Mobility, Suspension systems, Wheels and traction, Maneuverability, Stability, and Controllability	**1** 34, 35
ROVER DELIVERY PPT PDF **ROVER POWER** PPT PDF	Launch, landing, deployment, Hardening for heat, cold, radiation, and vibration. Electrical power demand, generation, and storage	3 4 9 28
ROBOTIC ARM DESIGN PPT PDF	Dexterous manipulation, Redundant manipulators, Psuedo-inverse velocity-control **PATH-PLANNING**, Attractive poles, Repelling-fields, Null-space, Heuristic search for DOF and energy minimization, *"**C**onsumption **O**f **A**vailable **R**edundancy (COAR),"* Rapid prototyping Calculus Tutorial Robots for the disabled	**5** (Reading used as Lecture) 14 15 54 22
SENSORS & NAVIGATION for Rovers and Arms PPT PDF PDF	**PATH-PLANNING**, Dead reckoning, Celestial navigation, Mapping, Positioning, Steering, Sensors, Tele-operation, Remote communication, Local and global path-planning, Obstacle avoidance, Systems integration, Autonomy **Virtual/Augmented Reality**	1 3 11 12 18 31 32 33 36 37 61 62 63
UAVS, UUV'S, AND SWARMS PPT PDF	Unmanned Aerial Vehicles (UAV's); Unmanned Underwater Vehicles (UUV's) Networked swarms, future Wunderbot Team of robots and probes	30

COMPUTER FUNDAMENTALS PPT PDF	Simulations, real-time control , Embedded systems, Microcontrollers, Microprocessors, PC's, Workstations, Super computers, Quality control	17 19 25 *26* 27 28 37

MACHINE INTELLIGENCE

VIDEO PPT PDF Readings used as lectures Upcoming Wunderlich Book Chapter PDF PPT PDF PDF Upcoming Wunderlich Book Chapter	INTRO TUTORIAL Symbolic AI (The original Machine Intelligence, now partnered with "Deep Learning" Neural Network techniques) • AI Expert Systems ○ Probability theory vs. Uncertainty, Confidence "Deep-Learning" Neural Networks HISTORY: Association, Threshold Logic, Synaptic modification, Hill-climbing, Perceptron, Adaline/Madilines, Linear separability (Generalizing & Classifying), Selective awareness, Hopfield nets, Self-organizing, Neocognitron, Simulated annealing (Global Optimization), Neuron transfer functions, Boltzmann machine, Back-propagation/generalized-delta-rule layered-network supervised (labeled) learning, Human brain physiology, Biological vs artificial neurons, Human senses. Human vs computer vision. • Biologically-inspired ("Spiking") vs. psychologically-inspired Artificial Neural Networks • MATLAB DEEP LEARNING (Neural Network) TOOLBOX • Neural Network Math and Code/Algorithm Development • Wunderlich Mental Ability Matrix (i.e., "What is Smart?") Philosophy & Psychology • Multivariable Calculus tutorial ○ Gradient Descent Neural Network Learning • Comparison of two Wunderlich Neurocomputer designs ○ Biologically-inspired "Bottom-Up" VLSI chip vs Psychologically-inspired "Top-Down" all-digital single-chip design with on-chip learning	55 57 58 73 **10 13 74 16 52 53 55 75** 56 **57 58 76 64** 65 67 68 69 70 **79** 80 **81 82 83**

PDF PPT	ETHICS: Replacing vs. aiding humans, Limiting robot autonomy IBM Watson - CONCEPTS: Observation/Evaluation/Decision-Making, Unstructured data, Natural language processing, Context, Intent, Inferences, Multimodal "Cognitive-Computing" (many forms of Machine Learning) and "Deep-Learning" (both supervised and unsupervised) METHODOLOGY: "Corpos" of literature, Curating, "Ingestion" (indexing & organizing), "QuestionAnswer" pairs (by experts) for "Ground Truth", Continuous learning, evidence-based recommendations, Yield of new inferences and patterns, hypothesis' generation/evidence-search/confidence from weighted evidence scores from many simultaneous algorithms for each of multiple answers, Data Analytics to help human experts augment their decisions - Hardware/ Software - HCI (Human Computer Interactions), including use of humanoids - Some initial applications (medicine, education, law, finance, weather) - Compare IBM Watson to its rivals (Google, Microsoft, etc) - CUDA CORES - TESLA DOJO COMPUTER (for cars and new robots)	77 38 39 65

Other Related Topics (time permitting):

PREVIOUS COURSE PDF1 PDF2	When course required for Sustainable Design and Industrial Engineers	43 44 59 60
HI-TECH GREEN ARCHITECTURE	AI in building environmental controls	40 VIDEO: 73
GREEN MANUFACTURING		45 46 47 48 49 50 51
INTELLIGENT ENERGY CONTROL	for generation, distribution, load-shedding, and storage	SUSTAINX
RAILROAD AUTOMATION		

REQUIRED READINGS will be selected from the following (In RED are Highly Recommended Purchases):

[1] Siegwart, R. and I. Nourbakhsh, I. (2004), ***Autonomous mobile robots***, Massachusetts Institute of Technology, 2004. (ISBN: 026219502X)
[2] Clark, Stankov, Pappalardo, Blanc, Greeley, and Lebreton (2016) , **Europa Jupiter System Mission; A Joint Endeavour by ESA and NASA**, NASA Report,
[3] Anthony H. Young, (2006) ***Lunar and planetary rovers: the wheels of Apollo and the quest for mars*** Springer; 1 edition. (ISBN: 0387307745)
[4] Ulivi, P. and Harland, D., ***Robotic exploration of the solar system: part II: hiatus and renewal, 1983-1996***, Praxis; 1 edition, November 25, 2008. (ISBN: 0387789049)
[5] Niku, S. B. (2001), ***Introduction to Robotics: Analysis, Systems, Applications***, Prentice Hall (ISBN: 0130613096)
[6] Greenberg, R. (2008), ***Unmasking Europa: The search for life on Jupiter's ocean moon***, Springer; 1 edition. (ISBN: 0387479368)
[7] Audouze, R. (Editor), G. Israel (Editor), ***The Cambridge atlas of astronomy,*** Cambridge University Press; 3 edition, , (ISBN: 0521434386)
[8] Website: **Europa, a Continuing Story of Discovery** [**http://www2.jpl.nasa.gov/galileo/europa/**].
[9] Website: **JPL Photojournal** [**http://photojournal.jpl.nasa.gov/catalog/PIA01144**].
[10] Wunderlich, J.T. (201X). **Two single-chip neurocomputer designs; one bottom-up, one top-down.** *(draft journal paper)*
[11] Painter, J. and Wunderlich, J.T. (2008). **Wunderbot IV: autonomous robot for international competition.** In *Proceedings of the 12th World Multi-Conference on Systemics, Cybernetics and Informatics: WMSCI 2008, Orlando, FL*: (pp. 62-67).
[12] Coleman, D. and Wunderlich, J.T. (2008). **O^3: an optimal and opportunistic path planner (with obstacle avoidance) using voronoi polygons.** In *Proceedings of IEEE the 10th international Workshop on Advanced Motion Control, Trento, Italy.* vol. 1, (pp. 371-376). IEEE Press.
[13] Wunderlich, J.T. (2004). **Top-down vs. bottom-up neurocomputer design.** In *Intelligent Engineering Systems through Artificial Neural Networks, Proceedings of ANNIE 2004 International Conference, St. Louis, MO.* H. Dagli (Ed.): Vol. 14. (pp. 855-866). ASME Press. [*"Novel Smart Engineering System Design Award, 2nd runner-up best paper"* from over 300 submissions],
[14] Wunderlich, J.T. (2004). **Simulating a robotic arm in a box: redundant kinematics, path planning, and rapid-prototyping for enclosed spaces.** In *Transactions of the Society for Modeling and Simulation International*: Vol. 80. (pp. 301-316). San Diego, CA: Sage Publications.
[15] Wunderlich, J.T. (2004). **Design of a welding arm for unibody automobile assembly.** In *Proceedings of IMG04 Intelligent Manipulation and Grasping International Conference, Genova, Italy*, R. Molfino (Ed.): (pp. 117-122). Genova, Italy: Grafica KC s.n.c Press.
[16] Wunderlich, J.T. (2003). **Defining the limits of machine intelligence.** In *Proceedings of IEEE SoutheastCon, Ocho Rios, Jamaica*, [CD-ROM]. IEEE Press.
[17] Campos, D. and Wunderlich, J. T. (2002). **Development of an interactive simulation with real-time robots for search and rescue.** In *Proceedings of IEEE/ASME International conference on Flexible Automation, Hiroshima, Japan*: (session U-007). ASME Press.
[18] Lister, M. and Wunderlich, J. T. (2002). **Digital communications for a mobile robot.** In *Proceedings of IEEE SoutheastCon*, Columbia, SC, [CD-ROM]. IEEE Press.
[19] Wunderlich, J.T. (2001). **Simulation vs. real-time control; with applications to robotics and neural networks.** In *Proceedings of 2001 ASEE Annual Conference & Exposition, Albuquerque, NM*: (session 2793), [CD-ROM]. ASEE Publications.
[20] Wunderlich, J.T. and Boncelet, C.G. (1996). **Local optimization of redundant manipulator kinematics within constrained workspaces.** In *Proceedings of IEEE Int'l Conference on Robotics and Automation*, Minneapolis, MN: Vol. (1). (pp. 127-132). IEEE Press.
[21] Wunderlich, J.T. (1996). **Optimal kinematic design of redundant and hyper-redundant** manipulators for constrained workspaces. *Ph.D. Dissertation*, University of Delaware.
[22] Wunderlich, J.T., S. Chen, D. Pino, and T. Rahman (1993). **Software architecture for a kinematically dissimilar master-slave telerobot**. In *Proceedings of SPIE Int'l Conference on Telemanipulator Technology and Space Telerobotics*, Boston, MA: Vol. (2057). (pp. 187-198). SPIE Press.
[23] Wunderlich, J.T., and Elias, J. (1993). **Design of an artificial dendritic tree VLSI microprocessor.** U.Del. research report, 1993.
[24] Wunderlich, J.T. (1992). **A vector-register neural-network microprocessor with on-chip learning.** *Masters Thesis*, Pennsylvania State University.
[25] Wunderlich, J.T. (1999). **Focusing on the blurry distinction between microprocessors and microcontrollers.** In *Proceedings of 1999 ASEE Annual Conference & Exposition, Charlotte, NC*: (session 3547), [CD-ROM]. ASEE Publications.
[26] Wunderlich, J.T. (2003). **Functional verification of SMP, MPP, and vector-register supercomputers through controlled randomness.** In *Proceedings of IEEE SoutheastCon, Ocho Rios, Jamaica*, M. Curtis (Ed.): (pp. 117-122). IEEE Press.
[27] Wunderlich, J.T. (1997). **Random number generator macros for the system assurance kernel product assurance macro interface**. Systems Programmer's User Manual for IBM S/390 Systems Architecture Verification, Poughkeepsie, NY.
[28] Patterson, R.L.. and Hammoud, Ahmad. (2004) **Reliability of Electronics for Cryogenic Space Applications Being Assessed**. *NASA Research and Technology 2004.*
[29] Pappalardo, R.T. (2006). **Europa: processes and habitability** (presentation)**.** Pasadena, CA: Jet Propulsion Laboratory, National Aeronautics and Space Administration
[30] Henderson, S., Shreshtha, S., Wunderlich, J.T. (2004). **A high speed AUV test platform** *(submitted to military conference).*
[31] Painter, J. G. (2008). **Vision system for Wunderbot IV autonomous robot**. *Elizabethtown College research report.*

[32] Crouse, J. (2008). **The joint architecture for unmanned systems: a subsystem of the wunderbot 4**. *Elizabethtown College research report.*
[33] Painter, J. G., Coleman, D., Crouse, J., Yorgey, C., and Wunderlich, J.T. (2008) **Wunderbot 4 IGVC report**. *Judged and published on-line by IGVC.*
[34] Boeing Company and NASA (1971) **LRV operations handbook**. Document LS006-002-2H.
[35] Boeing Company and NASA (1971) **LRV operations handbook. appendix A performance data**. Document LS006-002-2H.
[36] Carsen, A., Rankin, J., Fuguson, D., and Stentz, A. (2007). **Global path planning on board the mars exploration rovers**. *In Proceedings of the IEEE Aerospace Conference, 2007. IEEE Press. (available at http://marstech.jpl.nasa.gov/publications/z02_0102.pdf)*
[37] Bajracharya, M., Maimone, M.W., and Helmick, D. (2008)**. Autonomy for mars rovers: past, present, and future**. In *Computer*: December, 2008. (pp. 44-50). *IEEE Press. (available at **http://marstech.jpl.nasa.gov/publications/z02_0102.pdf**)*
[38] Wunderlich, J.T. (2011). **Designing robot autonomy: how tightly should we hold the leash?** *The 5th Int'l Conference on Design Principles and Practices,* Rome, Italy.
[39] Byman,D., Cronin, A.K., **Death from above; are drones worth it**, *Foreign Affairs* Vol 92,no.4, , July/August, 2013.
[40] Norbert Lechner, ***Heating, Cooling, Lighting: Sustainable Design Methods for Architects,*** 2007, Wiley; 3rd edition, November 24, 2008
[41] Wunderlich, J.T. and Wunderlich, J.J. (2013). **Green architecture and environmental design using rapid-prototyping social-networking sandbox tools, followed by professional architectural software.** ***Asian Conference on Sustainability, Energy & the Environment* (ACSEE 2013)**, June 6-9, Osaka, Japan. [1 of 3 chosen from 250 for extended 45-minute "Spot-lighted" Key-note talk] **TALK PAPER**
[42] Wunderlich, J.T. and Wunderlich, J.J. (2014). **Crowdsourced Architecture and Environmental Design.** 2nd *International Conference on Emerging Trends in Engineering and Technology (ICETET'2014*) May 30-31, London (United Kingdom). **TALK PAPER**
[43] Wunderlich, J.T.(2012).**Creating an engineering program in sustainable design for a U.S. liberal arts college.** *6th Int'l Conf on Design Principles & Practices*, Los Angeles
[44] Wunderlich, J.T. (2013). **Green robotics, automation, and machine intelligence; a new engineering course in sustainable design.** *International Symposium on Green Manufacturing and Applications* (ISGMA 2013), June 25-29, Oahu, Hawaii.
[45] Ishise,T., Kimura1,T. , Osako,K. , Matsuyama,S. and Nakanishi,K (2013). **Recyclability of fiber wastes as reinforcement of composite materials,** *International Symposium on Green Manufacturing and Applications* (ISGMA 2013), June 25-29, Oahu, Hawaii.
[46] Negoro,T., Inoya,H., Ota,T., Yamada,K., and Hamada,H. (2013). **Creation of PET bottle recycling society in small scale,** *International Symposium on Green Manufacturing and Applications* (ISGMA 2013), June 25-29, Oahu, Hawaii.
[47] Negoro,T., Inoya,H., Ota,T., Yamada,K., and Hamada,H**.** (2013). **Verification of the effect to reduction of emission of carbon dioxide by using recycled materials and dope-dyeing method,** *International Symposium on Green Manufacturing and Applications* (ISGMA 2013), June 25-29, Oahu, Hawaii.
[48] Cimellaro,G.P., Reinhorn,A.M., and Bruneau,M. (2013). **Sustainable warehouses and industrial shed structures after 2012 earthquake in northern italy,** *International Symposium on Green Manufacturing and Applications* (ISGMA 2013), June 25-29, Oahu, Hawaii.
[49] Shin,J.-H. and Chang,S.-M. (2013). **Aerodynamic design for the rotor of a savonius turbine using CFD,** *International Symposium on Green Manufacturing and Applications* (ISGMA 2013), June 25-29, Oahu, Hawaii.
[50] Park,M.-W., Kim,J-K. Kang,M, Eum,K, Lee,T., Park,H--S. and Park,J.-W**.** (2013). **Development of a process planning system for machining and assembly,** *International Symposium on Green Manufacturing and Applications* (ISGMA 2013), June 25-29, Oahu, Hawaii.
[51] Nam,S.-H., Shin,J.-H. , Lee,D.-H., Baek.J-Y., and Lee1,S.W.(2013). **Development of integrated shop operation system in multiple FMC environments with real-time re-scheduling architecture,** *International Symposium on Green Manufacturing and Applications* (ISGMA 2013), June 25-29, Oahu, Hawaii.
[52] Wunderlich, J.T. (1992). **A vector-register neural-network microprocessor with on-chip learning; Appendix A "Machine Intelligence History** (Part of Chapter 1 of a book draft)**"** *Masters Thesis*, Pennsylvania State University
[53] Wunderlich, J.T. (2009) **BIGXORtest.m Backpropagation Neural Network Matlab code.**
[54] Wunderlcih, J.T. (1993) **Robotics Review**, talk given to robotics researchers (U.Del, U.Penn, Oxford, Cambridge), Applied Science and Engineering Lab, A.I. Dupont Hospital.
[55] **Excerpts from AI Expert Systems Texts** (PART 1)
[56] **VP-Expert user manual**.
[57] Wunderlcih, J.T. (1991), VP-Expert Case Study: **"Doctor's Office Answering Service".**
[58] Wunderlcih, J.T. (1991), VP-Expert Case Study: **"Selecting a toy for a baby".**
[59] Wunderlich, J.T. (2009), **PhD Course in Advanced Robotics**, visiting Professor of Engineering, University of Trento, Italy.
[60] Wunderlich, J.T. (2017) **Development of Elizabethtown College Robotics & Machine Intelligence Lab**, Invited talk at Phoenix Contact Edunet Conference, Vienna, Austria.
[61] (2017): **Moving Closer to Reality,** IEEE Spectrum.
[62] (2017): **How Augmented Reality (AR) is changing the way we work,** IEEE Spectrum.
[63] (2017): **Second Life Founders Second Act,** IEEE Spectrum.
[64] Ferrucci, D.A.(2010), **"Building Watson: An Overview of the DeepQA Project"** , AI Magazine.
[65] Ferrucci, D.A.(2012),**" Introduction to "this is watson" ",** IBM Journal of Research and Development.
[66] VIDEO: PBS (2015) **"IBM Watson: Smartest machine ever built" ,** PBS NOVA episode
[67] Baker, Stephen (2012), ***"Final Jeopardy,"*** Mariner Books Publishing.
[68] Brynjolfsson , E and McAfee,A (2014), ***"The Second Machine Age"***, W Norton & Son Publishing.
[69] Kelly,J.E.,and Hamm,S (2013),"***Smart Machines, IBM's Watson and the Era of Cognitive Computing,"*** Columbia University Press
[70] E Salvi,E, Parimbelli,E, Basadonne,A, Viani, N (2017) **"MD Anderson Breaks With IBM Watson, Raising Questions About Artificial Intelligence in Oncology",** JNCI: Journal of the National Cancer Institute.
[71] VIDEO: Matias, J Nathan (2017) **"Governing Human and Machine Behavior in an Experimenting Society"** MIT PhD Dissertation Defense. Video.
[72] Borg, Scott (2015) Cybersecurity Training Course notes, Washington DC.
[73] VIDEO: Yorgey,M.,Starkey,L.,Vanderpool,A, and Estrada, T (2012), **Active Solar-tracking Photovoltaic System**, Elizabethtown College Senior Project Video
[74] Wunderlich,J,T, (2017) **Calculus Review for Neural Network Learning, and Robotic Jacobian Matrix elements**
[75] **Excerpts from AI Expert Systems Texts** (PART 2) – Probability Theory vs. Confidence Values
[76] IEEE Spectrum Special Report (2016), **"The Promise of Artificial Intelligence"** *and* **"Landing a Job in Artificial Intelligence"**
[77] VIDEO: Oxford University (2016), **IBM Watson discussion,** Oxford University Union.
[78] VIDEO: IBM (2014),**"IBM Watson: How it Works"** IBM.
[79] Niettaanmaki, P, (2015), **"Comparing IBM Watson to It's Rivals"** University of Jyvaskyla.
[80] Wunderlich, J.T. (2017) **Lecture notes on human vs. computer vision**.
[81] Soucek, B. (1989), ***Neural and Concurrent Real-Time Systems,*** John Wiley & Sons. 1989. (ISBN: 0471508896)
[82] Hertz, J., Krogh,A., Palmer, R. G. (1991), ***Introduction to the Theory of Neural Computation,*** Adison-Wesley Publishing, 1991. (ISBN: 020151601)
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DISABILITY SERVICES,
RELIGIOUS OBSERVANCES,
and COVID- RELATED EXPECTATIONS *(if and when put in effective for current semester)*

https://elizabethtown-my.sharepoint.com/:w:/g/personal/ouimetc_etown_edu/EfZ-QooKt_VPjgwsWJz230wB3Rb6CIHsPvE0xuqWCpr-UA?e=4%3acZzjpW&at=9

DISABILITY SERVICES: Elizabethtown College welcomes otherwise qualified students with disabilities and is committed to providing access for all students to courses, programs, services, and activities. If you have a documented disability such as a learning disability or chronic illness or a new circumstance such as a concussion and would like to request accommodations please contact the Director of Disability Services by phone (717-361-1227) or e-mail (daviesl@etown.edu). The Office of Disability Services can provide resources to you and facilitate communication with faculty about reasonable accommodations. After meeting with the Office of Disability Services, please set up an appointment to meet with me, the instructor, to discuss the accommodations as they pertain to my class.

RELIGIOUS OBSERVANCES: The College is eager to facilitate individual religious beliefs and practices whenever possible while retaining course student learning outcomes. It is your responsibility to meet with the class instructor in advance to request arrangements related to your religious observances that may conflict with this class, and to make appropriate plans to make up any missed work.

COVID-RELATED EXPECTATIONS: All students are expected to adhere to the established community expectations around safety, including: daily digital health reporting, physical distancing, proper wearing of facial coverings within buildings and classrooms and when within six feet of individuals outdoors, frequent handwashing, and participation in cleaning and sanitizing protocols as requested. You will be turned away from class if you do not have a face covering. Students diagnosed with a health condition that precludes mask wearing can contact Lynne Davies in Disability Services (daviesl@etown.edu) to request remote learning as a reasonable accommodation. **If you are exhibiting any symptoms of COVID or fail to pass the daily health screen, do not come to class.** Failure to adhere to the established community expectations around safety will result in notification of Campus Security and application of the student conduct process for failure to comply, endangering the well-being of others, and/or disorderly conduct. The student code of conduct applies also to participation in all virtual activities, including Zoom sessions and discussion boards.