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The problems are familiar. Perhaps a homeowner wants to cut her utility bills but can only spend $2000; should she install attic insulation, buy a new furnace, or install storm windows, or think about a solar water heater? Or an architect designs a house with some unusual features; how much energy will it use? Is that large south glass area going to reduce heating loads, or will it send the cooling bills through the roof?

The solution? One way to come up with an answer is to use a paper- and pencil method to determine how energy is utilized in a home. Unfortunately, that either takes pages and pages of calculation, or it is so crude that guesswork would do as well. There are computer programs that do the same job, faster and more accurately, but they were written for engineers by engineers. The input format usually frightens off all but the most hardened building scientist.

A third solution has become possible through the use of a microcomputer. Over the past decade microprocessors and memory chips have plummeted in price by over an order of magnitude. As a result computers have ceased to be the domain of the white-coated scientist, and have moved down to the corner store. Programs have done the same. Scientific programs for large mainframe computers often use strict input formats—a comma in the wrong place might void a run for which you have been waiting overnight. The greatly expanded user community of the low-cost microcomputers spawned new "user friendly," interactive programs with which the technically naive can carry out sophisticated analysis. The Computerized, Instrumented, Residential Audit (CIRA) is just such a program for building energy use calculations. It was developed at LBL because of the unique combination of building scientists and computer software experts present here.

CIRA represents both the state-of-the-art in interactive features for microcomputers and the latest developments in simplified models of building energy analysis. It asks simple questions in plain English, and offers help and lists of possible answers on request. It will even suggest the appropriate
answer to technical questions, such as thermal resistances, solar gain factors, and city altitudes, based on previous answers to more mundane questions on window types, shading devices and geographic location. In addition, the user can change incorrect answers, and is prevented from giving unreasonable ones.

It takes about 25 minutes at a video terminal to answer all the questions that CIRA needs to model a typical house. If the house is just a variation on another house entered earlier, hours or months ago, the time to enter the changes is considerably less. After answering all questions, the computer can perform either a complete design energy analysis, or produce a list of the best energy saving improvements.

To produce an optimized list of retrofits, the computer takes about ten minutes of calculation time. Aside from summary information on the physical and the economic assumptions, this list will indicate item-by-item energy savings, discounted paybacks, life-cycle dollar savings, internal rates of return, and cost of conserved energy. A design energy analysis is faster, and only takes a minute or so. That output is a set of graphs and tables of energy consumption, air infiltration rate, solar savings fraction and other parameters useful to a designer.

CIRA was designed to be used by energy auditors, architects, engineers, utilities, contractors; the whole range of professionals involved in building design, construction, and retrofitting. Thanks to a library-based structure for storing questions, assumptions and retrofit information, the program can easily be adapted by each group to suit its own needs.

The equipment required to run CIRA is a microcomputer, a video terminal, and a small printer for a total cost of about $4000 today. Almost no formal training is required to use the program; practice is the only requirement to make a crack user. A 500-page manual is provided mainly for reference for those who want to understand the insides of CIRA or want to change the assumptions.

The program costs $240, including the manual, and is now available from the Technical Information Department at LBL. Anyone interested in obtaining it should first ask for Pub. 425 Revised, which gives more details of the program inputs and outputs, and lists the technical specifications required of the microcomputer. The CIRA program is the product of four man-years of work by members of the Energy Performance of Buildings Group, primarily Robert Sonderegger, Jim Dixon and Jean-Yves Garnier. It is currently being validated against measured data from houses of differing types spread across many climate zones.

*DIVISION NEWS*

The Annual Division Review took place April 14 and 15. The Committee members had a broad knowledge of the topics presented (environmental research, except combustion, and indoor air quality). Director Shirley indicated that our presentations were well received. The report from the committee was sent to him in mid-May and will be reviewed with Elton.
SEAC (Scientific and Educational Advisory Committee, to President Saxon) met at the Lab on April 16 and 17 to review the E&E, Earth Sciences, and Physics divisions. SEAC was interested in our research projects, as well as the funding outlook for FY83. Elton gave a general overview of the Division's current work and recent accomplishments and discussed the influence of Congress on future funding. The Committee responded favorably to the presentations.

The Laboratory was visited by the Regents' Oversight Committee on May 13. Their mission is to oversee the three national labs managed by U.C. Several divisions presented aspects of their research, including acid rain research (John Harte) and conservation in buildings (Art Rosenfeld), from E&E.

A search committee was formed last fall to review candidates for the position of Program Leader for the Energy Analysis Program. The committee has made its final recommendations to Elton, and an offer will be extended to one of the three final candidates in the near future. Ron Ritschard chaired the committee. Other members were Art Rosenfeld, John Harte, Don Grether, Charles Hitch and three faculty members from UCB, Professors Michael Hanemann, Anthony Fisher, and Richard Gilbert. An ad was printed in Science Magazine, and 45 applications were received. The committee identified four of the applicants as potentially qualified for the job, and they were interviewed during May and early June.

Thanks to the efforts of many people in the Division, a draft version of the E&E Strategic Plan was completed in time for Elton's presentation of the Plan at the June 7 Associate Directors' meeting. The Plan has received many favorable comments. After taking into account specific comments from David Shirley, the E&E Program Leaders, and other interested people, a final version will be printed and distributed.

The Laboratory was visited by Jan Mares, the acting Undersecretary of DOE, on June 3 and by Kenneth Davis, the Deputy Secretary of DOE, on June 11. Elton and Art Rosenfeld made presentations to Mares, and Elton and Sam Berman gave presentations to Davis.

Members of the Energy Task Force of the Urban Consortium visited LBL on June 8 and 9 and met with representatives from our Solar, Energy Analysis and Energy Efficient Buildings programs. The Task Force, comprised of representatives from 15 large U.S. cities, was very interested in our research in energy use in buildings, and it is possible that we may undertake some projects in conjunction with them.

Quite a few changes have been taking place over the past month or so in the building 90 complex. The support groups that were in building 930 in downtown Berkeley (TID, procurement, business services, etc.) are moving back to the hill, and mostly into the 90 area. The change in space assignment to E&E has been fairly minor (we vacated trailer K and moved into trailer B). Coincidental with these moves were some
internal moves which were made in order to improve communications and
to make better use of space. The Energy Analysis Program, part of
which was in the trailers, is now largely consolidated on the third
floor of 90. EEB's Building Energy Data group, once quite scattered,
is now in trailer H. Finally, many of the people with offices in
Blackberry canyon are being moved up to 90.

*TRIPS, CONFERENCES AND PRESENTATIONS*

May

• After participating in workshops on residential energy use in Geneva
  and in Ispra, Italy, Lee Schipper went on to a United Nations
  workshop in Gävle, Sweden, followed by stops in Stockholm and
  Copenhagen to complete work on some DOE data analysis.

• Art Rosenfeld and three other U.S. conservation experts spent a week
  in Lisbon, at the request of N.A.S., to advise the Portugese DOE on
  energy management. According to Art, the Portugese were not very
  surprised to hear a Professor suggest that they tune their
  boilers and diesel trucks, and adopt codes and labels for buildings
  and appliances, but they were amazed and impressed to hear Mike
  Mertz, Manager of Conservation for PG&E, tell them how he spends
  $50,000 per year monitoring conservation.

• Larry Schaleger was in Gatlenburg, Tennessee, for the 4th Symposium
  on Biotechnology in Energy Production and Conservation, where he
  presented a paper on "Direct Liquefaction of Biomass: Results from
  Operation of Continuous Bench-Scale Unit in Liquefaction of Water
  Slurries of Douglas Fir Wood."

• Patrick Pagni took part in the research discussions 6th UJNR Panel
  Meeting on Fire Research and Safety held at the Science University of
  Tokyo.

• Elton Cairns chaired the Physical Electrochemistry Division and Gen­
  eral Session of the 161st Meeting of the Electrochemical Society held
  in Montreal.

• Don Lucas and Antoni Oppenheim attended the 1982 Spring Technical
  Meeting of the Canadian section of the Combustion Institute held in
  Alberta, Canada.

• Rolf Mehlhorn presented an invited paper, "Photodamage to Mitochon­
  drial Membranes," at the 73rd Annual Meeting of the American Oil
  Chemists Society in Toronto, Canada.
June

- A number of E&E staff participated in the ASHRAE Annual Meeting held in Toronto: Art Rosenfeld chaired a session on Building Energy Labels and presented his paper and one for PG&E on this topic; James Hirsch chaired a subcommittee on Systems Simulation; Max Sherman gave a presentation on CIRA; John Ingersoll made a presentation to the Weather Committee. Also attending were Fred Buhl and Bill Carroll.

- Lee Schipper was invited to make a presentation in Cambridge, after which he spent time in London working on DOE data analysis.

- Rollie Otto attended a conference on Acid Precipitation and Atmospheric Deposition: A Western Perspective held at Western Washington University in Bellingham, Washington. Kathy Tonnesson was also present at the conference. She gave a paper co-authored with Joan Oldfather, on their current work with John Harte on "Experimental Investigation of Biological Indicators of Lake Acidification in the Sierra Nevada."

*FEATURED PUBLICATION*

Solar Energy,
Vol. 27, No.5, pp. 367-386, 1981

"Detailed Loop Model (DLM) Analysis of Liquid Solar Thermoshipons with Heat Exchangers"

A. Mertol, W. Place, T. Webster, and R. Greif

ABSTRACT—An analytical Detailed Loop Model (DLM) has been developed to analyze the performance of solar thermosiphon water heaters with heat exchangers in storage tanks. The model has been used to study the performance of thermosiphons as a function of heat exchanger characteristics, heat transfer fluids, flow resistances, tank stratification, and tank elevation relative to the collector. The results indicate that good performance can be attained with these systems compared to thermosiphons without heat exchangers.

Following is a short discussion with Wayne Place and Tom Webster:

E&E: This paper not only presents a detailed study of the thermosiphon system with heat exchangers. I had expected that, but I was surprised at how much I learned about the various factors that influence the design of solar water heaters in general.

Wayne: I think we tried very hard to put that system within the context of other developments. In fact this is a general concern within the passive solar group. When we initiate a research project, we review the range of possibilities in order to identify the most promising research area within the technology. This review and evaluation process is certainly reflected in this paper.
Tom: Yes, we like to address the pertinent issues. In addition to the scientific results, the paper presents a broad range of practical information which would help the reader understand the important design issues.

Wayne: This project has presented a dual challenge. Many of the project participants have an applications background and are eager to see more extensive use of solar water heaters. On the other hand, we feel a strong obligation to do rigorous scientific work. One of the things that has hurt Solar is the number of snake oil salesmen in the field; they go as far as they think they need to go to get a saleable product, and proceed to make unsubstantiated, invalid, or totally nonsensical claims for their product's performance. We regard it as our function to assure that the design community and the consumer get understandable and highly reliable information. Unfortunately, the process of conducting rigorous scientific work is meticulous and painfully slow. It is also true that solar applications are far more complicated than they would appear at first glance, particularly the systems interactions. In thermosiphons, for example, the variable flow rates required a sophisticated analysis to which most of the great mass of heat transfer research is not applicable.

E&E: In your paper you model a single-phase heat transfer fluid. Doesn't a two phase (liquid to gas) heat exchanger system look more promising?

Tom: The initial selection of heat transfer fluid was made on the basis of safety and familiarity of the fluid in the solar industry. Until recently, single wall heat exchangers have not been considered for processes in which food or potable water might be contaminated by leakage through the heat exchanger wall. Single-wall heat exchangers are more attractive than double-wall heat exchangers, because of their simplicity of construction and greater heat transfer effectiveness. When we started this project there was a draft ASME standard allowing the use of propylene glycol with single wall heat exchangers, which explains the initial focus on that heat transfer fluid.

Wayne: We still intend to analyze and test two-phase heat transfer media, such as freon, but we haven't gotten to it yet. This takes us back to my point about careful scientific study. We were all impressed by the complexity and subtlety of thermosiphons. Because of this complexity, we have not gotten to the two-phase system as soon as we had hoped.

E&E: Thermosiphons are used extensively in Israel, so why all of the attention to a proven technology?

Tom: Within the United States, the major limitation to the use of conventional thermosiphons is the vulnerability to freezing of the potable water in the collector. When we started this project there had been no published research on thermosiphons using a non-freezing collection fluid.
Wayne: Your comment about the extensive use of thermosiphons in other countries raises a point which deserves to be emphasized. Thermosiphons have proven to be quite cost-effective in other countries, which is not unexpected. The most promising solar technologies will be those that use the equipment on a year-round basis, such as daylighting and solar water heating. Among the many solar heating techniques, thermosiphons possess the additional advantage of fabricational and mechanical simplicity and extreme reliability.

E&E: When the paper was written, the experimental work was still underway. Do you now have a better idea of how well your model works?

Wayne: We have completed about a hundred experimental test runs and the results are in good agreement with the performance predictions of the model. System performance is the bottom line in this business. If there is good agreement in that area, then the thermal model has done the most important part of its job. As usual, there are some differences between the observed and predicted behavior of the system. For example, the nighttime reverse flow is somewhat higher than predicted by the model, but the effect still appears to be small under most of the conditions of concern to us.

Tom: It should be noted that observed and predicted flow-rates have not yet been compared under exactly comparable conditions, so we do not know how the model is working in that regard. However, like nighttime reverse flow effects, the system behavior suggests that we could have large percentage variations between the observed and predicted flow rates, and still have very accurate performance predictions.

E&E: Is it fair to say that this work will play an important role in sorting out the important from less important parameters that must be considered in designing and building future solar water heaters?

Wayne: This work provides a scientific basis and a focus for future work on the subject.

E&E: Thank you for providing an inside perspective on the thoughts, motivations and ideas that led to this very interesting paper.

*PERSONNEL NEWS*

• In May the Building Energy Systems group worked together with visiting researcher Alain Lahellec on a new version of DOE-2. Alain works for RAMSES in Orsay, France, a solar energy group. He brought with him a metric version of DOE-2 which will be incorporated in the new version so that the program can be used in Europe.

• Dr Wolfgang Luhrsen is spending a year with the Energy Efficient Buildings Program learning about energy conservation and giving programming support to the Building Energy Data group. Wolfgang is from the University of Hamburg, where he was engaged in high energy physics research. He is taking an opportunity afforded by a German
government fellowship to make a career change to energy research.

*IN THE BEGINNING*

An interview with Mary Hunt, Principal Investigator
Instrumentation Survey for Environmental Monitoring

E&E: Through your involvement in the 11-year old Instrumentation Survey for Environmental Monitoring, you were affiliated with many of the original members of the E&E Division. You must have been privy to the lore of the origins of the Division. Could you tell us a little about the evolution?

MH: When I was asked to join the Instrumentation Survey in 1977, Dick Mack was still the P.I.; Bob Budnitz was no longer with the project since he had become the Acting Division Head; Craig Hollowell and Nabil Amer were still working with the project but were becoming increasingly involved with their individual research; Tony Nero, who was new to the project, was working on the Radiation volume; George Morton had been a consultant from the beginning. I learned that George held over 50 patents, including the color TV camera, which he designed while working with RCA.

E&E: You recently prepared one of the volumes for commercial publication.

MH: Yes, with George Morton and Bob Budnitz as editors, we completely revised the Radiation volume (Bob had written it originally) for John Wiley & Sons.

E&E: How many volumes have been published to date?

MH: Well, originally four volumes had been published by TID--Air, Water, Radiation, and Biomedical--by 1972. When I took over in 1977, the Radiation volume had not been updated since 1972 and was badly in need of revision. So we did a three-phase update. After the first and second phases had been published by TID, we were approached by a commercial publisher who was interested in publishing the volumes. At first we thought that it would be impossible for commercial publishers to copyright this material, but Candy Voelker, of TID, solved this problem with John Wiley & Sons as publishers.

E&E: So what is the future of the Survey now that you have achieved this goal?

MH: At the same time the Radiation volume was being readied for publication, the Water and Air volumes were being updated. We are planning to publish these updated volumes commercially and are waiting for word on funding from either DOE or outside sources to enable us to write an Energy volume, which we feel is very necessary. We are also working on a proposal with Campus to become consultants on environmental monitoring strategies for developing countries. We have good resources for such a project because in addition to our
instrumentation background, Alex Quintanilha is multi-lingual, and Charlie Case has worked with areas in the South Pacific. We feel we have a good team.

E&E: In addition to your work as P.I. of the Instrumentation Survey, you are also involved in other research projects at the Lab.

MH: I work with the Earth Sciences Division's Marine Science group on several projects. One is the Ocean Thermal Energy Conversion (OTEC) project which will probably be moving from the Lab. It will still receive DOE funding, however. I also participated in the underwater mapping, bathometry, of the western end of the island of Oahu, which was interesting. As part of that expedition, we also collected samples on Loilii Seamount, a submarine volcano off the island of Hawaii. We believe that the composition of the sediment indicates that it is very recent.

E&E: As a chemist, what brought you to the Laboratory?

MH: My husband, Arlon Hunt, had been working in the Solar group. Tony Nero mentioned to him that he was working on a short-term project for the California Energy Commission on electric power generation and needed some help. Arlon told Tony that he didn't know anyone who knew anything about electric power generation but he knew someone who could think. Of course, he was referring to me. I had just had our second child and was ready to go back to work. So Tony interviewed me, and I was hired. While I was working on this temporary job with Tony, I noticed that Dick Mack was advertising for someone to work on the Water volume of the Instrumentation Survey. So I interviewed and got the job. Then, after my first month on the job, Dick announced he was going to retire. Craig, Nabil and Tony were all establishing new research projects, and I was chosen as the new P.I. Dick had been at the Laboratory since the 1940's and taught me how the Lab worked, which proved to be very useful. Ralph McLaughlin had been one of the original Survey members, and I was very glad to get him back on the team. Thanks to Ralph and Dick, we had close ties with Fred Goulding, the head of the Instrumentation Group in E&TS, and Ted Hadeishi. Both have been invaluable resources for our survey.

E&E: Were you working in the Bay area prior to coming to the Lab?

MH: No. Arlon and I had just moved to Berkeley from Tucson, Arizona, where we had met as graduate students at the University of Arizona. Arlon had been hired by Mike Wahlig and Don Grether of the Solar group.

E&E: You mentioned the addition of another family member just before coming to work at the Lab.

MH: Robbie, who is now 5, was born just before I joined the Lab. We also have a daughter, Elena, who is 7. For the first two years at the Lab I was working 80% time so that I would have an extra day for the children.
E&E: What do you and your family enjoy doing for leisure?

MH: We travel a lot. In fact we're going to the Galapagos Islands and Ecuador in June. The kids are thrilled. I used to do photography before the children were born and am planning to pick it up again.

*RECENT REFEREEED JOURNAL ARTICLES*


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