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CADDMANIA: Causes and Cure

ORLANDO, FLORIDA

APRIL 22 - 24, 1985

CEPA

CADDMANIA: CAUSES AND CURE

FOREWORD

This volume contains formal papers presented at the 41st semiannual conference of the Society for Computer Applications in Engineering, Planning, and Architecture, Inc. (CEPA), held in Orlando, Florida, at the Sheraton Twin Towers Hotel, April 22-24, 1985.

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ISBN 0-933007-10-8

P R O C E E D I N G S

from

CADDMANIA: CAUSES AND CURE

CEPA's 1985 Spring Conference
- 20th Anniversary -
Orlando, Florida
April 22-24, 1985

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CADDMANIA: CAUSES AND CURE

Mr. Victor N. DeCario, P.E.
Director, Information Systems
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Miami, Florida

There is a growing malady in the world today which will change forever the practice of the engineering and architectural professions. Like a wild virus, it has infected the entire known professional world. The Atlanta Center for Disease Control likens it to the common cold: incurable, discomforting, non-lifethreatening, and here to stay.

This disease of the mind paralyzes normally confident executives and turns their confidence to jelly. Otherwise strong leaders become ineffectual and frustrated when confronted with an attack of this disorder. Only the very strongest have developed an immune system to temporarily thwart the ravages of the disease.

Clients have become unwitting hosts and rapidly transmit the infection through contract deliverables.

Anthropologists have uncovered evidence that both the ancient Mayans and the Egyptians may have been afflicted with the disease as portrayed in many of the hieroglyphics. Only Pago Pago has as not yet reported any incidence of infection.

Symptoms:

- Rapid heart beat
- Elevated blood pressure
- Light-headedness
- Hearing impairment
- Glazed eyes
- Dilation of the pupils
- Intense salivation
- Sweaty palms
- Occasional flatulence
- Intermittent incontinence
- Constriction of the throat
- An intense mesmerized appearance
- Brain relaxation
- Loss of eye-hand and mind-wallet coordination
- Consistent pleading for reading material
- An insatiable desire for pictures
- Ends with total collapse of the external senses into catatonia.

Transmissibility:

- Highly contagious
- Airborne or direct contact
- Has been transmitted through casual telephone conversations
- Many reported cases of mass infection through seminars
- Public apathy has permitted entire shows, spanning days, with thousands paying homage and administering self-infection during ritual demonstrations

Relief:

- Many over-the-counter solutions as well as home remedies have been proven effective, in clinical studies, to relieve the minor discomforts associated with the disease

- Severe cases require institutional incarceration for varying durations depending on the degree of infatuation of the patient and the instructional capabilities of the therapist

There are many antidotes, but only one cure ... PURCHASE.

Take one CPU semi-annually plus one or two workstations monthly as required to relieve pain (not available in suppository form)

If symptoms persist, consult a qualified vendor. Nine out of ten vendors surveyed recommend attendance at CADDMANIA: CAUSES and CURE to learn about the latest therapeutic advances in stemming this dread epidemic and to compare notes with fellow sufferers.

DON'T DELAY, REGISTER TODAY.

CADDMANIA: CAUSES AND CURE -- another quality conference by CEPA.

CADD:
PRODUCTIVITY, QUALITY
AND REALITY

Jack L. Thompson, PE[1]

Engineers and architects these days are facing a dilemma. Vendors, an occasional peer, and often, clients are touting the use of computers as a design tool with incredible productivity capabilities. With rare exception, however, neither the engineer nor, even more rarely, the architect is informed enough to discuss computer techniques knowledgeably so that he can separate needs from capability and what's practical from what's possible.

Our goal today is to raise your level of understanding of these systems in order for you to better understand the potential impact of CADD on your individual firms. This goal will be addressed by discussing not only the benefits of CADD but the pitfalls and opportunities as well.

Why should engineers and architects consider CADD? Significantly, the National Science Foundation reports that "CADD has greater potential to increase productivity than any invention since electricity." In addition, a recent study by the Professional Services Management Journal revealed that firms reporting CADD capability had higher average earnings per employee as compared to their non-CADD competitors and lower overhead. The latter was true, according to the published data, due to the CADD firms' better staff utilization. This study showed that only about 28% of design firms currently use any form of CADD equipment.

[1] President, The Professional Computer Services Co., Lynchburg, VA

CADD techniques offer both qualitative and quantitative benefits to professional designers. These include the following:

(1) There is the opportunity for lower design fees and higher profits.
(2) Business development opportunities are improved.
(3) Drafting quality is consistently high.
(4) Communications among architect, engineer and client are improved.
(4) Design errors are reduced.
(6) Construction bids are lower.
(7) Personnel problems are reduced.
(8) Details, descriptions and procedures are standardized.
(9) Elapsed time to complete projects is shortened.
(10) Project revisions affecting multiple disciplines can be performed efficiently, in shorter time, and with less risk.
(11) Project and drawing management is facilitated.
(12) Employee capabilities are enhanced.
(13) Alternative designs can be evaluated and documented economically.
(14) Construction estimates are more accurate.
(15) Construction management can be improved.
(16) Maintenance documents can be prepared economically.

CADD's Qualitative benefits, in my view, are much more important than its "so called" Quantitative rewards.

The National Science Foundation's prediction, quoted above, contains a key word--"Potential." And any system with that vast a "potential" insures a guaranteed risk. As for the PSMJ study, only those doing well will take the time to complete the forms! The qualitative aspects of CADD implementation reward the A/E in ways not available by other productivity

techniques. The CADD purchaser must understand and embrace the qualitative benefits of CADD before attempting a quantitative analysis. The former should create the basis for the decision; the latter, the method of accounting for it.

Once you have embraced the Qualitative aspects of CADD implementaion, you will be well on your way toward becoming a CADD user.

In order to determine actual costs and payback, a quantitative analysis is now in order.

Your quantitative analysis should begin with an "Application Analysis." This analysis consists of reviewing your drawings for a representative period of time, usually a year, in terms of both quantity and discipline. A matrix of similar details, design concepts and production features should be tabulated as well during this analysis. Representative costs and fees by drawing type must also be gathered. Once the analysis is complete, financial justification can be prepared. Before illustrating the computations, however, a few notes of caution are in order.

The key number in our computations is the "productivity ratio." Although I have selected conservative values for full-featured systems, operator skill and efficient use of the system's capability are <u>critical</u>. In the worst situation, CADD provides the potential for creating errors at a rate much higher than manual design and drafting methods. In addition, the productivity ratios shown don't occur immediately after system installation and training. It is not unusual for operators to take six to nine months to become comfortable with the range of techniques available. Relatively routine projects should be prepared initially in order for higher productivities to be achieved sooner. Once an operator's proficiency and confidence level rises, then more difficult work can be assigned. The example given in Table 1 is for a

TABLE 1

POTENTIAL CUMULATIVE PRODUCTIVITY GAINS OF CADD

DISCIPLINE	NUMBER OF DRAWINGS	HOURS PER DRAWINGS	MANUAL HOURS	CUMULATIVE MANUAL HOURS	PRODUCTIVITY RATIO	CADD HOURS	CUMULATIVE CADD HOURS	CUMULATIVE PRODUCTIVITY GAIN
ELECTRICAL	250	50	12500	12500	4.0	3125	3125	4.0
HVAC	150	70	10500	23000	2.5	4200	7325	3.1
PLUMBING	100	40	4000	27000	3.5	1140	8465	3.2
STRUCTURAL	150	50	7500	34500	3.5	2500	10965	3.2

hypothetical multi-disciplined engineering firm which prepared 650 drawings suitable for CADD. Table 1 shows a potential cumulative productivity gain of 3.2.

Typically, breakeven productivities range between 2.0 and 3.0 depending on how they are computed. The difference between available potential productivity gains and your breakeven productivity ratio represents your higher CADD profit, as compared to manual methods, or lower design fees . Considering the training curve mentioned earlier , it is not inconceivable for it to take up to a year for cumulative cash flows to become positive. Table 2 shows realistic productivity ranges that can ultimately be achieved for several technical disciplines.

This example, as noted earlier, is for full-featured CADD systems. This, in my view, means systems that provide good response, data-base capability and application software beyond the basic drawing capabilities commonly available. Productivities listed can usually not be achieved on systems without these capabilities.

Table 2

CADD Productivity Ranges

Discipline	Productivity
Electrical	4.0 - 8.0
HVAC	2.5 - 4.0
Plumbing	3.5 - 8.0
Structural	3.0 - 4.0
Architectural	2.0 - 4.0
P & ID	4.0 - 8.0
Civil	3.5 - 5.0
Mapping	4.0 - 6.0

While there exist many drafting-only systems with purchase prices as low as $15,000, I don't believe they satisfy the investment requirements of even the smallest firm. I urge my

clients to consider where they want to be 3 - 5 years hence and to value their investment in training as well as the worth of their historical design and drawing files that will have been accumulated by then. Do you want to repeat the system evaluation process at that time again, I ask ? What about the agony and cost of converting your files to the new system ?

I have therefore chosen to illustrate CADD costs using a four workstation 32-bit computer-based system.

There are 5 fundamental components of cost that must be recognized:

(1) Equipment
(2) Maintenance
(3) People
(4) Start-up
(5) Operations

A common mistake made by potential CADD system purchasers is to unreasonably emphasize the equipment's sticker price. On the low end, they fail to equate price to capability. Often, related operational costs are neglected. On the high end, potential users glance at the bottom line and immediately go into "sticker shock." The fact is that equipment is rarely purchased outright. In fact, with the exception of the largest industrial users, my experience is that it is almost always leased. Leasing adds an interest expense, but it provides a much better cash flow situation. Leasing can be done for as long as five years thereby offering the advantage of fixing a cost for planning purposes over the entire period.

Maintenance is a non-trivial cost and commonly amounts to 1% of the system's price per <u>month</u>. This is an item that you can look forward to going up during the five-year investment period.

In spite of what you may have heard, CADD systems do require some manner of systems support--some more than others. Certain functions like backup and disk maintenance must be performed by someone trained for the job. In addition, it is essential to have a designated employee who knows what to do when the system insists that 1 + 1 is not 2!

Many, but not all, systems will require some modification to your work area and some special environmental equipment. Workstation areas need to have a different lighting plan for best use of the system. These costs, as well as training for the manager and operators, must be included.

Finally, costs for space, power, paper, pens, etc. should be considered. It adds up to more than you think.

The following table illustrates these costs for a four workstation system with an installed price of $360,000 including hardware, systems software, application software, taxes and installation.

Monthly CADD Costs
4 Workstations @ $360,000

Equipment @ 0.0235	$8,500
Maintenance	$3,600
Systems Manager (1/2 time)	$1,600
Expendables	$ 700
Start-up	$ 600
TOTAL monthly	$15,000

Our $360,000 system will cost its owner, based on five-year amortizations and neglecting the ITC, $180,000 annually. Based on our 10,965 CADD Hour requirement, the system will cost only $16.42 per hour per workstation. This calculation is based on each workstation's being utilized about 1.5 shifts each.

Breakeven productivity can be calculated as:

$$\frac{\text{System cost + operator payroll cost}}{\text{operator payroll cost}}$$

The difference between 3.2 and breakeven may be lower fees and more work. Or, it may be higher profit. Your goal should be that it is some of both!

But, what about those who need full features but require less than the four workstations in our example. Half the number of workstations would lower the monthly equipment costs somewhat but not reduce the related costs significantly. Half the number of workstations would raise the average hourly cost to over $28 per hour. When hourly costs are projected at this level, alternative implementation plans should be considered.

At this need level a service bureau should be considered. If you are lucky enough to have one in your town, you can consider a walk-in type arrangement. Service bureaus offer a lot of flexibility, particularly in the variety of service they offer and by giving a potential CADD user the opportunity to ascend the 6-9 month training curve and build data-bases without having hundreds of thousands of dollars of equipment being under utilized.

Some service bureaus offer remote timesharing services that allow access to their software and computer resources with workstations located at their clients' offices. Fees for this type of service vary based on the hours used, but this alternative can usually be justified when only one or two workstations are needed but full-featured capability is required.

In 1886 in his annual report to Congress, which included future recommendations, the Commissioner of Labor noted that our country had all the railroads and canals that were needed,

that a sufficient network of communications had been established, and that an adequate Merchant Marine fleet was in place. He concluded that America was in a position to reap the many benefits it had earned through many years of hard work. He even suggested that, since we already had so many productive machines, that the Patent Office be closed! At that time Henry Ford was 23; Charles Stienmetz was 21; Madame Curie was a young lady of 19, Orville Wright, a lad of 15, was tinkering with bicycles; Marconi was 12; and in a small German town a 7-year-old youth named Einstein was devoting his life to soccer!

I urge you to carefully consider the information you're gathering today and evaluate it on the basis of these systems' overall, long-term impact on our profession. I suggest that if you find that the "Status Quo" is satisfactory, as did our long forgotten Commissioner of Labor, that you will have lost a significant opportunity to direct your firm on a new and more profitable course.

Earlier, I asked the question: "Why should you consider CADD?" Perhaps the best answer is that "Your competition is doing it!"

Use of Interactive Graphics at State DOTs

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In December of 1982, 1983, and 1984, the Transportation Research Board's Committee on Computer Graphics and Interactive Computing conducted a Survey of Interactive Graphics at State DOTs. The number of states using interactive graphics was 15 in 1982, 18 in 1983, and 26 in 1984. The 1984 survey covers the states currently using interactive graphics, the states that are purchasing interactive graphics equipment, the states that will purchase interactive graphics equipment within one year, how long a state has been using interactive graphics, interactive graphics workstation operator learning curve, management responsibilities, affects of interactive graphics operations, and data for three categories of systems: main-frame, minicomputer, and microcomputer. The data for each category includes application areas, productivity ratios by application areas, dollar investment, number of computers, type of computers, memory, interactive graphics workstations, disk storage, tape drives, plotters, line printers, card readers, power conditioners, other terminals, networking, screen copy devices, hours of use, location of interactive graphics workstations, remote telecommunications line use, data base management use, other application jobs on the CPU, monitoring interactive graphics use, charging for interactive graphics use, and major interactive graphics software packages used.

Transportation Research Board
Committee on Computer Graphics and Interactive Computing

December 1984 Survey of Interactive Graphics at State DOTs

For this survey, the following definitions shall apply:
Main-frame Interactive Graphics System - a multi-user, large-power computer system where the primary support function is not interactive graphics (example: an IBM 3081 with Tektronix terminals)
Minicomputer Interactive Graphics System - a multi-user, medium-power computer system where the primary support function is interactive graphics (example: an Auto-trol, Intergraph, Synercom, or IBM 43XX system)
Microcomputer Interactive Graphics System - a single-user, small-power computer system where the primary support function is interactive graphics (example: an Apple system)

1. Are you currently using an interactive graphics system?

Yes - 26 responses (50.0%)
AK AZ CA CO DE FL GA IA ID IL KY LA MI MN MS ND NY OH OK OR PA TX VT WA WI WV
8 new states are: AK AZ DE GA ID OR VT WV

No - 26 responses (50.0%)
AL AR CT DC HI IN KS MA MD ME MO MT NC NE NH NJ NM NV PR RI SC SD TN UT VA WY

Main-frame Interactive Graphics System:

res	per	system	states
4	80.0	IBM	ND OK TX WV
1	20.0	Burroughs	MI

Minicomputer Interactive Graphics System:

res	per	system	states
18	81.8	Intergraph Corp	CA DE FL GA ID IL KY LA MI MN NY OH OR PA TX VT WA WI
1	4.5	Auto-trol	CO
1	4.5	Calcomp	OK
1	4.5	H. Dell Foster	MS
1	4.5	Synercom	CA

Microcomputer Interactive Graphics System:

res	per	system	states
2	50.0	IBM Micro	IA OR
1	25.0	Tektronix	AK
1	25.0	Terak	AZ