San Francisco State University

School of Engineering

ENGR 300L – Engineering Experimentation

Open Ended Project

Research Topics of Interest

Produced by Ryan Fillhouer

SFSU Mechanical Engineering Class of 2020

(Last Updated 10/8/19)

The purpose of this document is to provide a current list of engineering topics that are going on around the world, as well as research questions that may stimulate ideas for the ENGR 300L Open Ended Project (OEP). The list includes ventures and issues from many different fields and is focused around engineering disciplines but is not strictly limited to these subjects.

Before reading the list, a great primer for ideas is the National Academy of Engineering’s (NAE) [14 Grand Challenges for Engineering](http://www.engineeringchallenges.org/challenges.aspx). That page shows what sort of engineering innovation needs are currently in the spotlight and where we, as creative engineers, are needed most.

The list is not all-inclusive and should be used to spark interest for digging deeper into a certain topic or project. Interesting outcomes may arise if you try and integrate multiple topics into your project, whether from the same category or from very different categories. For any questions, comments, or suggestions please feel free to email me at [rfillhouer@mail.sfsu.edu](mailto:rfillhouer@mail.sfsu.edu)

The list is broken down as shown in this example:

1. Broad Engineering Disciplines
   1. Research Areas
      1. Sub-Topics
2. Aerospace engineering
   1. Aerodynamics and Fluid Dynamics
      1. [Electric Car Styling Design and Low Aerodynamic Drag](https://iopscience.iop.org/article/10.1088/1757-899X/573/1/012014/pdf)
      2. [Study of Swept Angle Grid Fins Aerodynamics Performance](https://iopscience.iop.org/article/10.1088/1742-6596/1005/1/012013/pdf)
   2. Power and Propulsion systems
      1. [Modern Methods for Aircraft Power and Propulsion](https://www.preprints.org/manuscript/201903.0088/v1)
   3. Spacecraft Engineering
      1. [NASA Large UV/Optical/IR Surveyor (LUVOIR)](https://asd.gsfc.nasa.gov/luvoir/)
      2. [NASA Parker Solar Probe](https://www.nasa.gov/content/goddard/parker-solar-probe)
   4. Hypersonic Vehicles
      1. [Overview of Hypersonic Vehicles at the Department of Engineering of the University of Campania “L. Vanvitelli”](https://www.researchgate.net/profile/Giuseppe_Pezzella/publication/334301259_Overview_of_research_activities_on_Hypersonic_Vehicles_at_the_Department_of_Engineering_of_the_University_of_Campania_L_Vanvitelli/links/5d233527458515c11c1c5443/Overview-of-research-activities-on-Hypersonic-Vehicles-at-the-Department-of-Engineering-of-the-University-of-Campania-L-Vanvitelli.pdf)
      2. [Plasma Assisted Cooling of Hot Surfaces on Hypersonic Vehicles](https://www.frontiersin.org/articles/10.3389/fphy.2019.00009/full)
   5. Nanosatellites
      1. [Power Generation from Solar Radiation Torque on Nanosatellites](https://www.mdpi.com/2226-4310/6/5/50/htm)
      2. [SpaceX Starlink Mission](https://www.spacex.com/news/2019/05/24/starlink-mission)
3. Civil and Structural Engineering
   1. AI or Deep Learning Designed Structures
      1. (Book preview) [Optimization and AI in Civil and Structural Engineering](https://link.springer.com/book/10.1007/978-94-017-2492-0)
   2. Earthquake Engineering
      1. [Application of Fuzzy Logic to Earthquake Damage Predictions](https://aip.scitation.org/doi/pdf/10.1063/1.5112228?class=pdf)
   3. Sensing, Monitoring, and Controlling
      1. [Cognitive Buildings](https://www.researchgate.net/profile/Stalin_Ibanez/publication/330619649_A_Semantic_Model_for_Wireless_Sensor_Networks_in_Cognitive_Buildings/links/5c4aca74a6fdccd6b5c72711/A-Semantic-Model-for-Wireless-Sensor-Networks-in-Cognitive-Buildings.pdf)
      2. [Bridge Energy Harvester from Ambient Wind](https://www.semanticscholar.org/paper/Electromagnetic-Bridge-Energy-Harvester-Utilizing-Khan-Iqbal/2310c874ecdd6578556ea41945f669ea1429006c)
   4. Structural Resources in Space
      1. [Construction Materials for Lunar and Martian Colonies](http://etd.fcla.edu/CF/CFE0007331/Grossman_Dissertation_final.pdf)
      2. [Using Space Resources](https://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/19920022537.pdf)
      3. [Construction with Regolith](https://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20170002067.pdf)
      4. [Regolith-Based Construction Materials](https://stars.library.ucf.edu/cgi/viewcontent.cgi?article=7165&context=etd)
4. Chemical Engineering
   1. Biofuels, Catalysis, and Reactions
      1. [Microalgal Biodiesel Production](https://www.mdpi.com/1996-1073/10/12/2110/htm)
      2. [Machine Learning for Optimizing Biofuel Production](https://www.rdmag.com/article/2018/06/scientists-use-machine-learning-speed-biofuel-production)
      3. (Much more technical) [Artificial Neural Networks for Biofuel Production](https://www.tandfonline.com/doi/full/10.1080/13102818.2016.1269616)
   2. Nanopore Gene Sequencing Instruments
      1. [Oxford Nanopore MinION Device](https://genomebiology.biomedcentral.com/articles/10.1186/s13059-016-1103-0)
      2. [Emergence of Nanopores in Sequencing](https://iopscience.iop.org/article/10.1088/0957-4484/26/7/074003/meta)
   3. Polymers
      1. [Graphene-based Polymer Nanocomposites](https://www.sciencedirect.com/science/article/pii/S0032386110010372)
      2. [Catalytic Polymer Microrocket](https://onlinelibrary.wiley.com/doi/full/10.1002/asia.201900277)
5. Computer Engineering
   1. Artificial Intelligence
      1. [Image Analysis Using AI for Big Data Analytics](https://www.mdpi.com/1999-5903/11/8/178/htm)
      2. [Neural Network Models for Stock Selection](https://arxiv.org/ftp/arxiv/papers/1906/1906.05327.pdf)
   2. Cryptography and Blockchain
      1. (Highly Advanced Quantum Physics) [Quantum Blockchain](https://www.mdpi.com/2624-960X/1/1/2/htm)
      2. *QUESTION: Can blockchain be used for quality control in manufacturing?*
   3. Internet of Things (IoT)
      1. [Smart Buildings](https://arxiv.org/ftp/arxiv/papers/1904/1904.01460.pdf)
   4. Machine Learning and Data Science
      1. [Machine Learning for Medical Imaging](http://downloads.hindawi.com/journals/jhe/2019/9874591.pdf)
      2. [Big Data and Cyber-Physical Systems](https://arxiv.org/pdf/1810.12399.pdf)
   5. Quantum Computing
      1. [IBM Q](https://www.ibm.com/quantum-computing/learn/what-is-quantum-computing/)
      2. [The Hunt for Useful Quantum Computers](https://www.nature.com/articles/d41586-019-02936-3)
      3. [\*\*\*BREAKING\*\*\* 10/2/19 Quantum Computing Milestone](https://cosmosmagazine.com/physics/why-are-scientists-so-exicted-about-a-recently-claimed-quantum-computing-milestone)

1. Electrical Engineering
   1. Cyber-Physical Systems, Control Systems
      1. [Developing Cyber-Physical Systems with Natural Language Processing](https://depositonce.tu-berlin.de/bitstream/11303/9190/3/vogelsang_etal_NLP4RE2019preprint.pdf)
   2. Dichalcogenide Pseudocapacitors
      1. [Titanium Disulfide Coated Carbon Nanotube (Dr. Teh)](https://escholarship.org/content/qt2z28d492/qt2z28d492.pdf)
      2. [Supercapacitor for Energy Storage](https://pdfs.semanticscholar.org/69ff/da821b223e2d864b5a14d8ea5bbbe334940b.pdf)
   3. Smart Grid
      1. [Grid Modernization and the Smart Grid](https://www.energy.gov/oe/activities/technology-development/grid-modernization-and-smart-grid)
      2. [Global Smart Grid Market Overview](https://soundonsoundfest.com/2019/10/01/global-smart-grid-market-2019-company-overview-industry-insights-investment-analysis-outlook-2028/)
      3. [What is Smart Grid?](https://www.livescience.com/41920-smart-grid.html)
   4. Solar Cells, Thermophotovoltaic Cells
      1. [Ultraefficient Thermophotovoltaic Power Conversion](https://www.pnas.org/content/pnas/116/31/15356.full.pdf)
      2. [Power Generation at Night](https://www.engineering.com/ElectronicsDesign/ElectronicsDesignArticles/ArticleID/7025/Solar-Thermophotovoltaic-Cells-Can-Generate-Electricity-at-Night.aspx)
   5. Ultra-High-Voltage DC (UHVDC) Technology
      1. [Key Technical Parameters of 1100 kV Live Tank](https://iopscience.iop.org/article/10.1088/1757-899X/486/1/012007/pdf)
   6. Very-Large-Scale Integration (VLSI) Digital Circuits
      1. [Low Power Electronics and Novel Device Possibilities](https://www2.eecs.berkeley.edu/Pubs/TechRpts/2019/EECS-2019-13.pdf)

1. Mechanical Engineering
   1. Biomechanics and Biomimetics
      1. [Mechanical Properties of Skeletal Muscle (In Vivo)](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3732739/pdf/nihms401966.pdf)
      2. [Tissue Engineering for Wound Healing](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5467128/)
   2. Clean Energy
      1. [Ocean Energy](https://ejers.org/index.php/ejers/article/view/1062/425)
      2. [Footstep Power Generator](https://www.e3s-conferences.org/articles/e3sconf/pdf/2019/06/e3sconf_reee2018_02001.pdf)
   3. Computational Engineering
      1. [Computational Materials Design and Engineering](http://srg.northwestern.edu/Publications%20Library/Journals/2009_ComputationalMaterialsDesignEngineering_Kuehmann.pdf)
   4. Robotics and Controls
      1. [Wearable Robotics](https://arxiv.org/pdf/1903.08253.pdf)
      2. [Boston Dynamics](https://www.bostondynamics.com/robots)
2. Nuclear Engineering
   1. Thorium Reactors
      1. [Thorium Information](https://www.world-nuclear.org/information-library/current-and-future-generation/thorium.aspx)
      2. [Thorium Information II](https://whatisnuclear.com/thorium.html)
   2. Modular Reactors
      1. [Small Modular Reactors (SMRs)](https://www.energy.gov/ne/nuclear-reactor-technologies/small-modular-nuclear-reactors)
      2. [Layout of Modular Reactor Plant Using Genetic Algorithm](https://www.sciencedirect.com/science/article/pii/S0029549318308768)
   3. Nuclear Fusion
      1. [General Fusion](https://generalfusion.com/) (a Canadian Fusion Project)

1. Interdisciplinary or Miscellaneous
   1. [Dark Matter in Universe as the Geometry of Empty Space](https://arxiv.org/ftp/arxiv/papers/1110/1110.0035.pdf) (advanced modern physics)
   2. [Experiments at CERN](https://home.cern/science/experiments)
   3. [Lawrence Berkeley National Laboratory](https://www.lbl.gov/programs/in-focus/)
   4. [Lawrence Livermore National Laboratory](https://st.llnl.gov/news-center)
   5. [LIGO](https://www.ligo.caltech.edu/)
   6. [SLAC National Accelerator Laboratory](https://www6.slac.stanford.edu/news/news-center.aspx)