Determining the Effectiveness of the ASHRAE 90.1, 1999 Building Energy Code by Design Professionals in South Carolina and to Identify Barriers towards Implementation

Martin A. Davis and Yotin Artonkitjawat
1 Clemson University, Clemson, SC, USA

ABSTRACT: Although building energy codes have demonstrated their cost effectiveness in promoting energy conservation, there still exists resistance to their widespread acceptance. A survey was completed in the Spring 2002 of design professionals in South Carolina to determine the context of energy codes within the ‘culture’ of building, and to identify barriers to code implementation. Results indicate reservations amongst designers to current code compliance and to the enforcement procedures. Recommendations are presented that include changes to the process, continuing education and reducing misconceptions amongst designers and code officials.

Conference Topic: 2 Design strategies and tools
Keywords: energy code, compliance, continuing education

INTRODUCTION

The purpose of developing, adopting and enforcing building codes is to manage risk and uncertainty, not guarantee against building failure (Eisenberg, 2002). Codes are intended to be sophisticated guidelines based on the accumulated knowledge in response to disasters, crises, advances in environmental awareness, emerging social needs and new technology (Herman, 2002). Codes deal with what does and does not work. While highly informed, they are still best guesses based on assumptions of certain general conditions, reached through a process that attempts to balance numerous, sometimes conflicting, needs and demands. Code requirements are continuously evolving as we learn more, deal with failure and innovation, and shift our focus based on new awareness of problems, opportunities and responsibilities, with the overall goal being to protect the public by establishing minimum safety requirements for the built environment (Eisenberg, 2002). Over the past 30 years we now realize that what is required to make buildings safer may create harm and risk elsewhere. We all become less safe when we deplete finite resources and undermine the health of the natural systems that support life. The fact remains we cannot simply make buildings safer without placing them within an environmental context. By balancing all the risks, including those we are trying to avoid and those we inadvertently create elsewhere or defer to future generations, it is possible to fully discharge our responsibility to protecting the public safety, health and general welfare.

2. OBJECTIVES OF RESEARCH

How well do design professionals, e.g., architects, engineers and building code officials, respond to the building energy code compliance process? Are we to assume these professionals all share a common goal towards resource efficiency and energy use? Is the energy code compliance process a burden to these professionals? If so, how can we attempt to improve on its current format? A survey of design professionals in South Carolina was taken in the spring of 2002 consisting of architectural firms, engineering firms (including civil, mechanical and lighting) and building code officials. The survey was based on the non-experimental quantitative research method.

This research technique involved making careful descriptions of observed phenomena and exploring the possible relationships between different phenomena. The descriptive survey method dealt with a situation that demands the technique of observation as the principle means of collecting data (Leedy, 1997). The population for the study was carefully chosen, and specifically delimited to set precise parameters for ensuring discreteness to the population.

The instrument for observing data beyond the physical reach of the observer was the questionnaire. In this study, the questionnaire format was based on a previous investigation on tourism used by the Moore School of Business at the University of South Carolina. Specific topics were identified through a series of interviews ten months prior to the questionnaire with select design personnel who were actively involved in energy code procedures. A total
of 300 surveys were mailed in the spring 2002 semester throughout South Carolina. Ninety-three surveys were distributed to architectural firms; 91 sent to professional engineering firms, and 116 forwarded to building code officials/inspectors. A total of 65 surveyed were received representing a response of approximately 22%. Mailing lists were provided by the American Institute of Architects, South Carolina Chapter, SC Society of Professional Engineers, and the SC State Energy Office who maintained a current list of building codes officials/inspectors. Data was analyzed using a Microsoft Excel Spreadsheet Program.

3. GOALS OF THE STUDY

1. To understand the context of the building energy code within the ‘culture’ of the building design community in South Carolina.

2. To determine the impact the energy code compliance process on the design process in terms of creativity, production, time and costs.

3. Identify barriers to implementation by the design team in the building energy code process.

4. Establish recommendations to help reduce barriers and to further increase the acceptance and understanding of the building energy code process to all participants in the building process.

4. CURRENT PERCEPTIONS BY BUILDING DESIGNERS OF ASHRAE 90.1, 1999

It is important to understand the impact of the building energy code workshops sponsored by the SC State Energy Office. Only fifty-one percent of all firms surveyed attended energy building code workshops, while forty-nine percent did not. The breakdown of those who did attended any of these energy code workshops is listed in Table I.

Table I: Respondents Who Attended SC Building Energy Code Workshops

<table>
<thead>
<tr>
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<th>Percentage</th>
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<tbody>
<tr>
<td>Attended one Workshop</td>
<td>50%</td>
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<tr>
<td>Attended two Workshops</td>
<td>21%</td>
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<tr>
<td>Attended three Workshops</td>
<td>6%</td>
</tr>
<tr>
<td>Attended four Workshops</td>
<td>2%</td>
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<tr>
<td>non applicable</td>
<td>21%</td>
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Forty-two percent of the respondents used the ASHRAE 90.1 energy compliance procedures in all their commercial/institutional projects; 31% used it sometimes and 27% said no or non-applicable. Thirty-nine percent of the firms surveyed used in-house personnel in the code compliance process, while 40% used outside consultants and 18% used others. Thirty-seven percent of the firms indicated that one individual was assigned in their office with the task of dealing specifically with energy code compliance, 12% involved two individuals, 11% involved three individuals, 11% involved four individuals, and 18% used more than five personnel dealing with energy code compliance. Figure 1 indicates the percentage of respondents who focused on specific portions of the code. Multiple portions of the code such as the envelope and mechanical appear to be the primary areas of concentration. 48% used the COMcheck-ez compliance method 25% of the time; 5% used the COM check-EZ in 50% of the time, and only 9% used the COMcheck-EZ method in 75% of time. Only 1% used the COMcheck-EZ compliance method in 100% of their projects. There are four compliance paths in the energy building code. They are the prescriptive method that requires minimum standards, a component performance method that allows the designer to show compliance of construction assemblies, a trade off option that permits trade offs between building envelope components, and finally a energy cost budget method (User’s Manual Standard 90.1-2001). In the survey, 34% of the respondents followed the ‘prescriptive option’ in the compliance process; 23% followed the ‘energy-cost budget option’ and 12% followed the ‘trade-off option’.

Figure 1: Portion of the Energy Code Building Designers Consider Their Primary Focus

Figure 2 provides some indication of the uneven perceptions of the code by building designers with regard to overall building energy consumption. Nearly half (46%) of the surveys indicated that ASHRAE 90.1 effectively reduced energy use in buildings, while another 46% was uncertain. Eight percent were convinced the energy code did not reduce energy use in buildings.
How relevant are building energy codes to designers? Figure 3 indicates that over half (57%) of those responding think building energy performance needs to be mandated and enforced using a code format, 26% do not think codes are the best way to enforce energy conservation, 17% remain uncertain of the code's effectiveness on energy use.

Figure 4 provides some indication, as viewed by building designers, on the impact of the code compliance process on creativity and the design process. Twenty-seven percent of the design professionals (architects and engineers) thought that ASHRAE 90.1 did place limitations on the design process. This refers to the design, detailing and project delivery of a building. Forty-two percent thought that energy codes sometimes had a restrictive/adverse effect on the creative process, while 22% did not see any restrictions to the design process. When considering ‘creativity’, however, forty-nine percent of design professionals responding thought that the energy code did occasionally restrict the creative process, 31% did not while 16% confirming it did restrict creativity. Finally, does a working knowledge of ASHRAE 90.1 make a better designer? Forty-seven percent acknowledged the importance of the code; 17% did not think a working knowledge of the energy code makes for a better designer, while 16% had doubts.

Respondents generally felt little encouragement pursuing energy conservation issues to building owners/clients other than to do what was necessary to receive building code approval. This is reflected in Table 2, which ranks the importance given by owners/clients to design issues affecting the building
process. In this case, energy concerns ranked last of seven design issues.

Table 2: Order of Importance by Owner/Clients to Project Design Issues

<table>
<thead>
<tr>
<th>Rank</th>
<th>Project Design Issue</th>
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<tbody>
<tr>
<td>1</td>
<td>Budget</td>
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<tr>
<td>2</td>
<td>Program</td>
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<tr>
<td>3</td>
<td>Aesthetics</td>
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<tr>
<td>4</td>
<td>Schedule</td>
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<tr>
<td>5</td>
<td>Maintenance</td>
</tr>
<tr>
<td>6</td>
<td>Buildability</td>
</tr>
<tr>
<td>7</td>
<td>Energy</td>
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Fifty-seven percent of the respondents thought that owners had little interest in complying with energy codes, 32% had moderate interest while only 6% seem to have a high level of interest (see figure 6). Thirty-seven percent of the building designers indicated that reducing energy consumption has never been the prime focus of owners or vendors. Only 9% of the building designers surveyed indicated that energy was a prime concern for owners/clients. Nearly half surveyed indicated that it was sometimes (see figure 7).

Figure 6: Owners Interest of Energy and Building Issues-Bldg Designer's View

Most design professionals felt that predicted energy savings indicated in the compliance process has never been compared to actual field energy use data. Over half (51%) felt confident that the energy compliance measures specified in the design phases were met during the construction phase of the project.

Figure 7: Level of Concern of Energy Use by Owners-Bldg Designer's View

5. SEEKING ADVICE

Professional relationships between those designers and officials dealing with energy code compliance procedures appear to be mixed. Trying to determine how well the disciplines assist each other in the code compliance process is vague. Even though most respondents (32%) feel the code process is architecturally driven, it is the mechanical engineer who is considered the most important professional to answer questions and solve problems concerning the compliance process (see figure 8). When a discrepancy or problem develops within the compliance process, forty three percent of the firms surveyed actively sought answers from mechanical engineers, while only 8% sought answers from architects, building code officials (11%) and electrical engineers (1%).

Figure 8: Professionals to Contact When Discrepancies Develop
Figure 9: Views of Code Officials by Architects/Engineers in the Compliance Process

Figure 9 concerns the timely transfer of information between design professionals during the compliance process. Forty-seven percent of the architects responding received information from mechanical/electrical engineers sufficient to comply in a timely manner with the energy code procedures, while only 7% of the architects did not get information from engineers in a timely manner. 36% of the architects sometimes received information from that group in a timely manner. From the viewpoint of the engineer, however, only 28% received information from architects in a timely manner, zero respondents indicated no, while 57% of the mechanical/electrical engineers sometimes received pertinent information from their architects sufficient to comply in a timely manner. When considering the helpfulness of building code officials/inspectors providing information on energy code questions 39% indicated no, 32% indicated sometimes while only 17% indicated yes.

Figure 10: Views of A/E’s by Code Officials in the Compliance Process

Figure 10 reinforces and questions the importance of the building code official in the code compliance process. Of the code officials who responded, 57% thought that the energy information on the drawings sometimes met the compliance requirements on the first submission granting energy code approval. Over 20% indicated that compliance was not achieved on the first submission, and 17% indicated it typically was. Half of all building code officials responding indicated the ‘envelope’ portion of the energy code gave designers the most difficulty, followed by the ‘mechanical’ and ‘lighting’ portions.

Twenty-eight percent of the building code officials thought that their level of expertise was most helpful during the construction phase, followed by advising in the envelope portion, plan review and then lighting. When considering the role of the architect in the compliance process, 52% of the code officials thought the architect should be more collaborative; 32% thought the architect should have a significant role into the compliance procedure, and 2% thought the architect should play no significant role. Thirty-nine percent (39%) of all the building designers surveyed thought building code officials/inspectors were not helpful in providing answers to questions dealing with the energy code, while 32% though that these officials/inspectors were ‘somewhat’ helpful.

Figure 11: Portions of the Energy Code Providing Greatest Difficulty

Figure 11 indicates those portions of the ASHRAE 90.1, 1999 energy code that provided the greatest difficulty to design professionals during the energy compliance process.

Based on the views expressed during the design of the questionnaire, a list was created consisting of a minimum of twenty-two potential barriers affecting the implementation of the ASHRAE 90.1 code. Of this list the top ten barriers to implementation from the responses to the surveys are listed below:

Table 3: The Top Ten Barriers to Implementation of the Energy Code

1. Complexity of code procedures
2. Financial burden placed on design professionals to comply; building code officials unfamiliar with energy code requirements and disinterest by owners of energy related issues
3. Inability of design professionals to co-ordinate decisions in a timely manner
4. Inability of architects to fully comprehend energy conservation issues
5. Code officials are too busy with life safety issues
6. CONCLUSIONS

A recent AIA Journal (AIA, 2003) indicated that client demand for environmentally sensitive design is strong. The South Carolina survey on energy code compliance, however, does not confirm these views. Programs must be created that deal with perceptions by the design community on the relevance or merit of the energy code. This is a direct outcome of a disinterested owner/client base which limits the importance of energy conservation in building; the lack of verifiable data of predicted versus actual or in-situ energy savings to design professionals and clients; costs to the consultants and limitations, whether perceived or actual, on creativity and the design process. To many professionals, questions exist on the effectiveness of the energy code as a way to reduce energy use in buildings. Forty-six percent of the respondents think that the ASHRAE 90.1 standards effectively reduce energy use in buildings. Eight percent do not think the ASHRAE standards have any effect on energy conservation, however, 46% are uncertain of the benefits of the energy code. While fifty-seven percent of building designers indicated building energy performance needed to be mandated and enforced by a building code sixty-five percent of those who responded were uncertain that the ASHRAE 90.1 was the best format for reducing energy in buildings. Data needs to reach the grass roots level that presents the importance of energy to clients; costs to the consultants and limitations, whether perceived or actual, on creativity and the design process. As many professionals, questions exist on the effectiveness of the energy code as a way to reduce energy use in buildings.

Education, both graduate education and post professional training, is needed to assist designers of code changes, and to gain familiarity with language of the code. Courses need to be developed on applications and case studies. Education is also vital to help break up the traditional design process, which may account for the inability of professionals to effectively communicate with each other. It might also bring to the table a more linear design process involving key consultants early in the project. Education and the culture of design are not mutually co-dependent in professional schools. Codes are typically applied in practice and not integrated within academic design. Codes are boring to teach and hence the pool of academics are not prepared to tackle code related studio design issues. Accrediting agencies need to insist that schools of architecture and engineering are actively engaging students in code education. Closely tied with education is defining responsibilities of each member of the design team to better understand the merits of code compliance. Getting and exchanging information in a timely manner during the code compliance process should been stressed to all disciplines.

The importance and relevance of code officials as a key participant in the design process is needed. The survey indicated that code officials lack the expertise and time needed to be an effective team member. These individuals need to be better informed and more accessible to designers. Currently code officials are typically not an effective participant in the energy compliance process. This requires substantial costs to local authorities and may be problematic in the current economic climate.

REFERENCES


[4] Lighting Design + Application (July, 2003), Energy Concerns, 10-11 ‘..in many cases the architect of record will not pay the lighting designer a fee for an energy code compliance document.’

[5] University of South Carolina, Moore School of Business, July 2001