title	Ternary Computing Testbed
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proj_desc	As Moore's law reaches its limit, researchers are finding new and innovative ways to increase processor performance. Some techniques, such as multi-core processors, are relatively straight-forward and build upon well-established binary circuit systems, where other technologies such as quantum computing require a radical rethinking of the foundations of computer science. We propose to research a middle-ground by building a functional computer based on ternary (base 3) logic. Ternary computers would be digital, just as current binary computers, not as extreme of a change as quantum computers, but new enough to be, for the most part, unexplored territory. The earliest computers were analog, and the first digital computers were base 10, just as the decimal numbering system commonly used today. Shortly, binary computers became the norm as George Boole's algebra was found to be useful in their construction. The concept of a ternary computer has precedent---it has appeared and disappeared several times since a ternary computer named Setun was built in Russia in 1959---but it has not been well-developed. Ternary has several interesting properties making it attractive as a computational environment: * From ternary naturally follows "balanced ternary arithmetic", a numbering system using digits -1, 0, and 1, which Donald Knuth called the "the prettiest number system of all" [1]. Balanced ternary easily represents negative and positive integers without the need for a sign bit, and exhibits attractive round-off properties[3]. * Ternary can naturally be represented at the circuit level using negative, low, and positive voltages. This makes ternary a more attractive radix than higher values, which would cause difficulty in distinguishing between the valid states. * Ternary logic increases the density of data storage and correspondingly reduces the number of processing elements required to manipulate the data. We propose to investigate the feasibility and engineering techniques of building a small practical ternary computer. Our practices will be inspired by Shimon Schocken's workshop on computer construction, often offered as a college course titled "From Nand to Tetris", taught along with a book written by the instructor[4]. Schocken's course is composed of 12 components, from low-level logic gates to high-level application programming. We will roughly model our research on Schocken's course outline, beginning with ternary logic, ternary arithmetic, sequential logic and computer architecture, up through a small interactive game built on a ternary computer. The ultimate end goal is the realization of a physical ternary computer running a simple game. (Simulation of ternary on a binary computer may be used during the development process.) However, as this is a significant project, the focus of this research project will be on researching the fundamentals of ternary and designing a ternary computer system. The end result of this research project will build the principles and lay a foundation to be easily built upon, allowing for the project to be continued as an interdisciplinary senior project. Deliverables include: * A report summarizing the results of our research, * A design document outlining the proposed design, * Buildable specifications of components of the system, and * Prototypes of ternary logic gates and system components. Works Cited

	1. D.E. Knuth, The Art of Computer Programming - Volume 2: Seminumerical Algorithms, pp. 207-208. Addison-Wesley, 3rd ed., 1998. ISBN 0-201-89684-2. 2. American Scientist Online, November-December 2001: Third Base, Brian Hayes 3. Ternary computers: part I: motivation for ternary computers, International Symposium on Microarchitecture archive, Conference record of the 5th annual workshop on Microprogramming table of contents, Urbana, Illinois, 1972 4. The Elements of Computing Systems: Building a Modern Computer from First Principles by Noam Nisan and Shimon Schocken (MIT Press, 2005).
inter_desc	Building a complete computer system is a complex task, requiring a wide range of experience from the lowest transistor level through high-level computer science, held together and integrated by the field of computer engineering. Interdisciplinary majors will be EE, CSC, and CPE. This project was initiated by a group of just such students, who, I'm sure, would be prepared to work on it.
links	
students	3
majors	CSC, CPE, EE
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