



**Computer Aided Design (CAD) Pioneer Workshop
Day 1 Session 3: Key Companies (1960-1980)**

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David Brock: Well, for this next segment of the meeting, for about the next hour and 15 minutes or so, we are going to discuss the key companies from 1960 to 1980. And let's kick that off with comments, first, by Dave, and then we'll move on to other discussions.

Inviting Ken Versprille to discuss NURBS

Jon Peddie: Can I just pull you back a second to the previous session? I want to put Jon Hirschtick against Michael Payne and tell you both that I think we're missing a vital person in this discussion, and I've been unable to find him. Does anybody know where Ken Versprille is?

Jon Hirschtick: Oh, Ken Versprille? I know Ken. Yeah.

Peddie: I know you know him. We all know him. Does anybody know where he is?

Hirschtick: Well, yeah. I mean, I know-- he's working with CIMdata. But didn't one of the organizers, Burt or someone, try and get in touch with him?

Peddie: Yes. We all tried to get in touch with him. He didn't return any emails, and he should be here, because that's Dr. NURBS

Hirschtick: I'll text him right now. We'll see what's going on.

Peddie: Yeah, tell him to get his butt in here. He should be talking to us.

Hirschtick: I haven't talked to him in a while. But I mean, relative to the timescales of communication with this esteemed cast of characters, I would say I talk to him regularly for this crowd.

Peddie: Wouldn't it have been nice to have him here when Mike was saying that NURBS isn't anything we have to care about?

Hirschtick: Well, of course NURBS is something we have to hear about.

Peddie: Sorry, David. Where did you lose control, David?

Brock: Just a few seconds ago, but let's return to Dave [Kasik] and key companies, 1960 to 1980.

Automotive/Aerospace Developments

Kasik: Let me give you a little more detail about those companies. Anyway, I've been around computer graphics since 1969 doing computer-animated films from Johns Hopkins. I worked for Battelle [Memorial Institute], so I got to see the research side of the world. I retired from Boeing in 2016 as a senior technical fellow. I agree with the comment about marketing. We have a tendency in every business in the computer world to overpromise and underdeliver.

And people thought that I look like Jean Luc Picard. I certainly didn't look like him back in the day. Anyway, let me do tell you a little bit about how Boeing got into the world of computer graphics. And we mentioned earlier that Verne Hudson from Wichita coined the term "computer graphics." Bill Fetter, who will be on the next slide, popularized it. And the basic thing Boeing did, and it was 3D, was doing plots of everything from product definitions to contour plots. But what they really wound up doing is figuring out how to do reef studies for the pilots of ships around 1963, 1964. And Fetter did this work on Calcomp plotters. And that's where Peddie commented about Jack Bresenham, and what he did made it computationally feasible and cheap enough to do.

The interesting thing that Verne Hudson found in 1960, 1961 timeframe, is that it cost half as much to do a computer-generated plot of stuff like these plots--even with a keypunch operator-- than it did to do it by hand. And so the question is, how much did it cost Boeing to do one of these plots in 1962? Internal rates versus doing it by hand? Any guesses? This is part of the economics lesson.

Peddie: Yes, I would guess that it cost Boeing, in actual accountable dollars, about \$150.

Kasik: Well, accountable dollars is always a question in any aerospace company, but it turns out that the cost that Verne Hudson did back in 1960, said that it cost 20 bucks to do these plots by computer and 40 bucks to do it by hand.

Peddie: Yeah, but that doesn't count any overhead.

Kasik: Well, probably not, but still. Accounting is accounting. So anyway, let's talk a little bit about CAD with the computational geometry piece. There is a lot of work that happened in the 1960s with industrial people like GM, GM Research plus IBM developed a project called DAC-1 in 1960, 1961 timeframe. It's worth looking at the references at the end, so it's worth looking at Fred Krull's paper about it. As I understand, Pat Hanratty developed some of his 82000 software at General Motors based on what was happening in DAC-1. General Motors developed a whole bunch of

systems to try to automate the design of car bodies that had full-sized-- and I actually got to see these--coordinate measuring machines that would scan a full-size clay body. And it would do it in either the X or the Y direction. And then Bill Gordon came up with a brilliant algorithm called the Gordon Surfaces. And what he was able to do-- so they'd scan in one end the Y direction, and the other end the X direction. And the problem was that the lines didn't necessarily meet. There was enough variance in the coordinate measuring machines that the points didn't always coincide where they needed to coincide. Gordon came up with a way of interpolating an entire surface so that he accounted for the mismatches in X and Y. And an awful lot of that work was done with Doug Ross and Ken [Versprille]. And the academic tool to do this was what Sutherland did in Sketchpad. And I'm glad we've talked about that in a lot of ways.

Boeing Applications of CAD

Boeing started its interactive CAD journey in the late 1970s. I'll trace it a little bit through 1990, but the big deal in the very early days was to try to come up with shapes that would represent air foils. You really want the wings on any airplane, on any aerospace product, to behave nicely, for fuel conservation and many other reasons. But there were early works where you had a set of airfoils, and Boeing came up with a program called TX95. This was one of those instances, kind of like Spice, but it would come up with designs of airfoils based on batch input, design the lofts. So what Boeing wanted to do from the design perspective was do that as batch lofts. Boeing started in the use of NURBS, in the non-uniform rational b-spline piece, doing early work in 1978, 1979 with a guy named Jeff Lane, who came to us from the University of Utah, and Rich Riesenfeld.

They turned that idea into a big research project called TIGER. The idea was that Boeing had, from a commercial perspective, was to turn the TIGER research project into a commercial product called Acis. It was to be both device and computer hardware independent. From a device perspective, this software ran on everything from an Evans and Sutherland multipicture system and PS300 to an IBM 5080 to an Apollo workstation graphics system to a Sun workstation to an IBM PC. And we actually achieved that level of machine independence, but it never worked commercially.

For production, it's a really interesting story the way Boeing got into production for doing computer-aided drafting first, because the idea-- and this is important-- was to get rid of those people who were doing documentation via drafting-- to do that work and get rid of as many drafting tables as possible. So what they wound up doing is that all of the drafting work for both the 757 and 767 programs were done with computer-aided drafting systems. Computer Vision for the 757, and a package called Gerber IDA for the 767. This, of course, caused Boeing some problems. I mentioned configuration management, and there's a whole thread of configuration management.

But one of the early problems that Boeing ran into that we haven't talked about as a group yet is understanding how to transfer data, computer-aided design data, from system A to system B in a way that was reliable. So Boeing developed its own internal system, which is typical Boeing, called the Geometry Database and the Computer Information Interchange Network. CIIN for short, or for long, depending on how you want to look at it. That work led to the IGES standard of the early 1980s. The two people primarily involved with that from Boeing were Mike Lewald [ph?] and Walt Briefly [ph?]. That being said, Boeing had this thread of trying to do 3D design and really doing surface design to solve the lofting problem, because that wasn't solved with these drafting systems.

So Boeing took the TX95 results, and documented them in the drafting systems, but didn't really do a 3D surface representation for any of them. We wound up choosing NURBS because all of these air foils and the like were essentially designed using conic sections, and NURBS could represent conic sections continuously. It didn't have the piecewise polynomial problems that the Hanratty type systems had.

So, there was a big bakeoff. The first thing to go off the boards was the internal work that Boeing was doing, because it wasn't quite ready for primetime for Boeing scale work. The Medlock systems were chosen initially, but that turned out not to scale either. And so the IBM salesmen presentation and some other factors led to Boeing choosing CATIA version three, to design the 777. That work was done as a solid-model system for the entire 777. It was, by far, the largest attempt at doing a full product to that point in time. The point that I wanted to make with this is that there was a lot of work done in 3D, over and above the drafting things that were done in internal industrial products, as internal industrial products were during primarily the 1970s.

Hanratty Early Leadership

Those systems became the basis for multiple commercial systems. And I defer to Dave Weisberg's really fine book on what those systems were like in the 1960s and 1970s. A lot of the work that Hanratty did with AD2000 was the basis for many of these things. The legend is, and I would love to have this clarified, that Hanratty was able to sell sole-source licenses to his AD2000 package to multiple companies. Has anybody else heard that?

Marks: I have, yes.

Hirschtick: Yes. I mentioned that earlier. Absolutely, I've heard that. But I don't have personal knowledge of the subject.

Carl Bass: Yeah, I can't say whether it was true, but it was like the play/movie, The Producers.

Kasik: So Hanratty succeeded in selling that, because the basis of ComputerVision, Auto-trol, and Gerber IDS was another Hanratty system. Unigraphics was a Hanratty system from McDonnell-Douglas Automation. And I'm sure that there were others, including a system that I think Hanratty tried to develop for himself.

Brad Holtz: Dave Weisberg was at Auto-trol during those years. And when he wrote about it, he had inside knowledge.

Peter Marks: Dave, I have a question.

Kasik: Yes.

Marks: How much of this was that Hanratty was so unique; he was the only software guy I've met who was a three-ring salesman at the same time. And I'm wondering how much of the actual software was done by people at GM, and how much was Hanratty. I mean, Hanratty called himself the father of CAD and he certainly had a lot of kids out there. But how much of those software programs were actually his? Do you know?

Kasik: I do not know. I have one contact left from GM who worked on some of the internal graphics software, but not on their Fisher Body or Cadence software, so I can't tell you, Peter. I don't know. What I think is interesting, is that over and above what Hanratty sold, is the existence of multiple other sources of complex CAD software that were primarily done internally. We've already talked a little bit about what happened at Ford with Steve Coons, originally, with Coons patches and the like. There was another system at Ford that did Overhauser surfaces. Pierre Besier gets extraordinary chops for doing his work at Renault. MAGI we mentioned briefly, but they did a whole lot of modeling using constructive solid geometry, and there was a lot of the work from Ian Braid and the like.

McDonnell-Douglas and CADAM

And I'll give some academic references on the next chart. We haven't mentioned McDonnell-Douglas at all. They had a whole system that they had internally called CAD-D that was based on parametric surfaces/ The proponents for that system always claimed that they could model anything anytime, and take care of any problem, because they were agnostic about then actual geometry form. But you had to supply the computational geometry part. I mentioned that McDonnell-Douglas developed

Unigraphics, and it's still a successful system. We have not talked very much about Parasolid, which basically came out of the CAD Center in the UK and has had multiple hands in its development. CADAM generally doesn't get considered very much. It was really a drafting system. Chase, Lee Whitney and the like, did extraordinary work on making CADAM as responsive as possible. It was one of those things that they measured their success by the number of clicks that an operator had, because the more clicks, the faster the clicks, the more productive they were. That was the way that CADAM was built. It was pretty extraordinary in terms of how quick it was on an IBM mainframe, using IBM 2250s and 3250s. Their target was a quarter-second response per click. And by damn, they generally achieved it. Absolutely a 2D system, but really fast and really productive.

We mentioned Desk DRC and ideas like Geomod, for Peter and the like. Wayne Tiller was the NURBS guy behind it all. Extraordinary stuff. And Dassault Aviation, one of the big CAD companies now, had a CAM focus, and that led to CATIA. But that's industrial stuff. That's companies begetting commercial software companies. Large industrial companies. I found that really interesting in the basis of CAD.

Academic Developments

From an academic perspective, we talked about MIT and Sketchpad. Sketchpad was a wonderful constraint system. A guy named Rob White developed a system also at MIT in the late 1970s that was really quite sophisticated. Unfortunately I've lost the name of that CAD system someplace in the recesses of my mind. Utah influenced Boeing with its NURBS direction, with Reisenfeld and Cohen. Malcolm Sabin and folks at Shape Data were extraordinary influences at Cambridge. I've heard people mention Ari Requicha with PABL. RPI had Mike Wozny. There was at least a passing reference to Dave Rogers at the Naval Academy, who did some extraordinary work there. Chuck Eastman did a whole lot of CAD work for the architectural world. Daniel Cardoso Llach is part of that group. The work that happened in terms of Splines and the like, by Schurnberg at the Aberdeen Proving Ground developing Splines in 1946. Colonel DuBore took that further at Los Alamos, and eventually the Wisconsin University. And we can't forget Robin Forrest or Sabin at Cambridge.

There are probably other contributors that I haven't listed here, but I'm just trying to, in this particular segment, is to say that there were a lot of contributors, not all of whom were from a systems perspective. Most of the work that I saw in the 1960s and 1970s were clearly the result of industrial participants that kickstarted the whole CAD software business as small, independent companies. And that's the end of my story.

Brock: That's great. Thank you, David.

Peddie: It was fine.

Marks: That was terrific.

Kasik: There are some references in there and there are lots more.

Peddie: Is this your term paper for SIGGRAPH?

Kasik: No, I've got others.

Hirschtick: There's a lot there. Congratulations. You got stuff in there I never heard of. That's interesting. And I think there's always more, like you listed, obviously.

Kasik: Anyway, I think that it is important for this particular project, is to get as broad a brush as possible, because there is such a rich history. What I didn't delve into, at least in this piece, is how the education in computer gaming and computer animation worlds, were in fact started during this time. I didn't document any of that stuff, because there's a whole other set of geometry that's part of that world that includes things that are not commonly used currently, like Catmull's surfaces and Lon Carpenter's fractals and Benoit Mandelbrot fractals that are used to model complex 3D surfaces and geometries for purposes other than product design. That's the end of my story.

ACIS, Parasolid and Shape Data

Michael Payne: I think I want to correct something, slightly. Parasolid was created by Alan Grayer, Charles Lang and Ian Braid, who founded Shape Data. It was not the CAD Center. Those same three later went on to be the creators of ACIS. And the name came from Allan, Charlie and Ian's names

Kasik: When did ACIS start, Michael?

Payne: That was 1974. But they created Shape Data, which is the beginning of Parasolid. The difference was that while the geomodelling was similar, Parasolid had been written in some crazy language, and ACIS was then written in C.

Kasik: Okay. So I encountered ACIS with Dick Sauer.

Payne: Well, he was peddling it.

Hirschtick: Actually, one correction to you, Mike. Again, I'm not certain of this, but I believe Shape Data first produced Romulus and then Parasolid.

Payne: That's true, John, but it was those three guys.

Hirschtick: And then the guys produced ACIS. Yeah, it was those guys, but you said that the beginning of Shape Data was Parasolid. There was Romulus, Parasolid, Shape Data.

Payne: Correct.

Kasik: Thank you. Corrections are always welcome.

Payne: Well, in some circles, they're not.

Marks: I remember a tea at their place in Cambridge. These guys really did a wonderful job of bridging academic and commercial life.

Payne: But didn't it usually involve beer and curry, not tea?

Marks: Well, that was after you stepped away from the little cottages.

Grad: I have a question for all of you. This session is supposed to be about businesses. What businesses were started, who started them, and did any of them succeed?

Payne: Well, you can argue Parasolid succeeded from Shape Data.

Grad: Well, how did they start?

Hirschtick: Parasolid is after the 1960 to 1980 time period.

Payne: No, I think it started in the late 1970s.

Hirschtick: I'll bet you a beer or a pack of cigarettes, your choice, that Parasolid didn't start until after 1980.

Payne: I don't do cigarettes anymore.

Other Early CAD Software Products

Hirschtick: Pretty safe bet, in my book. But companies that were mentioned were Pat Hanratty, who was in the business, commercial companies. There were all these internal systems, which were really cool.

Grad: What was the company's name?

Hirschtick: Was it MCS? In later years, it was MCS, and he had a company before that, but I'll need someone with even more historical knowledge than me to answer that. I shouldn't say knowledge; information is not knowledge, I'm sure Joel would tell me. MCS isn't a bad guess.

Grad: Okay. Who started it and when?

Hirschtick: CADAM was started in the 1960's, I'm sure, right? And Patrick Hanratty. started MCS in the 1960s, to my best recollection. And then CADAM, I believe, was sold prior to the 1980 date, because I believe when I came in the business, CADAM was a commercial product. That was 1981.

Kasik: CADAM was, in fact, a commercial product.

Hirschtick: In the 1970s. Yeah. It started inhouse, right? And then became a core product.

Kasik: The point is that a lot of these systems started inhouse, with Chase Chason and Lee Whitney were two of the big, big contributors to CADAM.

Hirschtick: Yeah. And other than CADAM and Anvil, I don't know, Dave, can you mention in your exhaustive list of cool things happening, were there actually any other companies? I believe ComputerVision was founded possibly in 1969, as was Applicon, I believe they were founded then.

Dave Kasik: I'll defer to Weisberg's book on the small CAD companies. I tried not to include those. I was more interested in those that were begotten, to use a biblical term, that were begotten from large companies in that timeframe.

Hirschtick: Yeah, but for this purpose, anyone that was selling CAD systems or equipment or software, and there was no one selling software at all, I don't think, in those days, really.

Kasik: Well, Hanratty was.

Hirschtick: Well, Hanratty sold source code to companies that I believe all took it and sold it to end users as part of the computer system.

Kasik: Exactly.

Hirschtick: So in terms of what we might call a CAD software product offered to the user to buy, that's an interesting question. Who did that?

Kasik: So Boeing was offered 82000.

Hirschtick: Okay, so then Hanratty did offer it to users.

Kasik: Hanratty offered it to anybody who could walk.

Hirschtick: CADAM was offered to users, we believe.

Kasik: Absolutely. So Boeing had the opportunity to buy CADAM as well.

Hirschtick: Well, there must've been other systems offered to users.

Holtz: Cascade, at the time, Adra, these were the mid-1970s.

Hirschtick: Adra? Pre-1980?

Holtz: Yeah. They were right about 1977 to 1979, somewhere in that timeframe.

Kasik: What platforms did they run on?

Holtz: Automatix. They ran on HP Microsystems. What was it, a 5000 or something like that, Joel? Do you remember?

Hirschtick: Yeah. Brad, I'll buy you a beer if you tell me that Automatix was founded before 1980, I'll faint.

Kasik: I think that Dave Weisberg's book has the answer.

Hirschtick: January 1980. Whew. I just made it.

Holtz: I said it was at the end of the period, so...

Hirschtick: All right. Fair enough.

Grad: Patrick Hanratty. I'm looking for what companies started in the 1960s that were selling software, either directly or in conjunction with hardware for this purpose?

Hirschtick: I like that as a focused question, Burt. Now we're getting to the root of the topic for this session, and this group can't name more? That's interesting.

Kasik: SynthaVision certainly sold MAGI in the 1970s.

Marks: Did Auto-trol ever sell anything?

Holtz: Intergraph was selling software at the time. Hold on one second. I have a report that I did in 1977.

Marks: It's a little bit tangential, but the modelers for finite element analysis were in the 1970s...

Hirschtick: That's a great point.

Marks: Supertab, I did some of their educational programs in 1978, maybe 1979, something like that. And Patran came shortly after that. And some of the ideas, like higher-order elements and things like that, and having tessellated representations behind NURBS and stuff like that. I mean, there's a little bit of the genetics of that in modern CAD systems today.

Grad: I want to think more about the business aspects. The founders, the money, the sales, the marketing, because that's something that Dave Kasik didn't focus on as well as he did on the technology and the people and what they did.

Marks: Well, we can get to that in a bit, but certainly there were commercial systems being sold by SDRC and PDA on the finite element modeling side. But that was towards the end of that period.

Grad: When?

Marks: I was making films on how to use the stuff for SDRC, in like 1979, 1978, something like that. And I think PDA, followed somewhat shortly after that. I didn't get involved with them until probably much later, when Lou Demonica headed up the place.

Grad: They were running on the DEC machines? On things like the HP?

Marks: So PDP 11, VAX later, that kind of era. I am terrible at tagging things by date. I'm good at sequence, so you're going to have to doublecheck me.

Grad: That's all right. Go ahead, David.

Brock: I want to return to Michael Payne's comment in the first session about the importance of integrated circuit manufacture. I was surprised in my reading to see that some of the first companies started at the very end of the 1960s. I think it was the case for Applicon and ComputerVision both, that these were for mask-making or automatic control of aligners. Integrated circuit manufacture was the target for making the masks for printing chips.

Hirschtick: And if I remember correctly, when you exit the 1970s, coming into the 1980s, ComputerVision and Applicon were around and selling in the 1970s. ComputerVision and Applicon were like one and two. There was also companies like Auto-trol that we mentioned earlier, right?

Kasik: And Gerber ID.

Hirschtick: There were a zillion of them. Was Calma around then?

Kasik: Yes.

Bass: Calma was definitely around. By then, wasn't IBM selling CADAM? Because, I mean, just to answer the question, when IBM started marketing it, all of a sudden CADAM has much wider distribution.

Brock: It takes off.

Hirschtick: Yeah.

Holtz: So there were a whole bunch of mini CAD programs targeting the architecture industry in the 1975 or 1974 to 1980 timeframe. They were all using physically small computers about like this, but they were built-in, they were all system

integrated, and they were in the 100,000-to-150,000-dollar price range; they were all over the map. I mean, none of them went very far, but you would find that they were being sold by the reprographics companies. Carl, do you remember them?

Bass: No, I don't remember that portion. I remember the next phase, where the architecture companies, like the manufacturing, start producing their own software. Like, when SOE...

Holtz: Yeah. HOK did their own.

Bass: And SOM did their own. But I'm trying to put a name-- do you know any of the names of those companies in the..

Holtz: I have many of the names, but I'm not sure of the dates.

Hirschtick: The reprographics companies? The people who make drafting supplies?

Joel Orr: Stadler Mars, Mars CAD or something like that.

Holtz: Yeah. SCOP did theirs, but that was about 1981, I think. Automatix.

Hirschtick: Bradstock Systems.

Orr: There was Bruning.

Holtz: Data Automation.

Orr: What was the system that was based on the Tektronix desktop computer that designed log cabins? And its president crashed his BD5, unfortunately, and that brought the company all down at once. But there were a couple of interesting systems on that Tektronix desktop thing.

Hirschtick: I remember those Tektronix terminals, too. Those were awesome.

Conferences and the Holtz Rating Guide

Marks: Brad, when did you do your first CAD rating guide? Was that 1983 or something?

Holtz: No. Well, the precursor to the CAD rating guide was something that I did with Dan Raker in 1986, 1988. But this was the first edition of the CAD rating guide, which is what I'm looking at. And it's got 100 systems in it, but I think this was in 1989-- and Dan actually published it. The precursor to this was 1986. And that's what I was just going to see if I could pull out.

Marks: So Burt, if you wanted to track some of this down, Autofact was the big conference that people would come to, and I'm pretty sure that if you were to find conference programs-- I think 1978 was one maybe when I started getting involved in that. And you could just find CADAM showing up, giving talks and things like that. So that would be a way, I think, for you to find when people were out marketing themselves at the largest venue they could find at the time. And so towards the end of this window, to 1980, I think you'll find some more to do.

Peddie: Peter has, in his house, almost every badge he ever got at a conference. Not a joke. He's got this huge pile of these badges.

Hirschtick: I think you really do have to mention the importance of conferences to the history of our industry now, because in that era, our systems, these products-- of all types of software, it was imperative to see them in person. And you couldn't do that easily. If you were a potential customer, you would have to go visit a vendor.

Peddie: In the early 1980s, the big CAD companies, like ComputerVision and others, would bring an 18-wheeler into the conference area. Inside that, they would have a full CAD setup that you could walk through and understand how it would work.

Hirschtick: Yeah, so the shows were a very important part of knowledge dissemination, for not only the customers, but also for us, the people who built systems. It was a big thing for me to go to big shows and exhibits and walk around.

Grad: What were the big shows? Tell me the names.

Marks: Autofact, number one. NCGA was probably number two, while it existed. There were conference people in the Management Roundtable, which was very active.

Holtz: And AEC systems on the other side.

Marks: Yeah, yeah. That's right.

Hirschtick: The question is, for this discussion, does that go back pre-1980? I don't know because I would not have gone to a conference then.

Marks: I think 1978 is my recollection, but again, I'm not sure.

Hirschtick: And certainly by the early 1980s, they were happening.

Marks: My recollection, and again, I footnote that my time recollections are terrible, but I believe by 1978, you had vendors showing up both on the floor and in the Autofact conferences. And it typically was like CADAM was a big deal then, and stuff like that. So it was right near the end of this window, and by 1981 to 1985, there was a glut of these people. And then, of course, today no one goes to conferences, but it's online. So anyhow, somebody-- you could go to the SME, or you could go to the machine design show, and you can find one of these things that'll start showing up.

Peddie: I was just going to mention at these conferences, there was a guy who was pretty famous at SIGGRAPH whose name is Carl Machover, and Carl used to run little sideshows also, at various places. And he-- I think it was in conjunction with NCGA. I'm not sure if that's absolutely correct or not, but he had a side section of NC-- Joel will remember that, since Joel started NCGA.

Orr: Yeah. I did a conference called CG77 in Milwaukee, and I had Carl as my keynoter. And I'd have to find the stuff, because my memory does not yield it at this point. But yeah, it was an interesting endeavor, but it didn't go far at the time. It was basically a one-shot deal. Carl's conferences were all supported by Frost and Sullivan, the data people-- data meaning something different than it does today, meaning commercial data about stuff. And Michael, wasn't there something going on in Europe at the time-- conferences, et al? I know Frost and Sullivan held events in Europe.

Peddie: Well, what about the AEC conference in Chicago?

Holtz: Yeah, that AEC systems. That's what I had mentioned earlier.

Orr: Yeah. Yeah, that was a big one for the AEC arena, of course.

Peddie: But that's still CAD.

Orr: Absolutely.

Holtz: Oh, absolutely.

Brock: Dave, did you want to weigh in on this topic.

Kasik: So the show that had many of the CAD vendors early on at the SIGGRAPH conference in the 1970s, I actually have the program for the exhibitors from 1980. So that should feed right into what you're looking for, Burt.

Grad: If I can make a comment, Carl Machover happens to be my fraternity brother, and of course he died very young. He and I went to RPI. He was a year behind me in my fraternity, and he was also a very good friend of mine for lots of years.

Hirschtick: A nice man, may he rest in peace.

Grad: Yeah. All of his records, all of his files, are at the Charles Babbage Institute at the University of Minnesota. And that's another source we can use, David, in the future

Peddie: There's one other conference I'd call your attention to, which was not specifically CAD but had a CAD component to it, and that's CeBIT. CeBIT used to have a huge stage for CAD presence.

Orr: In Europe.

Bass: And the other one that started around 1980 was Eurographics.

Peddie: Yeah. Eurographics is still running, but it's more academic.

Bass: Yeah, but that was the one that Jose did. Jose started it, and all of these conferences had a ton of CAD added, just because it was a visual thing that you could show off. It was practical.

Kasik: But it was also the main application, right?

Bass: Right. Yeah, around 1980, it splits between industrial and entertainment. You may not have seen it, Dave, but that's when it starts with Able and Wavefront and Alias, then it's off to modeling. There's a whole separate history, and it turns into a gigantic market.

Peddie: Yeah, but the other thing that happened is that the big CAD companies broke off from the national-international conventions and did their own shows. Not the least of which is AutoCAD, right?

Holtz: Cad Camp.

Bass: Yes, that's right.

Kasik: So Carl, NCGA started in large part because they saw SIGGRAPH making a bunch of money on their exhibits.

Bass: Yeah.

Kasik: So Carl was a man ahead of his time, and that's what caused SIGGRAPH to lose, essentially, the CAD companies.

Peddie: And yet AutoCAD Institute carries on.

Orr: The NCGA was formed because SIGGRAPH didn't want to appear commercial. Commercial meant bad in those days for the many academics who were involved in that arena. so..

Kasik: So having been part of SIGGRAPH 50 years, that's partially true, but not totally, because the markets just changed.

Orr: I think you're right.

Industry Consolidation?

Kasik: There was competition, and there are a lot of things that have spun out from SIGGRAPH that are clearly academic. So that's a little harsh.

Brock: I have a question for the group. I want to get into the role of publications, kind of market research and consultants. I was interested in the broad landscape of this period. Do we see a lot of companies addressing particular niches? Are there any waves of consolidation in the 1960 to 1980 time period of these firms? Is there competition among them?

Holtz: We were still in expansion at that stage.

Kasik: Absolutely.

Holtz: Consolidation doesn't happen until about 1986 or 1987.

Kasik: Or even later. You're in the right ballpark, I agree.

Brock: Joel?

Orr: I think in the 1970s, there was also a clear distinction between hardware and software. There were digitizer companies that had false starts into drafting systems. I'm thinking of the former Scriptographics that became Summagraphics, and even Bendix, one of the first large-table digitizers; they weren't very good at promoting their CAD system. And initially, many of the issues, as I recall, were that there weren't only direct view storage tubes. There was also the indirect view storage tube made by Princeton Electronic Products. And the war between vectors and pixels was still on at the time.

Hardware and Software Systems Sales

Holtz: Yeah, except, Joel, that was in the early period where most of the CAD vendors were selling systems, not software.

Orr: Right.

Holtz: Now David, your question about fallout, the one thing that did happen during the 1979 to 1981 time period, and was really killed with the advent of Autodesk in 1982, 1983, was that whole slew that I had mentioned earlier about the AEC mini-CAD systems.

Brock: So, could you talk more about those systems and why that happened?

Holtz: Those mini-CAD systems were the first generation, if you will, that was selling software on top of other people's hardware. Or they were buying other people's hardware and integrating it..

Kasik: Or repackaging.

Holtz: And repackaging it. Bruning was probably the best example. They were a well-known plotter or reprographics firm. They would get something together, slap their name on it. When AutoCAD came out in November of 1982 or so, and then Tom Lazear with VersaCAD and some others, it kind of obviated the need for the use of minicomputers. There was really no advantage to those other systems, which were also a lot more expensive.

Brock: And were they running on minicomputers?

Holtz: Well, they were running on something that I would call a microcomputer—they were before the PCs.

Brock: Okay, but they were microprocessor based?

Orr: Yes.

Holtz: Yeah. Like an HP 5000.

Marks: Well, I was going to say that early on, to get any kind of response, there was some sense in having a turnkey system. And as a profit thing, you could buy hardware and mark that up twice, and make it part of your system. And so right around this period of time, Applicon, Calma, Intergraph, they all had these expensive pieces of hardware that most of their margins were on. And hardware, you can trace hardware as both an opportunity and a trap throughout the history of CAD.

So, building your own system was a trap around this period for a whole lot of time. There were all kinds of people. I mean, I had lots of clients who were going to build floating-point systems. And it's like Moore's Law made more venture capital hardware ideas for accelerators obsolete than you can imagine. And guys like Jon Hirschtick were geniuses seeing that they could move better software to an affordable platform, run it just the same way. There's this whole little kind of interaction of hardware and software throughout. And right around this period of time, a bunch of companies really had to scramble, because a whole bunch of their profit margin and cashflow disappeared.

Brock: I see. Wow, that's really interesting. Burt?

Grad: May I ask one other question? Which of those companies succeeded well enough to continue to be significant in the 1980s, separately from the PCs?

Marks: Oh, a bunch of them. So like Applicon, Intergraph. They kept going for a long period of time. It was the next wave of hardware, probably, that killed them off.

Holtz: Autotrol, and ComputerVision were in there, too.

Marks: Yeah, Calma. But these guys eventually, they survived that battle because they had a higher functionality. But they didn't survive the next battle. They couldn't sell them.

Kasik: I'd also argue that IBM's packaging of CADAM and CATIA was basically a turnkey system that involved IBM mainframes rather than mini and microcomputers.

And IBM was a master at marketing those successfully until the PC and workstation revolution occurred in the 1990s.

Marks: CAE was part of that, too. The SDRC offering was the triumph which was the end of that. But this is, I think, outside of your timeframe.

Peddie: Sun and SGI came out in the 1980s.

Marks: Yeah.

Orr: Jim Medlock surprised a lot people when-- it may have been in a Forbes interview. He let it be known that most of his profits were coming from hardware at the time. And the transition that was going on to software, with the understanding that software is the key to moving forward, and hardware-- thank you Gordon Moore-- would keep on its way without packaging. That was a surprising statement, but it worked for Intergraph for a time. It may have been pre-Intergraph. It may have been still M&S Systems.

Kasik: M&S Computing.

Holtz: That carried through for quite a while; they exited the hardware business in 1994 or 1996.

Evangelists and Influencers

Grad: Was there an evangelist at this point in time? Are you the right evangelists? Were you guys, Joel and Jon Pettie and Brad, were you the guys selling this? Or what was going on?

Peddie: Well, we were influencers.

Orr: Yes, we were.

Peddie: We were proto-influencers. We were out there waving the flag for these guys.

Orr: Sun Tik-Tok.

Peddie: Yeah. We danced, but no one videoed it.

Holtz: Yeah.

Marks: But there were dozens of influencers. I mean, Joel was amazing. I mean, this guy was so fast on his feet. He was like a Comedy Central performer on anything technical. You give him two words to start with, and he would give you 30 completely polished minutes of excitement and challenge and the rest of that. But there were many, many folks that were out there as evangelists, and companies like Lynn Allen's had their own, definitely, just like Apple had its evangelists. So we could list a hundred. There's Bob Johnson in Solid Modeling. So we had all kinds of people out there who were genuinely excited about the technology and wanted to spread the word.

Kasik: And there were the CAD conferences and newsletters

Brock: Could we maybe talk a little bit about how that worked in practice with these people writing newsletters, people doing consulting, people doing other sorts of publications, and how that functioned both for consumers of CAD and for producers of CAD?

Holtz: The newsletters for the industry really were broad beginning in the 1980s. I don't know of any significant pieces that are pre-1980. Maybe somebody else does, but Dave Weisberg's newspaper that Joel and I acquired as part of Cyon Research, and we bundled it with Steve Wolf's piece, and then we also consolidated several other things into one. But my earliest experience of a newsletter was in the AEC Systems area, which-- around 1974 to 1975, it was Design System Strategies from Dan Raker. That was about the only one that was out there that I'm aware of at the time.

Marks: There was also the Frost and Sullivan reports that maybe started around 1978, something like that. But the market researchers did these kind of overall views, "Oh, this is going to be exciting. It's going to be a 100-million-dollar market any time soon." And so that might have been in this timeframe.

Brock: Were there any particular analysts from the financial sector who were big players there?

Marks: Jay Fleischauer. But that was after 1980, I think.

Payne: Yeah, that's later.

Brock: Okay. Well, could we maybe talk about some of the consulting that was going on at this time, for those in this period who are participating in it? What was the

nature of the consulting? What were you doing? How'd it all work? What impact did it have?

Marks: I could maybe-- I mean, this is kind of in my alley for stuff like that. And I'm going to hold up a book called Diffusion of Innovations. And Everett Rogers, even before there was a Clayton Christian and stuff like that, had this notion of what separates an innovation that takes hold quickly from one that sputters and fails? And I used a lot of his stuff. But I came up with my own rubric, because he missed a couple things called factors. Seven factors in adoption. And that became, from about 1979 on, my checklist for any program. So how do we make people familiar? How do we convince them of the advantages in ways that are real to them? How do we make it compatible with what they're doing? How do we make it affordable and tryable even when systems are 150 grand? How do we make the results observable, so they can see it daily, what's going on? How do we make it responsive, where they get good response time? And then finally, what are the standards and sanctions.

And at SDRC, one of the things that we did, beginning at the end of the 1970s was, because Jack Lemon was a professor at Hart and the guys were there, we used education as the entry level. So we would run sessions on computer-aided engineering with the vice presidents of engineering for Volkswagen and Ford and GM, Caterpillar and Deere. And that became a way of showing the benefits. We give examples and stuff like that. But anyhow, there's a whole series of things, of people doing consulting, people doing trial projects. You could literally go through those seven Fs and go, who are the people who are the evangelists who made it familiar? What were the key obstacles to selling it? What were the compatibility issues, like interoperability at Boeing? Which people got it out of lower-cost platforms or gave free university things to make it trialable? How did you show the benefit-- and so you could kind of go through that if you wanted to have a history of those seven areas.

Brock: Daniel, did you have a comment?

Llach: Yeah. I think it's a question that builds on your question, David, about consulting, and also on Peter's points that he just made. It's a question about how did you sort of engage with the users, or the potential users of the technologies you were developing? Are you aware of any efforts to address the specific needs of a specific niche of users? Like architects or mechanical engineers? Or were most efforts geared towards more kind of general systems? I know that, for example, Carl has been very involved with all of this, and I think Brad also had that sort of background. I'm really curious to see how the user figures in the early development of these technologies.

Industry Application Driven Development

Marks: I think there are multiple approaches to that. For SDRC and some of the larger companies, it started often with a project, done for the customer, focused on a very specific problem. So it might be boom noise in the interiors of cars. Or one of SDRC's projects-- the Cadillac Seville--how do you make a car that's 1,000 pounds lighter ride like a de Ville, and what are the analyses for that? And then follow the software sales after that. Most of the CAD vendors-- I mean, look at how PTC started. They would pick an application area, then the next application area, the next application area and so on. And Autodesk started kind of owning drafting, and only after the 1980 period of time really started filling out the suites. So they're probably, arguably, the dominant player in all this kind of stuff. There's always an outreach. I mean, the sales guys often want to sell the box, and to really get penetration of the companies, either to the user groups or the consulting, or they have the dealers, or they have the consultants, there's a whole bunch of ways to show companies this stuff can work for them, as well as the box.

Holtz: Yeah. In the early days, you had the companies that were developing their own systems, and they were their own customer. You had software vendors who were focused on delivering specific applications, as Peter said, to a very small group of their biggest customers. It is only with the advent in the 1980s, or late 1980s, where companies like Autodesk and its peers, and later SolidWorks, while ninety percent of what they're doing is for 90 percent of their customers. Whereas in the early days, it's 90 percent of what's being done is being done for five percent of their customers.

Bass: And Brad, let me ask a question. Would you say that this was revolving around the consultants and advisors? It always seems like the vendor point of view, certainly early on, if you wanted to understand the point of view of the consultants and people who wrote newsletters and stuff, it was a follow-the-money kind of a thing, where many of these businesses were marginal, and they went through newsletters and conferences and just consulting. And so they often seemed to represent large customers. Because I always found, certainly at Autodesk, as you pointed out, I thought that was a perfect point. It used to be for a handful of customers. Then a number of companies came along that did it for more mainstream. And it took a while for the consultancy class to move over and represent the broad market, as opposed to the biggest customers. I used to have people come to me and say, "Ford wants this," or, "Boeing wants that." And I'd go, "So what?"

CAD Consultants

Holtz: Yeah, but are you asking about the consultancy side?

Bass: Yeah, because I know a number of people have tried to push the conversation there.

Holtz: From our standpoint, and I would include Joel here, there's a group of broad consultants. I'd put Kathleen Maher in there. And what Syncdata is doing, in general, what Cyon Research was doing, we were not ever advocating for a individual customer. And then you had people like Dave Burdick and others, who were basically an external resource to try and make things happen for them. And that was a very, very different subset of the consulting industry.

Marks: If I could just maybe trace a little bit of history, too, for Burt and others. You had some companies that followed the company thing. So like Unigraphics, for example, was a company that its roots were in this transition period of 1980s, but through the 1980s said, "If we have five big customers, we're good." And today, what's left of that, at Siemen's, is very strong with NX and stuff, but focused on those big problems. And then you've got the eventual winners in revenue and size, like Autodesk, and SolidWorks, if it doesn't get messed up by PTC. They are really going for a broad, low-cost approach, "Hey, it's free for you if you want to put it on your 3D printer." So what the market looks like today goes back to 1980, and decisions made about who was our customer target way back then.

Hirschtick: I would very much draw a hard line, today, which goes back to-- and you can trace its roots back. There are companies who are building tools to maximize the productivity of the individual. And there are companies that are building tools to maximize the productivity of the enterprise, even when it's at the expense of the individual. And that's really a clear thing. So one of the things that the SolidWorks user base is so strong on is that SolidWorks is building tools to make their users happy as individuals. If you are staying with the same company, with Dassault and CATIA and the other things that they are doing, they are doing things that are smart business decisions for tools for large enterprises. And even smaller enterprises, where the complexities of the enterprise require imposing compromise on the part of the individual user.

Brock: Michael, did you want to get in on this?

Payne: Yeah. I usually have a sort of contrary view to Brad Holtz, but not always. The last thing he said, I agreed with to some degree. But I think you don't find new things starting based on what a consultant said, or even what a market says. It's more like the technology, and I use that in the loosest sense of what is technology-- you can choose hardware, software, whatever. Over time, it advances. It gets faster, more complicated. We are not islands, where somehow we create something all on our own. For example, AutoCAD, was not possible except for the IBM PC. Medusa was much better than that. We know that, right, Carl? So people who often work for larger

companies said, "This company can't innovate, and I'm going to go and do this somewhere else," usually in a small company.

If they did well, it got to be a bigger company, and the cycle would repeat, maybe with different people. But I think that where a consultant said this or that is not relevant to that issue. It's somebody sees the opportunity to solve a problem, which means they might be able to sell it and make some money out of it. And the idea that we can do this, let's get on and do it. And I don't think that idea exists in large companies. A lot of the consultants are reporting what they've seen, repackaging it and making a nice living out of it. And now that may be a facetious point of view, but maybe it's a bit true.

Holtz: So let me be clear, that in no way do any of the analysts in the industry believe that they are making major strides in influencing where products go.

Payne: Okay, so we can agree on something.

Holtz: Yeah, sure. We can absolutely agree on that. I was responding to the question as asked. And that is what were we as consultants doing. You do raise a very interesting point, and that is in the early days, tools that were relatively inexpensive, that optimized my productivity, crept into the company because they were able to let folks get their job done. And that is, in many ways, the power of what happened with Autodesk, and for that matter most of the 1982 to 1986 entries into the marketplace.

Industry Sales Leaders

Brock: We're scheduled to take another break, but I had a kind of burning question I wanted to ask about the structure of the industry in this earlier period. Now, I take it that IBM's selling of CADAM was kind of dominant in the industry in this period. Is that a true statement?

Payne: Maybe IBM selling CADAM and then CATIA was dominant.

Brock: Yeah. Okay. IBM's sales of CAD were dominant.

Hirschtick: Actually, pre-1980, I think ComputerVision and Applicon were also pretty powerful salesforces, too.

Kasik: So I'd say you've got to understand that IBM didn't really start pushing CATIA until the mid-1980s. Okay? They hadn't gotten into the 3D world at all. And even CATIA was not the biggest focus of their business; they didn't realize the CAD market was big enough. Those turnkey systems that have been discussed, the

ComputerVisions, the Calmas, the Applicons, the Intergraphs, et cetera, were the dominant players in the CAD market.

Holtz: In the early days, the big players were, in my experience, in the regions that I was dealing with, it was CalComp and Intergraph for the most part, with a little bit of Autotrol, on the AEC side.

Kasik: On the AEC side, but what about CalComp's other areas?

Brock: Well, let me try and get to the second part of the question, which is maybe more interesting than how dominant IBM was or wasn't. It just seems like the structure of what IBM was doing seems very particular. You have Lockheed, and it spins out a company, CADAM Inc., and that has this technology, and then this relationship to IBM, that it's selling that technology everywhere. And then later in time, you have Dassault. They spin off Dassault systems that has CATIA, and then, again, it has this kind of relationship with IBM in selling it. Maybe Burt knows, other people know, but is that kind of an unusual structure for an IBM business in this timeframe, of basically selling the products of these aerospace spinoffs?

Payne: IBM, when they stopped doing it, had a 20-billion-dollar application software business, which they managed to blow. But it sort of went with their computers. You needed their computers to run the stuff on.

Grad: Michael, let me make a comment. I was at IBM, of course, in the 1960s and 1970s. And we had a thing called unbundling, where we separately priced software from hardware. And we set up a whole software organization. And it was a total failure, because we announced 17 programs, but the only ones that made money were like CICS on the mainframe. That made billions of dollars. The other programs mostly failed. The company said we could not announce a program unless we could prove how much hardware it would sell. My pricing on every piece of software was controlled by the product divisions who produced the hardware. And all of our successful software programs were semi-systems programs. Database, data communications kind of thing.

Kasik: IMS was certainly successful.

Grad: IMS was the other one that was quite successful.

Kasik: The third-party applications, though, Burt, like CATIA and CADAM, were big pull-throughs in terms of hardware sales.

Payne: Absolutely.

Grad: They were great for hardware sales, but they were not independent software that we were making money on. And I left the company in 1978 because they were not permitting us to make money off of the software. It wasn't until Gerstner came in in the 1990s, that he built the software and services business. Anyway, that's my personal opinion.

Marks: Yeah, I think it's maybe best understood from a sales standpoint. So all of these large companies already had IBM mainframes. The sales guys were in there every single day. And they go, "I already have a customer, and all I have to do is put these engineering applications on the machines, which are going to suck so many cycles of power they're going to have to buy another mainframe next year."

Kasik: Exactly.

Brock: I get it.

Payne: Oh yes, that's true

CADAM, CATIA, IBM and Dassault

Marks: And so that was the motivation. And they were immensely successful with that, because the second you put CADAM or CATIA on and try to have sub-second response, you need a whole lot more mainframes. The interesting thing that happened in the 1980s is that then the users were so pissed off that their CIOs were managing this, that they ended up with two IT organizations, a technical IT, which Dave might be kind of like a hero in, and the office IT. But it explained how it got there and how it disappeared, I think, by sales guys selling to a customer they knew.

Brock: Again, it's this hardware-software relationship that we've been talking about.

Kasik: The other thing that IBM in particular wound-up selling are graphics terminals--the IBM 2250, the IBM 3250 and the IBM 5080. I think they sold thousands and thousands of those units.

Marks: Yeah. Yeah, good point.

Peddie: It also spawned the clone industry. The IBM terminals that Dave was referring to also spawned the clone industry.

Payne: The more CATIA, the more units.

Kasik: Exactly.

Peddie: And so there was an explosion in the 1980s of companies that were making graphics terminals that were IBM-compatible, and they were also 4014-compatible. And they were somewhere between one-half to one-fourth the cost of the big brand names. They all went out of business, too.

Grad: I don't think that IBM sold CATIA as a software program product. But I could be wrong.

Payne: Dassault bought it from IBM lock, stock and barrel at one point in the 1980s.

Kasik: Dassault eventually bought CATIA.

Payne: No, Dassault bought CADAM.

Kasik: I'm sorry, Dassault bought CADAM. Apology. I misspoke. But certainly what I saw in terms of the CATIA relationship is that IBM pushed buying directly from Dassault Systems the CATIA product.

Grad: That's my memory, but that's later.

Kasik: But the same thing is true with CATIA. it was almost like a bundled sale, and you dealt both with IBM for hardware and with Dassault for CATIA.

Grad: Tell me again, though, who owned CADAM, the software?

Payne: It was owned by IBM, because Dassault bought it from IBM. I don't mean to use, they bought the software to sell.

Payne: I was there when they did that.

Grad: Were you in the UK or US?

Payne: I was in the US, but I was working with mes amis Francais, better known as the French.

Grad: I wonder if it was an international sale, because the rules on European sales were not the same as US sales.

Payne: In the end, Dassault owned CADAM.

Kasik: Yes. And CADAM spun out of Lockheed.

Payne: Yeah, that's right.

Bass: It comes out of Lockheed, and then about ten years later, it gets bought by IBM, and then it gets sold again to Dassault.

Grad: IBM actually bought CADAM?

Payne: That's the second time I've told you that today.

Grad: I know that you told me that, but was it bought before 1978 when I left IBM?

Bass: Yeah, so it may have been past your time. Hold on. The Wikipedia page has CADAM formed as a subsidiary of Lockheed in 1983, and it was sold to IBM in 1989. And then they do the micro-CADAM, and then closer to 2000 it gets sold to Dassault.

Kasik: So one of the things that's difficult with the timeframe of 1960 to 1980 is that there was so much consolidation and "michegas" [craziness] that happened until about 1990, when things started coalescing a whole lot more, at least from my observation. The 1980s were wild and crazy when it comes to the evolution of all of these CAD systems.

Payne: Well, you are about right, because there was this fellow who was in the Medusa company, whatever it was called. I've forgotten it now. John Childers, he became the first managing director of the privatized CAD center. He would talk about industries such as we are, that when it was young and not everything worked right and it was clumsy and this, that and the other, there would be lots and lots of players. As things started working, there would end up with just two and a half companies. And I think we're seeing that in CAD-- whether it's electrical CAD or mechanical CAD or AEC CAD, that Childers' theory is true. Then you look around at many things in the world, and that's also true. You have two and a half players, meaning sometimes it's two, sometimes it's three. In rental cars, you've got two and a half players. Hertz, Avis and National. They're the half a player.

END OF DAY 1 SESSION 3