Energy Programs *(These are my personal views on this topic - VCT)*

The Use of Energy Programs

The main purpose of energy programs today is code compliance and LEED certification. The Energy Cost Budget method considers Demand and TOU utility rates. This requires all four phases of the program – Loads, Systems, Plants & Economics.

The use of energy programs was not mandatory until States introduced energy codes. Except for California and Florida, almost all the other States introduced codes less than 10 years ago. Federal buildings had 10CFR434 which is not as stringent as ASHRAE Std90. LEED is not mandatory. All architectural-engineering design firms (AEDs) in the USA must now have expertise in the use of at least one of major recognized energy programs or they have to subcontract this work to a firm that does.

Energy programs were therefore not used on most projects until the introduction of codes. With easy to use windows, graphics and forms interfaces to energy programs today (which did not exist until the late 1990s), energy programs are now also routinely and frequently used to evaluate Energy Conservation Measures (ECMs) during the design process.

With the goal towards low (or net zero) energy buildings, non-conventional and innovative designs of building (envelope, lighting, day-lighting, HVAC systems, and DHW), energy programs now play a very important role. The benefits of these designs should not depend on the experience of AEDs only, as in the past which can vary considerably.

The staff involved in the architectural-engineering design (AED) process consists of architects (design, technical and project management) and engineers (civil, structural, mechanical, electrical, lighting, plumbing and fire protection). A million square feet building typically goes through the phases of Schematic Design (SD), Design Development (DD), Construction Documents (CD) and Construction (checking shop drawings and site visits). Relative to the total cost of the AED process for major projects, the cost of energy analysis is not significant. The percent of energy analysis time might increase with decreasing floor areas.

Some of the programs developed outside the US might have the advantages of importing Autodesk CAD and BIM models. They might have useful design features such as CFD, etc., but they cannot yet compete with the DOE2 based and other US developed programs for code compliance in the USA because of limitations in Systems, Plants and Utility-Rate-Analysis.

It is easier to enter energy program input directly than to import detailed data from CAD and BIM models which are going to come with large quantities irrelevant data. The eQUEST feature of being able to trace AutoCAD drawings (discarding irrelevant layers of text etc.) is all that is necessary. It ensures fast accurate physical modeling. Energy programs should be easy to learn and to use to keep AED costs down.

Energy program users are mainly AEDs that use the programs on real building projects. They are also used by academic institutions for teaching in the classroom. The success and value of energy programs should be measured by its use on real building projects for design-evaluation, code-compliance and LEED-certification. AEDs have this responsibility and they should be involved in the design and development of such programs and not just academia, research institutions, and software firms that are not involved with real buildings. This objective can be achieved if AEDs were to create an organization that represents them. There is presently no inter-disciplinary organization that specifically caters to the interests of AEDs.

Theoretically Accurate Calculations

Judgment and experience are applied throughout the design process. Besides weather, it is not possible to predict the precise internal scheduled loads of a building. The trend has been that, while lighting loads have decreased due to standards and codes and new technologies, the receptacle equipment loads have increased due to computers and communication equipment. Client provided information of internal loads can result in under estimated cooling loads in commercial buildings. 99.6% ASHRAE winter design conditions can result in under estimated heating loads in residential buildings.

The 102-story Empire State building was built around 1930 and several large commercial buildings have been built since then through the 1960s without the aid of computers. There were no spreadsheets or calculators – just slide rules. There was minimal use of computers through the 1980s until cheap PCs became available in the 1990s. Extreme theoretically computer calculated accuracy of energy programs is still not as important as engineering judgment and experience during the design process.

Air, water and heat transfer equipment performance in manufacturer's catalogs and computer programs are typically based on test data that are based on the specifications of AMCA (Air Movement & Control Association) and AHRI (Air-Conditioning Heating & Refrigeration Institute). Performance curves (based on engineering theory and physics) are generated from this statistical data. Equipment performance based solely on the properties of materials and physics & engineering theory is not considered reliable enough.

Today all heating and cooling loads calculations are done with computers and not manually. It is possible to use computer programs by understanding just the input terms and without understanding how this input affects the results from computer programs. eQUEST Schematic Design is an example where all the engineering design data is presented as defaults by the program given the building type. The user has to enter the building and zone shapes and dimensions which can also be done by tracing AutoCAD drawings. You don't have to know the subject in theory or practice. Someone that does not have AE design experience or have basic engineering knowledge of all the components of "Loads, Systems, Plants and Economics" of energy programs can enter inappropriate data into the program and get results showing energy savings over ASHRAE Std90.

Mechanical engineers with an HVAC background are qualified to use energy programs. Architects and other building engineers need to understand the theory before they can claim to be able to perform energy analysis. Architects are concerned mainly with envelope design. The commercial cooling and fenestration chapters of the earlier ASHRAE Handbook of Fundamentals in the 1970s and 1990s could be used in the classroom to teach this subject. The CLTD-SCL-CLF method demonstrated how building materials affected loads. The 2005 Handbook, describing the heat balance method, is not suitable for teaching this subject.

Energy programs are external to the design process. The greater theoretical accuracy features of Energy-Plus described earlier over DOE21E are not going to be considered by practitioners unless the computer program make the design process easier, faster, more efficient and less expensive. **CAD programs have definitely made the drafting process more efficient and reliable. They have made a big difference to inter-disciplinary space integration.** Programs such as CFD add to the cost of the design process.

The best energy program to use in AED offices is not necessarily the one with the most “Xs” in the report “Contrasting the Capabilities of Building Energy Performance Simulation programs v1.0”. Ease of use, financial stability of the program vendor and customer support are determining factors. The report does not consider these factors. eQUEST has the advantage of being the only program that is free to the public worldwide except in California since program development is supported by California tax payers.

The Energy Program Software Business

Developing, marketing and supporting energy programs are not profitable businesses for the private sector. The number of potential customers is few and they are not willing to pay more than the cost of, say, and MS Office program which would be less than $500 per copy. This industry cannot support more than two or three competitors in this field.

Regarding an open source energy program by a non-profit group, it would have to compete with the eQUEST program based on DOE22 which is free and appears to be well funded by CA utility companies that make their money selling utilities not energy programs. The open source energy program based on DOE21E would also have to compete with TRACE by Trane and HAP by Carrier which are also well funded and they can justify their costs because the software also promotes their main HVAC equipment products. One of the advantages of using TRACE and HAP is the excellent customer support whereas eQUEST and DOE22 have no customer support. TRACE and HAP also assure long term stability. An open source DOE21E energy program would still require a forms and graphics interface like Visual-DOE and Energy-Pro.

A non-profit association of AEDs could possibly support the development of interfaces to the publicly funded programs of DOE21E and Energy-Plus. They could support interfaces like Visual-DOE and Design-Builder but they might have to become non-profit organizations.

DOE21E Energy Program by USDOE

DOE21E is a public domain program. DOE21E was extensively used by Architectural-Engineering Design firms (AEDs) from the early 1980s and until recently. It represented the energy program standard for the industry. The DOE2 program is still the standard since the most popular program today, eQUEST, is based on an upgrade of DOE21E – DOE22. Com-Check, based on DOE21E, is also still widely used.

The direct use of the DOE21E-BDL declined when forms and graphics interfaces became available, since 2000, for energy programs such as TRACE, HAP and DOE2. Although DOE21E-BDL can be used directly, this project’s success will still depend on privately developed forms and graphics interfaces such as Visual-DOE and Energy-Pro.

The Loads segment of the energy program should be usable as a design loads program. This requires a “Space” level under the “Zone” level. TRACE presently has this feature and it can be used as a Loads program also. All spaces in the zone are controlled by a thermostat in one of the spaces and the temps in the other spaces are allowed to float. The “hourly energy analysis” part of the DOE2 program should track these floating temps and determine the steady state temp condition of the spaces without the thermostat. The attachment includes a proposed form for space level input.

There should be an option to specify 2 or even 3 perimeter zones. The first would be a thermal zone for the envelope which could be as small as 6 inches depth to offset thermal transmission loads based on outdoor air temp and solar radiation on the outside surface. Office buildings are designed this way with separate zone control (terminal box) with perimeter linear slot diffusers serving this half-foot deep zone only. This zone conditioning maintains the inside surface temps of the envelope to eliminate the effect of radiant heating and cooling discomfort on people. This is typical of office buildings. The attachment shows a figure demonstrating this zone.

Residential buildings have perimeter heating systems at the floor level (heat rises) which maintains the temps of the inside surfaces of the envelope. Perimeter cooling systems at the floor level are not as effective. Often the perimeter system is heating only and cooling is by air supply in the interior. In climates where outdoor temps exceed 120F with high solar radiation on the outside, the inside surface temps of inefficient glass cause discomfort due to the Mean Radiation Temp (MRT) effect if there is no perimeter cooling system. Presently DOE21E calculates the outside surface temps (can be viewed only in hourly reports) but not inside surface temps. The program should calculate MRT at two specified distances from the inside surface.

The figure also shows how the ceiling drops from just under the bottom of the floor above slab ***with no ceiling plenum*** to about 10 feet above the floor which leaves about 3 feet plenum space. Percent glass can be as high as 80% which allows solar radiation heat gains and day-lighting to reach depths of 30 feet. Light shelves with reflective ceilings also extend the day-lighting perimeter zone. Day-lighting analysis should be able to estimate day-lighting levels separately for 0-15 feet and 15-30 feet depths and there would be separate lighting dimming controls for each segment. Solar radiation would be applied to the first segment of 15 feet as before.

So there should be the option of being able to specify three types of perimeter zones. (1) for the envelope which deals with inside surface temps affected by transmission & solar radiation on the temperature of the outside surface, (2) a thermal perimeter zone of about 15 feet affected by solar radiation & interior loads and day-lighting, and (3) an additional day-lighting zone beyond 15 feet which would include interior loads.

It should be possible to specify at least two HVAC systems to serve spaces and zones. Example: WSHP, FCU, Baseboard, and other "non-air" perimeter systems, and a supply air or a dedicated outdoor air system (DOAS). The first takes care of temperatures and the second takes care of air flow – minimum supply air changes in medical facilities and ventilation requirements in all other facilities. Presently hotel rooms and apartments can have a "non-air" system in the space, but the outdoor air has to be supplied to the corridor and assumed transferred to the spaces through door undercuts.

It should be possible to specify more than one exhaust system. Example: Toilet Exhaust (TX), Kitchen Exhaust (KX), Laundry Exhaust (LX), and General Exhaust (GX) with separate schedules. As with "systems", spaces and zones would be assigned to the exhaust systems. Heat recovery between outdoor and exhaust air in hotels and apartments should be defined separately.

The Systems segment should include input forms for (1) Fans + Ductwork-Systems and (2) Pumps + Piping-Systems. See attachment. The information is obtained from running ductwork, piping and equipment selection programs and from manual design procedures. The Fan and Pump heads entered into the energy program forms would represent operation at peak design conditions determined by the Loads segment. Part load performance would be based on Fan and Pump laws. Energy programs are now used for code compliance when submitting construction documents (CDs). It helps if information from the CD equipment schedules can be entered into the energy program to record how the final fan and pump heads were obtained.

DOE21E will require additional systems such as UFAD, run-around coil loop heat recovery, GSHP (the last two are available in JJH's version 136 but not in LBNL's version 110), etc. If USDOE has joint ownership with JJH of DOE22, then a lot of its new features can be copied including PV. A simple way of simulating UFAD would be to let the user specify a space temp for up to 7 feet from floor level (say 75F) and another temp for the space from 7 feet to the ceiling (say 65F in winter and 85F in summer). This amounts to assuming space volume/mass temps of 72F in winter and 78F in summer. Actual UFAD performance would be better.

There is actually an advantage of having four independent segments of Loads, Systems, Plants & Economics instead of putting the first three segments within one time loop. AEDs are more interested in practicality rather than extreme theoretical accuracy and it helps to check and correct the results of each segment before going to the next. The accuracy gained by modeling Loads, Systems & Plants in one time loop is not significant to AEDs since the results of energy programs are not used in the design process and therefore does not affect construction and operation.

The DOE21E program requires better organized and presented libraries. As with TRACE there should be a Global Library that can be used by all projects and from this the user should be able to create Project Libraries by customizing and adding information. It should be possible to transfer one project library to the next project for customizing.

Libraries are used by AEDs to set their own design standards and to comply with codes. See attachment for space design standards. Presently it is possible to do this with the SET-DEFAULT and PARAMETER commands and by copying BDL segments of one DOE21E project to another. It is not possible to do this with eQUEST but possible with DOE22 and easy to do with TRACE.

Up to date libraries of major utility rate structures can also help reduce design analysis time. This can be done with DOE21E by saving BDL templates of utility rates and copying them to other projects. The rates might vary between utility companies but the rate structure and format of a particular company do not change often. DOE21E BDL templates of schedules and constructions (layers of materials) can also be saved into libraries. I have tried doing this with DOE22, but when it is read by eQUEST, the utility rates, schedules and constructions are broken up into their components and grouped separately.

The DOE21E and Com-Check programs should be linked – the DOE21E program should check for ASHRAE Std90 and Code compliance using information in the libraries..

The DOE21E program requires new summary output reports that fit in with the design procedures of AEDs for space, ductwork & piping design, equipment selection & scheduling, code compliance and LEED certification. It should be possible for users to create their own output reports, tables and charts for client presentations. Check figures such as btuh/sf and cfm/sf should be shown for each surface and space. This would include selecting the FORTRAN variables used now to generate hourly reports, and tabulating & charting day and month profiles. Detailed reports are only required for checking data when there are questions about the results. An AED group should be responsible for creating the formats and contents of these new reports.

Building design decisions are not made solely by comparing energy conservation measures (ECMs). First costs, maintenance labor and replacement parts costs and availability, ease of maintenance, reliability and durability of systems, and environmental impacts have to be considered. Final decisions are made based mainly on overall life-cycle costs, payback periods and return on investments. Life cycle cost analysis (LCCA) is required to compare ECMs.

Readily available and up to data cost estimating programs are therefore required to complement energy programs. They do not have to be the detailed itemized ordering and costing systems used by contractors. The cost estimating systems would be designed for comparing ECMs only and only relative accuracy and reliability are important.

The DOE21E should be linked to the BLCC5 (Building Life Cycle Costs) program and a cost estimating program. DOE21E would be the core of a package of integrated programs which would include graphics-forms interfaces that can import CAD drawings, Com-Check, BLCC5, first + operating cost estimating, GSHP, PV, CFD, etc..

http://www1.eere.energy.gov/femp/information/download_blcc.html#blcc
http://www.energycodes.gov/comcheck/ez_download.stm

The comment statements inserted into DOE22 disappear when it is read by eQUEST. One of the advantages of the BDL of the DOE2 and Energy-Plus programs is that it can be read as design and modeling specifications (with comments) unlike the information that is scattered in different input forms. There are advantages to using the BDL directly without input forms or using the two methods together. Interfaces should retain the comment statements inserted in the BDL.

The Building Description Language used to model the building in the input (*.inp) file could be improved with consistent and expanded keywords and expressions. The same applies to imbedding user created programming statements, functions and subroutines to perform specialized tasks required by projects. DOE2.2 already has a more advanced system compared to DOE21E (and it is better documented in volume 3) and perhaps it can be copied into DOE21E. BDL has several advantages over entering data using forms.

One of the reasons given for replacing DOE21E (and DOE22) with Energy-Plus was that the FORTRAN-77 code was outdated and badly organized & written by numerous programmers who have since moved on. The source codes of the major energy programs (TRNSYS, TRACE, ESP-r) originated in the 1970s also. eQUEST is based on DOE2 which is based on FORTRAN-77. However 30 years of use has probably eliminated most of the bugs of these programs. In my opinion the DOE21E source code is therefore not obsolete unless there are errors in the analysis. The old code can be frozen and new enhancements can be added by working with output from the old code subroutines.

Several private firms have developed easy to use forms and graphics interfaces to DOE21E. Energy-Plus is not an upgrade of DOE21E. If USDOE and LBNL were to abandon DOE21E, then these private firms will lose their investment. ***Either USDOE continues developing and maintaining DOE21E, or it should compensate the private firms for their losses. Why should any private firm develop an interface to Energy-Plus if USDOE cannot be trusted?***

Energy-Plus Program by USDOE

My familiarity with this program is as of 2005 and is limited. The comments below could be questionable and erroneous.

The execution time needs to be reduced.

There is an option to choose between time intervals from 60 minutes to 10 minutes (I think). AEDs are going to choose the simpler 1-hour intervals. Weather data comes in 1-hour intervals and weather does not repeat itself from one year to the next. Schedules of interior loads are in 1-hour intervals and they are approximate. 15-minute time intervals might have some significance in power demand measurement since utility demand rates are based on 15-minute intervals and not the average of 60 minutes. This would result in an error with programs that use 1-hour intervals.

There should be an option to choose between the heat balance method (which adds to the execution time) and the transfer function method used by DOE21E. Energy programs are used by AEDs to compare alternatives such as baseline and proposed. As with time-intervals, extreme theoretical accuracy is not an issue. Schematic Design (SD), Design Development (DD) and Construction Documents (CD) phases are based on design and equipment selection programs and the results of energy programs are not used again during design.

There should be an option in the Systems segment to specify complete air (ducts) and fluid/liquid (pipes) system packages with their equipment as one input system with associated parameters similar to DOE21E, TRACE, etc. Ductwork and piping design with equipment occurs throughout the design process. Energy programs are used during the Schematic Design (SD) phase when this information is not available.

Energy-Plus can now build a dozen HVAC templates for easy input of typical systems – fan coil, VAV, PTAC, PTHP, WSHP, PVAV, etc. However, these template inputs then get converted into full inputs for E+ which includes nodes, branches, list, loops, etc., which adds to the execution time. Performance of each component of the network (piping, ductwork, coils, fans, etc.) should be entered with input forms information from the CDs. See attachment for fan and pump analysis forms.

Energy programs are now expected to show energy code compliance when submitting their construction documents (CD). AEDs cannot justify the additional time and cost to recreate ductwork & piping networks for each system with equipment and enter other detailed information again into an energy program at the CD submission stage of the project.

Energy programs are used to compare energy conservation measures (ECMs) and for estimating the building energy use. Measurement & Verification (M&V) of energy use in completed building projects tend to show that computer predictions tend to be lower than actual energy use. The enhancements in Energy-Plus cannot claim to produce superior and more accurate results compared to results from the DOE2 program.

The features of Energy-Plus described above are mainly of interest to research institutions. AEDs are going to continue using DOE2 based programs such as eQUEST (or TRACE and HAP) until Energy-Plus becomes easier to understand, learn-to-use, and to use. The Energy-Plus execution time is such that the user will have to work on other tasks while the program finishes running. This is an inconvenience that AEDs will avoid.

Energy-Plus has added some significant modeling features that DOE-2 did not have, e.g. natural ventilation, radiant cooling and heating, UFAD, thermal displacement ventilation, day-lighting and controls, thermal comfort, water usage, PVT, and renewable power. These features are important to the AED process and the barriers that prevent AEDs from using the Energy-Plus program should be removed and they should also be added to the DOE21E program so that private firms that invested in interfaces to DOE21E can benefit from it.

Even if Energy-Plus is fixed to become significantly easier, faster and less expensive (in personnel time) to use compared to the currently used programs in the US (eQUEST, TRACE and HAP), it would now have to overcome the inertia and apathy of users to make them switch from the programs that they have mastered. The privately developed interface to the Energy-Plus program will have to compete with the free eQUEST interface to DOE2.2 and they would have to compete with the stability and reputation of the companies offering TRACE and HAP.

DOE21E should therefore still be supported, maintained and enhanced by USDOE and LBNL until AEDs accept Energy-Plus as the replacement program for DOE21E.

eQUEST Interface to DOE2.2 Program

It helps to also know how to use the DOE2 program directly when using the interfaces to the program such as eQUEST, VisualDOE and EnergyPro. It forces you to use the reference manuals that come with the DOE2 program and to understand the meaning and overall significance of each input item. You can avoid this when using interface programs such as eQUEST because of all the default values and design decisions assumed by this program for different types of Buildings and also for different types of ZONES, Systems & Plants.

In the case of large projects the results of every zone and system has to be examined to make sure that there were no accidental input errors. If a zone result does not look right based on engineering experience, then the sub-components must be checked. If this does not produce a satisfactory answer then it is possible to examine the hourly values of a variable in the case of the DOE2 based programs.

eQUEST is good program, The following negative comments about eQUEST relates to component names and default assumptions. The program user should be allowed to enter names and defaults as with the DOE2.2 program.

It is difficult and tedious to recognize every layer, construction, schedule, zone and system name assumed by eQUEST and change them to the ones you see on the drawings. Some projects have over 1000 zones and nearly 100 systems. The project cannot be broken up into smaller pieces because it affects the demand cost and there is still only one plant. The user should be able to enter their own names as with DOE2.2.

Besides automatically creating "names" eQUEST automatically creates surface components and schedules for each zone. The result is what appears to be tons of indecipherable gibberish. Except for plant and economics reports, it is difficult to check the other reports. eQUEST allows you to use your own names when you create building shell components and air side system types. However, the reports do not show these names.

The eQUEST program assumes all the "design-criteria" given building and component type and we have to check each form and cell to see what was assumed. It should show, the default, minimum and maximum values for the cell entry and the user should be able to enter the value. A document listing the defaults, minimum, maximum values (like the DOE21E BDL Summary document) and other assumptions will be helpful. The "Activity Areas Allocation" form should allow the creation of user named activity instead of having to use "Unknown".

I tried creating DOE2.1E and eQUEST models of a 50 zone project but because of the numerous default values and assumptions made by eQUEST (even with building type = Unknown) and the difficulty of fixing every design criteria value and schedule to match client specifications, it is difficult to get the results of DOE2.1E and eQUEST to match. It took a day to create DOE21E model using my own component names a data. It took several days to create the same model by changing the eQUEST names and defaults to match the names and values in the construction drawings, schedules and specifications. See project "High-Rise Mixed-Use Bldg".

In the case of such large projects with 100 or more zones, it helps to first create Master (or Global as in TRACE) and Project (created by editing a copy of Master) data for different types of Buildings, Zones, Systems & Plants, first and then creating each component such as Zone by assigning and editing a project component. This can be done with most programs such as TRACE and even the APEC MEP programs that were first developed in the 1960s.

In the case of DOE2.1E the Master, Project and Component override can done with design criteria assignments under PARAMETER, then with commands and keywords such SPACE-CONDITIONS, SET-DEFAULT-FOR, ZONE- (CONTROL, AIR, FANS), SYSTEM- (CONTROL, AIR,-FANS, TERMINAL, FLUID, EQUIPMENT), PLANT- (PARAMETERS), etc, . The Min-Max range and Default is published in the manuals and BDL Summary. It can be done in DOE22 and used as templates (libraries) that can be copied into other projects. This is not possible with eQUEST,

Energy Savings for LEED Certification

Architects today try to maximize the percent glass of the envelope. This creates a better living environment and increases the productivity of its occupants which also saves energy. The first costs, construction costs and operating costs (robotic window washing of the smooth outside surface, etc.) of glass high-rise buildings are low. The construction time is short because sections of the building (envelope, toilets, etc) are manufactured away from the site and assembled at the site. I watched the 92 above grade floors of the Trump Tower in Chicago being completed in less than two years. Glass buildings are lighter and therefore today's choice for all types of commercial buildings – residential and commercial.

The main source of energy savings of a glass building is day-lighting. Because ASHRAE Std90 suggests a perimeter zone depth of 15 feet for HVAC, it also means that you cannot get the maximum day-lighting credit for buildings that are 90% glass and with high ceilings. The vertical glass could have PV properties with a small overall efficiency of converting light to 110V electricity. Both energy savings features require day-light**.**

8,760 hours per year of building usage (Ex. hospitals) is more efficient use of the building but the percent energy savings of this building is going to be less compared to an office building that operates during the day only (less efficient use of the building) and with the same envelope.

ASHRAE Std90 for the envelope is very stringent, the percent glass now tops out at 40%. Significant energy savings cannot be gained by increasing envelope efficiency. These 70% to 85% glass buildings are not going to meet Std90 envelope requirements. 1.0 watt/sf for lighting is very stringent for an office building and so also are the mechanical systems standards. The recommended systems by Std90 for different types of buildings and areas are usually the best system that should be used. Installing some other system just to increase percent energy savings may not be in the client's best interests. The equipment (receptacle) loads have to be the same for baseline and proposed. The higher the equipment load, the lower the percent energy savings.

It is not practical to achieve LEED Silver with percent energy savings for high-rise buildings in urban locations, particularly with buildings that operate 8760 hours per year. The attachments show two case studies. The project "Middle-School + Community-Center" is based on the Chicago Center for Green Technology (CCGT) which received LEED Platinum. The roof area to floor area is high and it can be covered with Photo-Voltaic (PV) panels. There is plenty of ground area to install Ground Source Heat Pumps (GSHP). The building is 60% glass maximizing Day-lighting all year. It is possible to achieve more than 50% energy savings over Std90 with this building. In the case of the "High-Rise-Bldg" the impact of day-lighting is offset by heat exchange through the high percent envelope glass area.

High percent energy savings does not therefore necessarily mean a better or optimized designed building in terms of the client's interests. Percent energy savings should therefore not be the criteria for energy efficient building design. It should be based on Energy Conservation Measures (ECM) used for the given building that are more energy efficient compared to ASHRAE Std90 for the given building type and size which usually results in increased first costs. The ECMs are going to be different for different types of buildings in different locations. If the ECM used is inappropriate, then the client pays a price for the high percent energy savings.

Architectural-Engineering Design firms (AEDs)

Presently, and in the past, AEDs could not justify the cost of paying any attention to software development intended for their own use. One of the reasons why AEDs are not involved is because it requires non-chargeable (overhead) time. A partnership group representing AEDs and academia would be the solution.

Compliance with energy codes and LEED certification is an additional expense that US AEDs did not have before. AED fees in the US have steadily gone down over the years because of competition, particularly competition from overseas. The AED business cost is mainly labor. In today's global economy with communications technologies (internet, fast data transfer, video conferencing, etc.), AE design for US projects can be done in countries with lower wages.

Improving the efficiency of the AE design process in the US is therefore urgent. The “E” in “AED” would include Civil, Structural, Mechanical, Electrical, Lighting and Plumbing. Formalizing the study of inter-disciplinary coordination, design software integration, and AED production & cost management could be one of the projects of this proposed AED group. This would be similar to industrial engineering & management in the manufacturing industry. As many of the AE design process tasks will have to be formally defined and documented in detail and costs associated with the tasks. The tasks would have to be by software as much as possible, so that the task costs are not dependent on the skills, knowledge and experience of people.

The research lab for developing production management procedures for AEDs is the AED firm. There is therefore a need to form an AED group in the US to address issues that affect them which includes energy and other software development.

There is presently no group or forum of any kind representing AEDs. Every group (IBPSA, IAI, ASHRAE energy research and computer committees, etc.) are dominated by academia and research institutions. Few AEDs understand their numerous research projects, papers, proceedings, conferences, etc. Few are even aware that they are occurring since they have no impact on their work.

There is a lot of research & development and innovations that occur with real building projects. Actually every new building is a creative and innovative research project. Academia should take the responsibility of working with AEDs in documenting the special features of these projects. In other words develop case studies of different types of building projects for teaching.

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