ECE 592-052
Exploring the Theoretical Limits of Efficiency

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Objective or Description:

This is one credit survey course.

The goal of this course is to examine a variety of technologies and benchmark them against theoretical limits of efficiency. When considering technology development, typically one finds that over time the metrics that define a technology follow an S-shaped curve, where after rapid improvements, the technology approaches theoretical physical limits. Then improvements become more incremental. Often this leads to a search to replace the old technology by a newer more advantageous technology. Similarly, when one looks at the efficiency and lifetime of motors, solar cells, wind turbines, batteries, power conversion circuits one can find that examples of where limits in size reduction, energy efficiency or availability of materials are being reached.

The motivation for this course, is that as mankind enters the Anthropocene era, it is imperative that when developing new technologies physicists, engineers and scientists take a global perspective and consider the limitations of the future availability natural resources, population growth, changing demographics and the distribution of wealth and technology. Clearly new technologies related to communications, renewable energies, how people move from one place to another, etc. will have huge impacts on the quality of people's lives. However, it is an open question where the fundamental theoretical limits these new technologies are how efficient they are and the resources they consume. Understanding the limits of efficiency would help map out technology limits and help engineers, citizens and policy makers understand limits of technology and efficiencies that can be obtained.

Prerequisites: Senior Undergrad, or Graduate Student Standing.

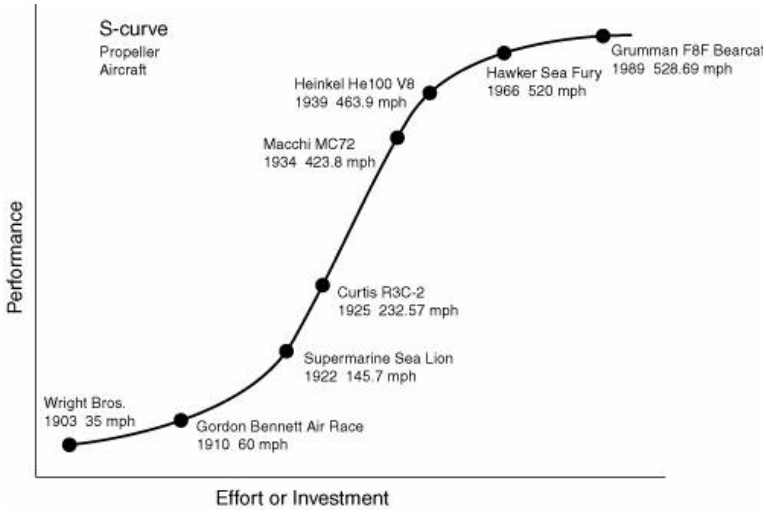
Textbook: The student will be provided selected readings from the literature.

Topics: Topics to be analyzed will be based on students interests. Candidate topics include Solar Cells, Wind Turbines, Power Inverters, Light Emitting Diodes, Lasers, Telecommunications, Moore's law, Thermo-electric devices, Refrigeration/ Air conditioning, Desalination Systems, Combustion Engines etc.

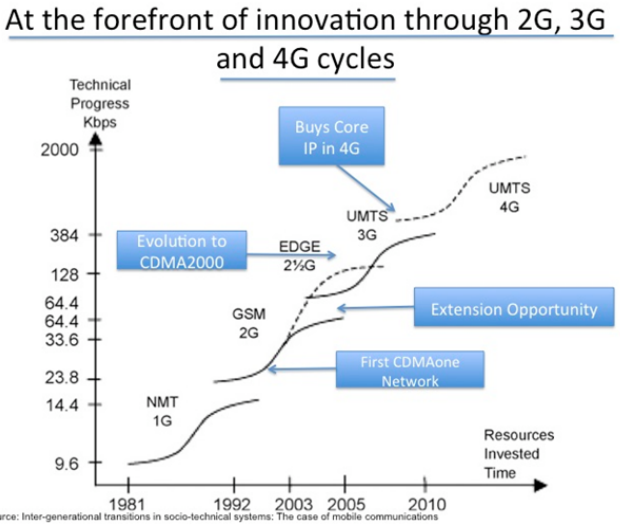
Grading:
The course will meet once a week to discuss technologies and share technical information.
Attendance/Participation: 30%
Presentation: 30%
3-5 page technical paper 40%

Cross-listing in other departments: N/A

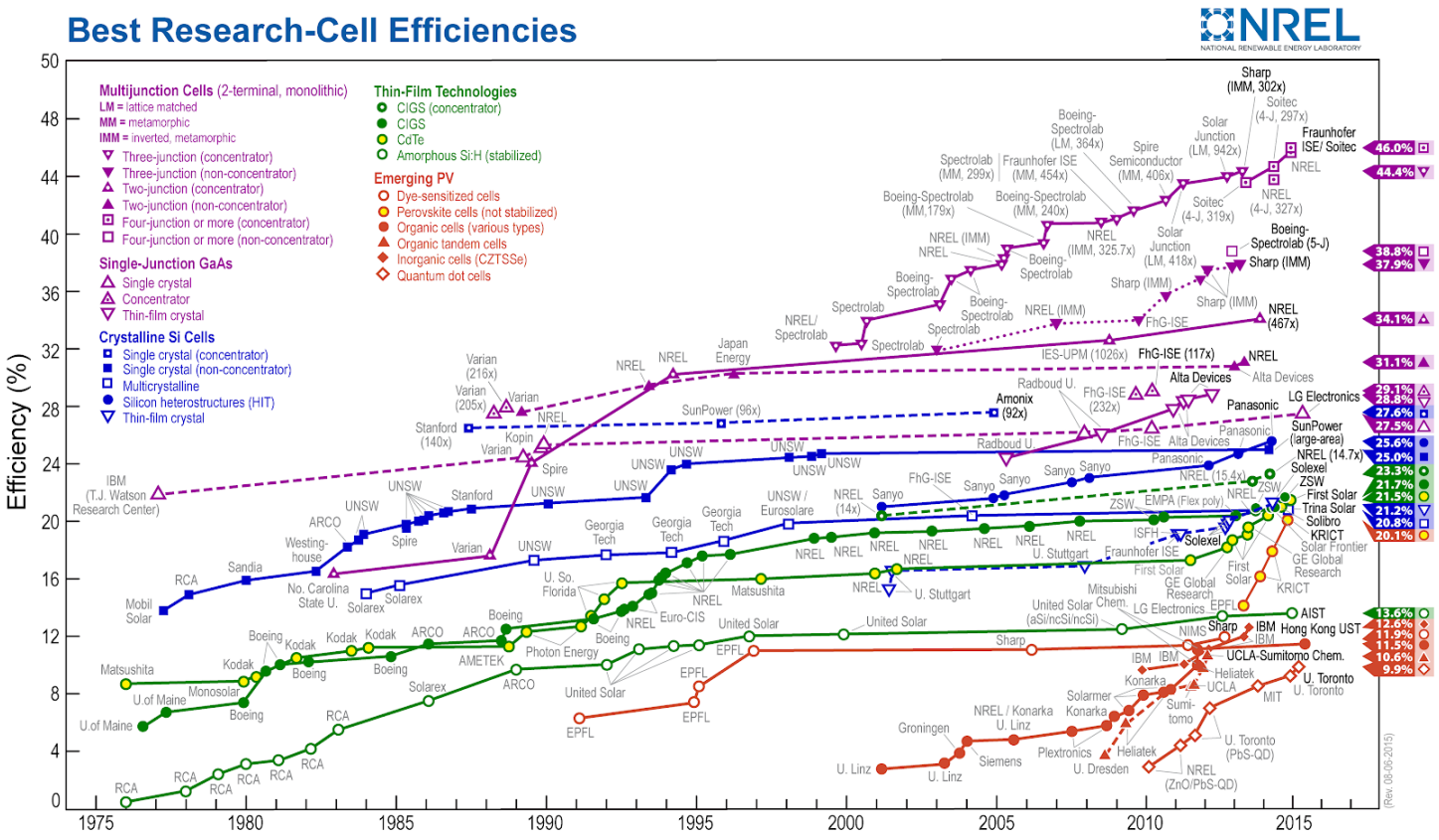
Some examples of different technologies and how they evolve over time. The course will examine what limits technologies from a fundamental perspective to better predict where technology performance may end up.



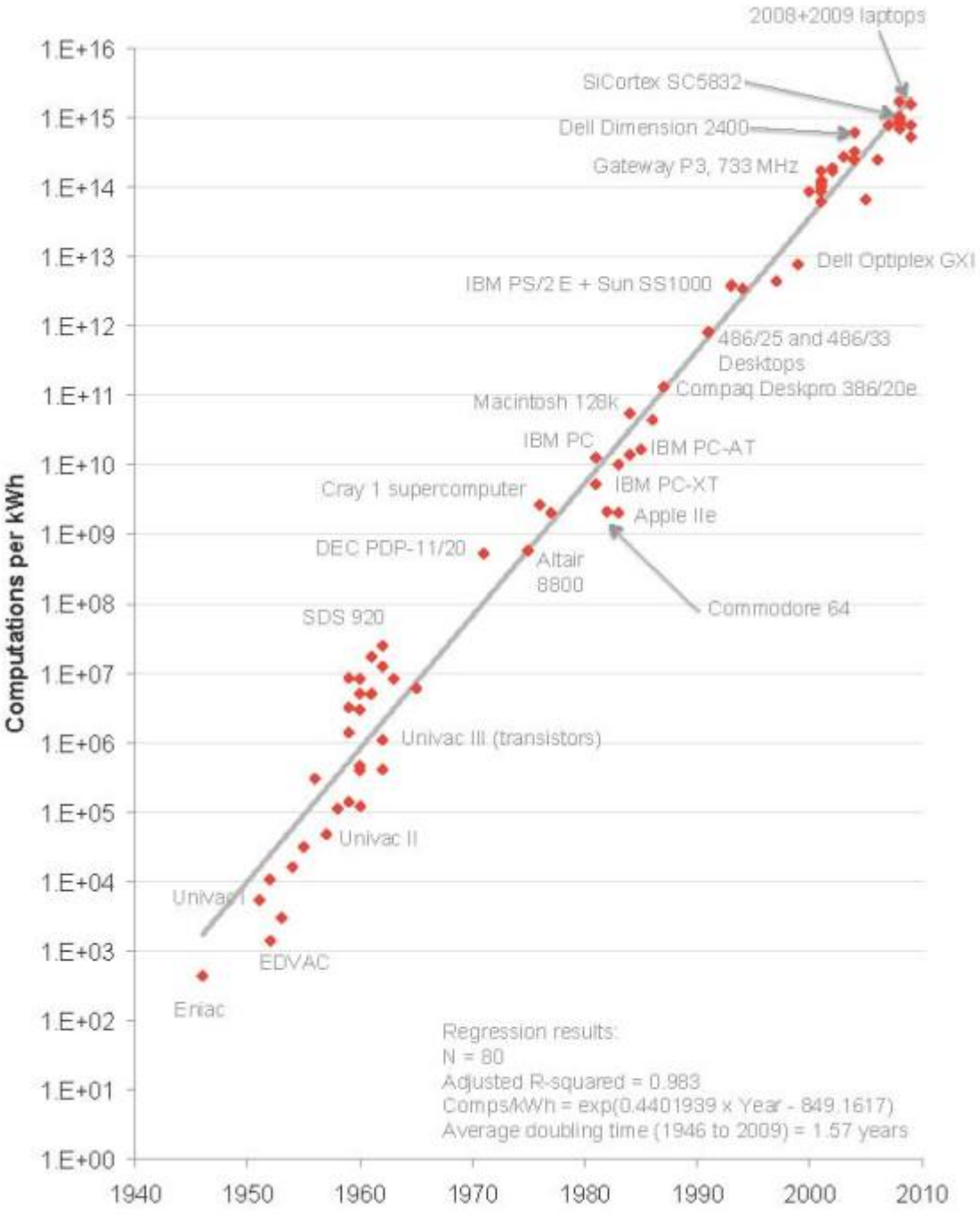
Limits of Propeller Driven Aircraft.



Telecommunications Technology Replacement



Progress of solar cell technologies.



Computations per kWhr.