Design Philosophy: Implications for Computer Integration in the Practice of Architecture

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The growing complexities of modern environments and the socioeconomic pressures to maintain efficient design/build cycles have forced architects to seek new tools and methods to help them manage the processes that have developed as a result of new knowledge in architectural design. This trend has accelerated in the past few decades because of developments in both cognitive and computer sciences. In allied disciplines, the introduction and use of computers have significantly improved design practices. Yet at best, in disciplines such as architectural design, computational aids have attained marginal improvements in the design process despite efforts by universities in the professional education of architects.

With regard to architecture, Gutman (1988, 2) has said, "To acknowledge its true character is to shatter several myths concerning the power, freedom, and autonomy of the profession." The architecture profession has become increasingly complex: the designer, once a generalist and key decision-maker in architecture has become a team player in a complex management process. Haider (1986) states that contemporary design problems have become too complex and interrelated to be approached in the traditional manner. Gutman (1988) noted that the profession must be prepared to change in order to successfully deal with the contradictory opportunities and constraints which have transformed the system of architectural design, the methods by which clients choose architects, the roles assigned to architects in the design process, and the standards by which the merits of buildings and architects are judged and evaluated. New tools and methods have been adopted to assist architects in dealing with emerging architectural complexities and some of these are helping to change the methods architects use in practicing their profession (Kalisperis 1988).

One such tool, the computer, has had a dramatic impact on the profession in recent years. Since the advent of the micro-computer in the 1980's, computers have become commonplace in architecture offices. Computer-Aided Drafting and Design (CADD) systems have also become commonplace. However, while CADD systems have become more prevalent in architects' offices, there are indications that these systems are supporting only some of the basic needs of the profession. Basic architectural needs are often addressed in terms of drafting (or documentation) on one hand, and design on the other. In order to discuss the roles of CADD systems in the architecture profession, the fundamental differences between drafting and design should be recognized. Drafting is a graphic method of documentation: a "highly standardized process, with a high level of accuracy required" (Crosley 1988, 4). The success of CADD for production-oriented documentation has been the topic of numerous surveys and articles citing increased productivity, drawing accuracy, and drawing quality as recognized benefits. Akin (1978) and Lawson (1982) noted that the process of designing takes place in conjunction with or parallel to the processes of drafting, which they defined as drawing, erasing, modifying, and redrawing. Design is the other integral part of architecture. Design is "a creative activity that involves bringing into being something new and useful that had not existed previously" (Jones 1970, 4), and includes graphic or qualitative as well as nongraphic or quantitative factors (Crosley 1988). While architects could be using the computer as a tool to test quantitative and qualitative tasks during design, it appears that the use of computers for design is not as successful or widespread as the use of computers for drafting and documentation. As Kalisperis (1988, 109) stated, "In the design documentation stage, the introduction of Computer-Aided Drafting has
made a considerable impact. However, computing in architectural design as it is being implemented today is not integrated in the basic design process."

In order to evaluate computer utilization by architects with regard to architectural design, assessments must be made which pertain specifically to this profession. The most prevalent method of reporting and understanding computer use by architects has been through surveys. However, previous CADD surveys have addressed CADD utilization in terms of quantitative variables, such as firm size, and little information exists on how CADD is actually being integrated into the architectural design process. Wite (1987, 118) stated "reports of how working architects are using the information management capabilities of the computers are still difficult to obtain." However, to achieve a complete understanding of architectural computing, it is imperative that CADD use by architects be approached in terms of design. Therefore, since a minimal amount of information existed on CADD utilization by architects in terms of design, it was the intent of this research to explore the integration of CADD into the architectural design process by examining the utilization of CADD by architects based on design philosophy and their approach to the making of architecture.

The areas of analysis were developed to examine CADD use in terms of design. For comparative purposes, the first analysis examined whether relationships existed between firm size and standard criteria often used in surveys of this types, such as CADD user characteristics, educational background, system characteristics, and applications. Also included was a new variable satisfaction level. Then a similar analysis examined whether relationships existed between a firm's design philosophy and the same characteristics. This comparison was important because traditionally CADD use had been examined only by firm size. While pertinent to some issues, firm size does not address CADD utilization in terms of design. This research proposed that a firm's design philosophy was an important variable in understanding CADD use by architects, and when used in conjunction with firm size, better explained the use of CADD by architects. Satisfaction was another new variable used by this research to better understand architectural computing. It revealed information not evident when examining CADD use only by quantitative variables.

The other area of analysis examined whether CADD-user characteristics, system characteristics, applications, and/or satisfaction levels differed with notable architecture firms. Many architecture firms are recognized by the profession through design awards and the recognition of notable projects in architectural publications. Some firms have emerged as outstanding design firms through repeated recognition of innovative and progressive designs. An examination of how some of these firms, noted for their design abilities, were using CADD provided additional insights into the CADD utilization in the architectural design process.

Survey design

A survey was chosen as the method to explore CADD utilization by architects because it allowed for the examination of the greatest number of respondents within the constraints of this research. In exploring issues pertinent to this survey, many CADD articles, as well as previous surveys, were reviewed. These articles provided indicators to factors that might be significant with regard to CADD utilization.

The initial intent of the research was to examine firms that would be representative of the entire architectural population. The AIA membership was determined to be the best possible alternative to testing all architectural firms and consequently used for development of the survey sample. In order to develop a sample of architectural firms, the AIA directory, Pro File, was used. The 1989 AIA Firm Survey Report reported that CADD utilization rates varied by firm size, with 80% of large firms utilizing CADD compared to 21% of small firms (AIA 1989, 76). Due to this variation, a sample representative of AIA firms based on firm size was considered critical in obtaining accurate data. A stratified random sample provided a representative number of firms in each size category and questionnaires were mailed to each randomly selected firm. Some other CADD surveys used non-random samples, which could produce biases leading to unreliable survey results. A sample size of 450 firms was established, with the number limited by economic constraints. The survey sample stratification was
based on the five firm size classifications as defined in the AIA’s 1989 Firm Survey.

One of the more critical portions of the survey design was to establish an indicator to define a firm’s approach to design. Previous research and concepts developed by Gutman (1988) and Cox (1987) provided a basis for making this distinction. While an entire study could be developed to examine this concept alone, it was necessary to simplify the categorization method because it was only one part of the overall research goal. Therefore, a scale representing a continuum was developed with the key words “Design/Theory” and “Pragmatic/Service” used as the scale anchors. Although this classification method may be overly simplified, based on the magnitude of the overall concept, the relationships between this question and other questions could be correlated to verify the design philosophy response validity.

Survey analysis

While many analyses were performed as part of the overall research project, only a few are presented in the following section. In order to determine the reliability of the survey, data were compared to previous surveys reported in the literature. The comparison included: 1) response rates, 2) CADD use, 3) firm size information, 4) type of CADD package used, and 5) CADD applications. In general, the similarity of the responses to other surveys of this type lead to increased confidence in the results of this survey. The response rate, 28.7%, was slightly higher than other CADD surveys. With regard to CADD use 47.3% of the firms were using CADD and 52.7% were not using CADD, figures almost identical to those obtained by the 1989 MicroCAD News survey, which also employed a random sample technique. Similar to other surveys, AutoCAD was by far the most commonly used CADD package, with 42.7% of the respondents using this package. Of the various CADD applications, 98.2% were using 2-D features, 40.7% were using 3-D features, and 20.4% were using solids modeling features, figures comparable to those in the MicroCAD News survey.

Unique to our survey was an analysis of CADD firms in terms of design philosophy. Firms were grouped into categories that reflected their self-reported approach to design. Responses to the question concerning firm design philosophy were recorded on a scale of 1.0 indicating “Design/Theory,” to 5.0 reflecting a “Pragmatic/Service” orientation. Although there was no encouragement to do so, respondents grouped themselves into three categories. The division which best reflected this tri-modal distribution was obtained by dividing the scale into three equal sections. In the following analysis, these groups are referred to as Design/Theory firms, Mid-range firms, and Pragmatic firms. Based on this division, 13.8% of the respondents using CADD were Design/Theory firms, 51.7% were Mid-range firms, and 34.5% were Pragmatic firms.

The validity of the design philosophy categories was supported by examining the use of CADD in design phases (Schematic Design and Design Development) versus documentation phases (Construction Documents) of a project by each group. Design firms were expected to use CADD more in the early stages of the design process than the other groups. As shown in figure 1, this was the case with respect to 2-D applications. Just the opposite was true of the documentation phases, where Pragmatic firms used CADD more than the other groups. With regard to 3-D applications, Design/Theory firms also used 3-D features more in the design phases than the other groups. Of the Design/Theory firms, 50.0% used 3-D in the design phases, compared to 27.0% of Mid-range firms and 15.8% of Pragmatic firms. CADD utilization of 3-D applications in the documentation phases was almost non-existent, with only two Mid-range firms using these capabilities for documentation.

With regard to overall CADD use, 100% of both Design/Theory and Pragmatic firms were using 2-D features, while 96.3% of Mid-range firms were using 2-D. 3-D features were being used by 57.1% of Design/Theory firms, 55.6% of Mid-range firms, and 15.8% of Pragmatic firms. Solids Modeling was being used by 57.1% of the Design/Theory firms, 22.2% of the Mid-range firms, and 5.3% of the Pragmatic firms. See figure 1.

The variable used to define satisfaction (reported as CADD-productivity satisfaction) was recorded on a scale of “Very Satisfied” “Not Satisfied.” Of particular interest is the fact that while AutoCAD was the most widely used CADD package, it received the lowest satisfaction rating. See figure 2.
2-D Utilization

<table>
<thead>
<tr>
<th>Phase</th>
<th>Philosophy</th>
<th>Design/Theory</th>
<th>Mid-range</th>
<th>Pragmatic</th>
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</table>

| Documentation | Design/Theory | Mid-range | Pragmatic |

3-D Utilization

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<thead>
<tr>
<th>Phase</th>
<th>Philosophy</th>
<th>Design/Theory</th>
<th>Mid-range</th>
<th>Pragmatic</th>
</tr>
</thead>
</table>

| Documentation | Design/Theory | Mid-range | Pragmatic |

Figure 1: CADD utilization by design philosophy

CADD Package

- Detased
- Arris
- Multi
- Versaced
- Others
- Autocad

CADD Productivity Satisfaction

Not Satisfied ➔ Very Satisfied

Figure 2: CADD productivity satisfaction by CADD package
The mean for CADD-productivity satisfaction varied only slightly between the three design philosophy groups. Pragmatic firms reported the highest degree of satisfaction, followed closely by the Mid-range firms and then the Design/Theory firms. While the difference in CADD-productivity satisfaction between the design philosophy groups was minimal, only 62.5% of the Design/Theory firms thought they had purchased the right CADD package as opposed to 73.3% of Mid-range firms and to 95.0% of Pragmatic firms.

As previously noted, AutoCAD was the most widely used CADD package. Since AutoCAD was the overwhelming leader in number of packages implemented, it was appropriate in many analyses to compare AutoCAD users with all other package users. Figure 2 shows the CADD-productivity satisfaction means of firms using various CADD packages. The CADD-productivity satisfaction for packages which received a low number of responses should be viewed with discretion, since the low number of responses may not produce an accurate description of the package. An inverse correlation existed between frequency and satisfaction: as the number of responses increased, the satisfaction decreased. A greater percentage of Pragmatic firms were using AutoCAD than Mid-range and Design/Theory firms, which supported other results in this research which showed that AutoCAD is a documentation-oriented package. In terms of CADD-productivity satisfaction, AutoCAD users were less satisfied than users of other packages. When examining the satisfaction by design philosophy for AutoCAD and other package users, the difference was significant for the Design/Theory and Mid-range firms while the Pragmatic firms rated AutoCAD and other packages almost identically. When satisfaction was compared to design philosophy for each of the firm sizes, it was noted that for firms with more than five employees using AutoCAD, all of the firms were either Mid-range or Pragmatic. See figure 3.

As figure 4 shows, the number of principals, managers, and architects proficient with CADD was significantly lower than that of interns and technical and drafting personnel (CADD operators and draftspersons). This could be explained by the exposure of these employee types to computer and CADD systems. Interns and CADD operators had probably used these systems in schools, while a majority of principals, managers, and architects were practicing before computers became popular in the architecture profession and education. Overall, it could be an indication that CADD was not easy to learn. As one respondent noted, "I've been in the business over 42 years and used a slide rule till ten years ago. There needs to be a simple method to teach Old Dogs the use of the CADD system." Eventually, as interns become architects, managers, and principals, the percentage of upper level personnel proficient with CADD should increase. Personnel responsible for system management varied.

<table>
<thead>
<tr>
<th>Design Philosophy</th>
<th>CADD Package</th>
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<tbody>
<tr>
<td>Design/Theory</td>
<td>AutoCAD</td>
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<td></td>
<td>Others</td>
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<tr>
<td>Middle-range</td>
<td>AutoCAD</td>
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<td></td>
<td>Others</td>
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<tr>
<td>Pragmatic</td>
<td>AutoCAD</td>
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<td></td>
<td>Others</td>
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Figure 3: Firms using AutoCAD and other packages by design philosophy.
between the respondents. While principals and managers were not as highly proficient with CADD as other groups, 57.6% of the respondents reported the job of system management being performed by principals or managers. Of the other firms, 13.6% were using architects as system managers, 10.2% were using interns, 5.1% were using computer specialists, 1.7% had more than one manager, and 11.9% were using a variety of other personnel as system managers.

Figure 5 shows CADD-productivity satisfaction for the various system managers. It should be noted that time allotted to system management appeared to influence CADD-productivity satisfaction. As the time spent on system management increased, individual CADD-productivity satisfaction increased. In addition, the satisfaction for systems managed by interns was higher than that for systems run by other groups, including architects. The fact that the

![Bar chart](chart1.png)

**Figure 4: Employee profile**

- Intern
- Draftsperson
- Principal
- Architect
- Comp. Spec.

**Time Spent on System Management**

**CADD Productivity Satisfaction**

![Bar chart](chart2.png)

**Figure 5: System performance vs. system management**

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firms using computer specialists as system managers reported the lowest satisfaction could be an indication that these individuals had a limited knowledge of architecture. This is significant because non-integrated and/or non-architecturally oriented CADD packages may require the utilization of a computer specialist to assist in the integration of architecture-specific application packages. In addition, the principals and managers were devoting a much lower percentage of their time to system management.

This could explain the low CADD-productivity satisfaction reported by firms using this group as system managers. In addition, according to the 1989 AIA firm survey, principals ranked improvements in design quality very low with regard to other possible benefits of CADD. System management could be one factor contributing to this statement. The combination of the large percentage of principals/managers responsible for managing CADD systems, coupled with the low amount of time they devoted to this task and their educational background could effect the design benefits derived from CADD.

Of particular interest is a result that clearly shows the significance of satisfaction as an indicator of CADD utilization. While AutoCAD was the most widely used CADD package, it received the lowest satisfaction rating. It was the only individually identified package with a mean below the overall average and was significantly below other notable packages such as Datacad, Arris, and Versacad. CADD-productivity satisfaction by system manager was compared for AutoCAD versus other packages. In reviewing this analysis a trend was noted. Firms with systems managed by computer specialists reported a higher satisfaction for AutoCAD, while those managed by principals/managers, architects, and interns were lower. This difference could indicate that the more the system manager knew about the profession of architecture, the less satisfied the system manager and the firm were with AutoCAD. This was significant because it suggested, again, that AutoCAD was not satisfying the needs of architects and architecture firms.

In reviewing the CADD productivity of the various system managers by design philosophy, it was noted that CADD-productivity satisfaction with interns was higher for design/theory firms. This could be attributed to the fact that many college architectural programs concentrate more on design, which is the orientation of design/theory firms. Therefore, interns could fulfill this role better in a design/theory oriented firm. However, the low number of responses should be noted and while these results are not statistically significant, they suggest a logical relationship between design orientation and interns.

Amount of time devoted to system management varied both with the type of package used and design philosophy. Time spent on system management varied greatly between CADD packages, as shown in figure 6. The high average for AutoCAD may explain why the productivity satisfaction was lower than the other packages, such as Datacad (see figure 2). Arris users spent the most time on system management, but were

![Figure 6: Time spent on system management by CADD package](image)

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very satisfied. Witt (1989) pointed out that the complexity of Arris affects firms that can afford a computer manager differently from firms where the principal must manage everything. It appeared that a certain amount of time and effort must be devoted by a firm in order to properly utilize Arris and smaller firms may not be able to allot enough of either to CADD system management and development. Also time spent on system management varied considerably based on the system used. The research findings indicate that for Macintoshes, system management required 20% of the time, while MS-DOS required 33%, Unix/Xenix 59.2%, and multi-systems 71.7%. With regard to design philosophy, design/theory firms spent more time on system management (37.3%), which compared to 32.9% for mid-range firms and 26.5% for pragmatic firms. This smaller amount of time for pragmatic firms could be an indication that CADD packages better supported documentation needs, since more pragmatic firms utilized CADD during project documentation phases.

Notable firm survey

A separate survey was conducted of 24 notable architecture firms. All of the firms chosen have had an impact and influence on the profession. Many of the firms were chosen on the basis of recognition from awards received and articles published in architectural periodicals over the past two years. Other firms were chosen because of references in CADD articles reviewing their achievements and accomplishments with regard to computer integration in architecture. Therefore, while certainly not intended as a complete list of firms fulfilling these requirements, this sample does represent firms recognized throughout the profession as truly exemplary. Of the original 24 surveys mailed, 13 responded. These firms included: John Burgee Architects, Cambridge Seven, Eisenman Architects, Frank O. Gehry and Associates, Michael Graves, Kohn Pederson Fox Associates, MGA Partners, Murphy/Jahn Architects, Cesar Pelli and Associates, Gwathmey Siegel and Associates, Robert A. M. Stern Architects, Tigerman/McCurry, and Venturi, Rauch and Scott Brown. Counter to our expectations, of the firms chosen from design award references 76.5% responded to the survey, while none of the firms chosen from CADD references responded.

Among the 13 respondents, eight were using CADD, a higher utilization rate than the random survey. The CADD-productivity satisfaction mean for the notable firms was higher than the random survey mean. AutoCAD was being used by 62.5% of the notable firms, and the satisfaction by CADD package for these firms was much higher for AutoCAD than the satisfaction reported by AutoCAD users in the random survey.

The average percentage of personnel proficient with CADD in the notable firms was much lower than design/theory firms in the random survey, but similar to the percentage reported by all respondents in the random survey. CADD proficiency by personnel categories, as shown in figure 7, differed from the percentages of the random survey.

![Employee CADD proficiency of notable firms](image)

**Figure 7**: Employee CADD proficiency of notable firms

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The CADD-productivity satisfaction mean for the notable firms was higher than the random survey mean and could be an indication that these firms have a better understanding of CADD use and implementation. If reviewed by CADD-productivity satisfaction, the firms using an intern and a computer specialist for system management reported the highest possible satisfaction, followed by firms using a manager or CADD Committee/computer specialist as system managers reporting very high satisfaction, firms using architects and interns as system managers were only slightly less satisfied.

**Discussion**

Two original areas of research formed the basis of this study: satisfaction and design philosophy. Results of analysis of these areas were compared to CADD use by firm size. A survey of notable firms indicated CADD use in the forefront of the profession. This research conclusively showed that a variable indicating a firm’s design philosophy should be included when analyzing CADD use by architects. The use of this approach is logical because design is an integral part of architecture. While some information must still be addressed in terms of quantifiable variables such as firm size, these variables should not be used alone when assessing CADD use by the architectural profession. In addition, the use of satisfaction as an indicator provided information not revealed when discussing CADD use in quantitative terms such as number of installations. While each of these areas independently provided information not previously addressed, when examined collectively, the results led to three conclusions regarding computing in the architectural design process: 1) The benefits of using CADD in the design process appeared to be recognized by architecture firms; 2) Some CADD packages appeared to better support the design needs while other packages appeared to better support the documentation needs of architecture firms; 3) It appeared that refinements are needed by CADD manufacturers to make CADD a viable design tool that will meet the design needs of the profession.

The benefits of using CADD in the design process appeared to be recognized by architecture firms. Design/Theory-oriented firms and notable firms recognize this by using CADD as more than a simple documentation device. This conclusion is supported by the fact that more of these firms used CADD during all project phases, including the design phases. In addition, a greater percentage of the design-oriented firms were utilizing 3-D and solids modeling features in conjunction with 2-D applications. In addition, the CADD-productivity satisfaction for notable firms was higher than that for all firms in the random survey. This result indicated that firms using CADD in the design process were more satisfied than those using CADD for only documentation tasks.

Some CADD packages appeared to support design needs better while others to support documentation needs better. This difference is important for architects to recognize when implementing CADD because, as seen by the ratings of AutoCAD, a package recognized as an exemplary CADD package may be acceptable for documentation needs, but not adequately support design needs. This inadequacy could be one reason, as researchers have noted, that the integration of computing into the design process has been minimal, as well as the fact that, according to the 1989 AIA firm survey, principals ranked improvements in design quality very low with regard to other possible benefits of CADD. Based on literature review and results from this survey, certain CADD packages appeared to be emerging as design-oriented packages due to their architectural orientation.

Overall, firms using other packages were more satisfied with productivity than firms using AutoCAD. When analyzed by firm size, all groups were less satisfied with AutoCAD than groups using other systems. In an examination of AutoCAD by design philosophy showed differences. Design/Theory and Mid-range firms were much more satisfied with other packages than with AutoCAD. However, Pragmatic firms reported an identical satisfaction level between AutoCAD and other packages.

To further examine the low satisfaction levels reported by AutoCAD users, differences in feature integration and package orientation were considered. It was noted that the difference in satisfaction between integrated and non-integrated package was minimal. Therefore, it appeared that differences between systems designed specifically for architects, such as Datacad, Arris, and Versacad and the general-
purpose package, AutoCAD, could be contributing to this difference. This conclusion is logical since the procedures and methodologies used in architecture and the architectural design process vary greatly from those used in other disciplines such as engineering, for which AutoCAD was originally designed.

Finally, it appears that many CADD manufacturers need to make refinements in their products in order to make CADD a viable design tool that will meet architects’ needs. While some firms utilized CADD in the design process, various results indicated that overall, CADD packages were not adequately supporting design needs. Many of the results from this research supported this conclusion. Design/Theory firms are the least satisfied of the three design philosophy groups that they purchased the right CADD package. Design decision-makers, such as principals, managers, and architects are the least proficient with CADD, which is an indication that CADD packages are still difficult to learn and in addition are not supporting the design tasks with which these individuals are involved.

Conclusions

In order for well-directed change to occur regarding computer integration into the design process, it is imperative that architects, educators, researchers, and manufacturers work together to develop applications for all phases and aspects of the profession. Architects must inform manufacturers of needed applications and refinements pertaining to the profession of architecture. However, it is only through the understanding of the potential of computing that architects will be able to better direct future products. According to Radford and Stevens (1987, 13), “practicing architects have been ignorant of the scope and potential of computing in architectural design.” However, architects need not become computer specialists to comprehend basic computing concepts, and once a basic knowledge of system capabilities is gained with respect to computing in the design process, users can start demanding the applications appropriate to their design environment.

Also, the AIA must take some of the responsibility for directing change which will be beneficial to the architectural profession with regard to CADD. It appears that the AIA should find a better means for evaluating, reviewing, assessing, and reporting CADD implementation in terms of design. The concept of design philosophy, as presented by this research, could provide one such means. Analyses of this nature should be presented in the AIA Firm Survey Report which examines the architectural profession. The value and intent of these surveys have far reaching impact and CADD manufacturers may take notice of the issue of computing in the architectural design process if they are evaluated periodically by the profession with regard to design.

Educators must also assume responsibility for the integration of CADD into the architectural design process. As the respondents indicated, many CADD systems were being managed by interns, and those firms were the most satisfied. Interns would have attended university more recently than older architects, and hence would have the benefit of being educated in computer use in design. Educators must emphasize the importance of CADD integration into the design process so students are aware of the overall potential of computing in architecture, and consequently transfer this knowledge into firm environments. Computer education should be incorporated into the mainstream of design studio, rather than being limited to a peripheral skill acquired in a separate course. Also, continuing education should be offered for practicing architects so that they could become familiar with the possibilities presented by incorporating computers into the design process and not simply utilizing them as drafting tools. Early continuing education course simply emphasized the documentation and drafting capabilities in an attempt to make practicing architects computer literate. The knowledge of how to integrate computers from the very beginning of the design process is necessary for architects who have already established practices.

CADD manufacturers must assume responsibility for better understanding the profession and supplying its needs, because their products are having a dramatic impact on the architectural profession. Manufacturers must make the distinction between drafting/documentation needs and design needs. This distinction can be recognized, in part, through this type of research which explored CADD utilization in terms of design. Features and applications are needed which will support all firm types, including the
firms which concentrate more on architectural design, such as the Design/Theory firms. According to Radford and Stevens (1987), the future may well belong to the computer system that will support the designer in all areas of design activity.

The data analyzed here are suggestive of factors important to the integration of CADD in the architectural design process. This research should be viewed as an initial step in assessing CADD use by architects in terms more appropriate to the profession, such as design. As Weingarten (1987, 61) noted, "It is time for all of us to confront the computer on its own terms. The architect who refuses, fearing encroachment upon the design process, has abdicated control to those that might understand the machine, but not its intent."

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& Sons.


