IEEE Madison Section Newsletter

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A New, Efficient, Low-Emissions, Light-Weight, and Low-Cost Diesel Engine

Date/Time: Thursday, April 9, 2009, 11:45 AM – 1:00 PM
(NOTE: second Thursday of the month rather than our normal third Thursday)
Speaker: James Lemke, Ph.D., CTO, Achates Power, Inc., San Diego, CA
Location: Rocky Rococo's Pizza, 7952 Tree Lane (Madison Beltline Hwy. at Mineral Pt. Rd.), 608.829.1444
Menu: Pizza buffet, salad and soft drinks ($5.00 members, $10.00 non-members, free for UW-Madison student members)
RSVP: by April 6th to David Marca via e-mail (dmarca@openprocess.com) or call 617.645.1358

Non-member guests are always welcome!

The 2% annual worldwide growth in energy usage projected by the EIA will be unachievable in the very near future from any mix of new and current energy sources. This will put increasing pressure on developing high-efficiency engines for transportation and other applications.

The development is privately funded and is being done in a state-of-the-art facility with an engineering and scientific staff of 47. A Technical Advisory Board of engine experts meets regularly; it is comprised of three members of the NAE and four Fellows of the SAE. Extensive use is made of FEA, CFD, KIVA-3, and a cluster computer. The company has developed its own proprietary fuel injection systems aided by laser Doppler anemometry instrumentation. All parts except crankshafts are made in house with 3 axis, 4 axis, and 5 axis numerical mills and NC lathes.

The principles behind the basic engine and status of the development will be described.

James Lemke is a member of the National Academy of Engineering, Fellow of the IEEE, and Fellow of the AAAS. He has been awarded the IEEE Magnetic Society Reynold B. Johnson Storage Award and the Revelle Medal from UCSD. He has been designated Distinguished Lecturer by the IEEE Magnetics Society and was formerly a Fellow of the Eastman Kodak Research Laboratories. He has been awarded 80 U.S. patents and numerous foreign patents.

Dr. Lemke has a Ph.D. in Theoretical Physics from UCSB, an M.S. in Physics from Northwestern University where he was a Woodrow Wilson Fellow, and a B.S. in Physics from IIT. He is currently an Adjunct Professor in ECE at University of California San Diego.

His professional career has been primarily in the field of applied science and engineering with an emphasis on information theory, magnetic materials, information storage devices, and internal combustion engines.

He founded Spin Physics, Inc. (SPI) in 1968 and ran it as CEO and CTO for approximately 15 years. The company employed a workforce of 650 and made magnetic recording transducers employing unique magnetic materials developed and patented by the company. At one time 50% of the broadcast hours on television worldwide were recorded on SPI magnetic heads, and 90% of the recorders at the National Security Agency used SPI heads. Dr. Lemke sold the company to Eastman Kodak and became a Fellow of the Eastman Kodak Research Laboratories. Subsequently, he has founded and sold several other companies that developed high-density information storage devices employing unconventional materials. He has licensed his patents to IBM, RCA, Seagate, 3M, and many others.

His current interests are in the field of efficient internal combustion engines. He founded Achates Power, Inc. to develop a uniquely lightweight, environmentally clean compression-ignition engine based on 10 years of his research in this field. Achates Power has a scientific/engineering staff of 75 in a state-of-the-art laboratory in San Diego.

He is a 7,000 hour pilot with multi-engine and instrument ratings.

Meeting Lunch Fee Reduced

Some of you may have noticed that we now have a three-tiered fee structure for the general meetings. The IEEE Madison Section has a relatively large cash reserve and in an effort to reduce the excess, as well as to provide some relief from the current economic turmoil, the board has decided to reduce the lunch fee for IEEE members. The new fee structure is $5.00 for IEEE members, $10.00 for non-members and guests and free for UW-Madison IEEE Student Section members.

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Thinking Inside the Box

by Donald Christiansen

The other day my neighbor said to me, "Every time I ask you guys a technical question you start drawing boxes and squares!" By "you guys" he was referring to three or four engineers of his acquaintance.

His provocative observation started me thinking about how the symbolism of engineering has evolved as engineering design has gotten more complex and abstract. To help recall some of the earlier ways that circuits and systems were graphically depicted, I visited a nearby university library. I first scanned several issues of the *Electrical Review* from 1884 (the year AIEE was founded). Subtitled "A weekly journal of electric light, telephone, telegraph, and scientific progress," it had illustrations that were almost entirely electromechanical—telephones, telegraph keys, phone jacks, motors, and dynamos. All were pictured literally in circuit diagrams, the only element shown symbolically being the battery.

I then went on to the works of Nikola Tesla. When he was active in the late 19th century, his work, too, was illustrated quite literally. In a paper delivered to the IEE in London in 1892, he used many drawings of the actual electrical components. The following year, in a lecture at the Franklin Institute in Philadelphia, he used circuit drawings that were hybrids—a mix of literal sketches of generators and switches along with symbols for coils, transformers, and capacitors.

The Wiring Diagram

This approach to illustrating electrical connections, useful to electricians, technicians, and craftsmen, came into its own in the first part of the 20th century. These were very pictorial, and were designed to avoid ambiguities in connecting components or assembling and installing equipment.

Schematics

The arrival of electronics, driven by the advent of the vacuum tube, spurred engineers to develop and standardize component symbols. These symbols became the essence of circuit schematic diagrams. The symbol for the vacuum tube underwent a few variations, with its grids alternating between squiggles and dashed lines, the latter eventually prevailing.

I found a paper by Edwin Armstrong published in the *Proceedings of the IRE* in 1915. In it were schematics that depicted the audion (vacuum triode) minus the envelope, with the grid and plate in a vertical position. In another Armstrong *Proceedings* publication, this one in 1924 on the super-heterodyne receiver, the tube elements were shown in the now generally accepted horizontal position, and were encased in an oval that represented the physical envelope.

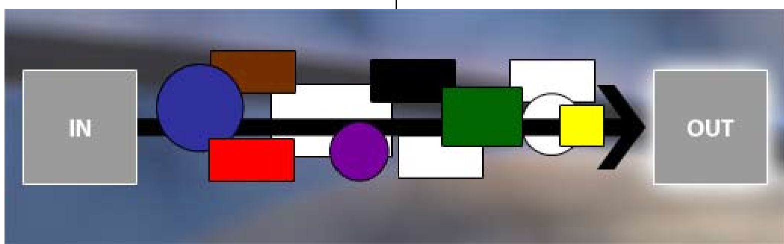
The Box Arrives

The various functions of a radio receiver were called stages (e.g., r.f. amplifier stage, detector stage, etc.) and soon were represented simply as rectangles in a "block diagram." The blocks in a block diagram quickly caught on as a shorthand way to represent larger and larger sections of more complex systems, and, when convenient, entire subsystems that were readily available "off the shelf."

I came across a 1936 Armstrong paper on frequency modulation in which he used many block diagrams. He referred to them, taken together, as "diagrammatic arrangements" or "general arrangements" of a circuit. Individual blocks were, typically, amplifiers, frequency multipliers, filters, detectors, conversion systems, etc.

Systems Analysis and Design

The increasing complexity of systems inspired serious attempts to organize systems planning, design, development, and manufacture into logical steps. This challenge helped spawn the disciplines of systems engineering and systems management and their concomitant graphical tools. Who among us has not used flowcharts, pert charts and matrices to good advantage? And, of course, block diagrams to designate the physical partitioning, operational functions, and required physical interfaces of large systems. Today's textbooks on systems engineering are peppered with block diagrams representing not simply system partitioning but complex interactions at all phases of engineering from conception to deployment. On the other hand, many of the mathematically-based graphic aids aimed at comprehending large systems remain stalled at the academic level. Even the well-known Venn diagram has its limitations. Two – or three-set Venn diagrams are readily interpreted visually, suggesting common characteristics of individual sets in their areas of overlap. But higher-order Venn diagrams, while visually interesting, are increasingly difficult to interpret.



The tricotyledon theory of system design is based on mathematical set theory. One way to illustrate its state transitions and outputs is through the use of circles with arrows looping between and among them. Yet examining a moderately complex system using this notation can boggle the mind.

The Entrenched Box

The IEC (International Electrotechnical Commission) has long since abandoned the traditional logic gate symbols (AND, NOR, OR, etc.) for a standard square. And while it may be resisted by many oldtimers, the "new" resistor symbol is a long rectangle.

My neighbor was right. My quick trip through history confirmed the importance of the box. It has become an abstraction for more interesting stuff inside it that we either take for granted or have forgotten completely. We cannot design without the box. I suppose there are certain specialists (antenna designers, perhaps) who might even go for several months without drawing a box. Computer engineers, on the other hand, would be hard pressed to resist the beckoning call of the box for more than an hour or so.

Except for the physicists, the days of representing transistors and ICs in cross section have virtually vanished. ICs themselves are represented as rectangles and because of their high pin-count we leave it to the computer to interconnect them. This opens the Pandora's box (no pun intended) of design automation and its subset, schematic capture. But I'll leave that for another time.

Meanwhile, call it what we may—block, square, rectangle—the box is here to stay. Long live the box!

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IEC Graphical Symbols http://tc3.iec.ch

Symbols to Standardize Computer Concepts http://umw.electronicstalk.com/news/inw103.html

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