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The one that broke out

Officially: The only one

Wavelink

If you look here you would be right to initially think that the Grass Valley Company had plenty of spinoffs. There was only one. All the others that appear, according to the chart, to emulate from Grass Valley were prior GVG employees who for various reasons struck out on their own. That is except the one we will look at shortly.

In retrospect there should probably have been another one, and it should have occurred first.

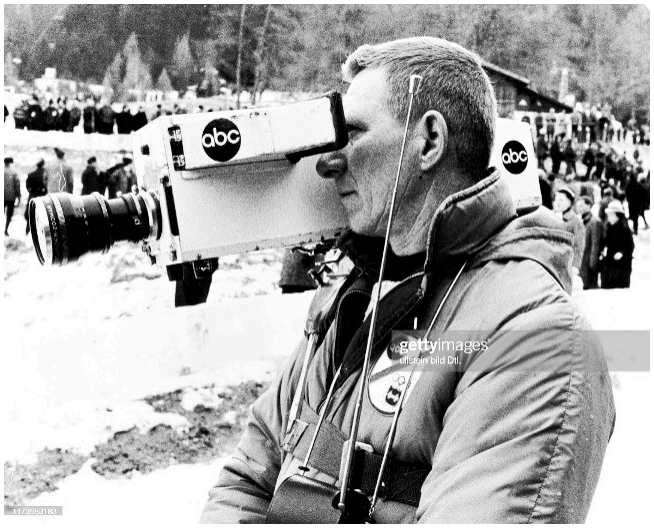
The first Olympic Games televised in the U.S were the 1960 Winter Olympics from Squaw Valley (Lake Tahoe, not far from Grass Valley) and the Summer Olympics in Rome. These were done by CBS. CBS paid almost nothing for the rights at the Tahoe venue and paid only half a million for the games in Rome. In the Winter games, during a men's slalom event, CBS allowed officials to review tape of one of the runs, to determine if a skier had missed a gate. This gave CBS the idea for instant replay, which was debuted in anything resembling its present form in 1965.

ABC, the third network in a three-network race back in the early 60s, had aggressively gone after sports as a way to delineate themselves. They couldn't out spend the other two, but they innovated, and when the chance to get the 1964 Innsbruck Winter Olympics presented itself, for over a half million dollars instead of the $50K CBS spent for the 1960 Winter Olympics, ABC jumped at it. They had lured legionary sportscaster Jim McKay who covered the Olympics for CBS to ABC in 1961, and with the production staff ABC had put together for their Wide World of Sports franchise, they were uniquely qualified to make a go of it. Technology being what it was at the time, the 16,5 hours of coverage was videotaped, in black and white, and flown back to the states. Luckily most events at Innsbruck were in the morning, giving enough time given the seven-hour time difference between Austria and the east coast of the U.S. for the events to be flown back and aired that evening.

The Geo-synchronous satellite for television use was still a few years away, so the only live event aired in the states was a 15-minute window of the closing ceremonies provided by the Telstar satellite, launched in 1962, which had to be tracked as it passed over Europe.

ABC held onto the Olympics until 1988 and then lost the rights to NBC. The last Winter Olympics ABC aired cost them over three hundred million dollars.

As mentioned ABC often looked to the Group as their engineering arm. As we looked at in another article, ABC was pushing for another innovation for the 1980 Olympics, the 300 switcher. ABC also presented a special project on top of the mess that was the 300, they asked the Group to develop a system to send video down fiber optics for use at the 80 Olympics. While extremely common today, it was a novel idea inside the television industry in the late 70s.



Sports drove most of the technical innovation at ABC at that time. While ABC had no dedicated engineering labs, they had capable engineers who built, retrofitted, and maintained their facilities. One in Los Angeles took the imaging tube and its yoke out of a GE black & white video camera and installed it the case seen in the photo on the left.

Not to be outdone, an engineer in New York (right photo) did the same, but this time used an RCA camera. The New York version had an electronic viewfinder, while the Los Angeles version had an optical sight.

The rest of the electronics for both cameras were still spread out in the camera head, and control units.

Eric Rosenthal of ABC Engineering asked Birney Dayton to head up the fiber project for those Olympics to solve the "long-run"

problem. The Winter Olympics required cameras placed high up on mountains to cover the ski runs. These could literally require runs of well over a mile. Sending analog video down coax cables, would not cut it. The only other way to get camera video off the mountain was with microwaves. Microwave gear was expensive, still not very portable, and most importantly required line of site. Often not possible in these settings, and many paths would require multiple links to get the signal where it needed to go.

In addition, ABC prided themselves in firsts. Peter Cervalic of ABC connived for the Group's system to be used for the opening ceremony, which would make it the first fiber system ever to carry video, even though AT&T had a fiber link back to New York City.

One additional project that ABC wanted the Group to do at that Olympics was a four-channel audio transmission system.

This was the Groups first digital project. It was audio, not video. While the video fiber products were analog, this audio project was not. This became the core of the first fiber products offered by the Group. Dayton, who was involved with this, might have foreshadowed his future, as we will see later, as he ended up running a company that focused on digital audio for part of its life.

It got out that the Olympics was using digital audio, and there were reports that it added stress to the viewers. It was absolutely not true. All audio you consumed today through television transmission is digital. This digital product just plain worked and was extremely reliable. The Group had very little problems making the thing. However, it was too expensive, and it was far cheaper to run analog audio, so over the next couple years they sold only a couple of units, so they gave up trying to sell it. The fiber folks went back to concentrating on analog devices.

Soon the Group got a second order for a fiber system, this one at Epcot Center, to supply video to kiosks. Using fiber on long runs eliminated another issue, especially in Florida in the summer, lightning induced voltage spikes.

Wavelink was formed in 1983 and had its own building, which was also out by the airport. The original department manager, Pete Mountanos, is standing in the doorway.

Mountanos saw an opportunity to sell the product to telecom companies and talked Jerry Sakai, who oversaw the Modular Division as part of the management council, and Modular G.M. Randy Hood into letting him set up a separate operation in a building near Modular's. Mountanos realized that there were only a few companies that had all the pieces to build 1.2 GHz fiber backbone. The Group was one of them. Even though the idea of Grass Valley getting into the telco industry was considered by many to be foolish, But Mountanos had to overcome the ingrained notion in many that the company was a video company and not a transmission company.

The company branded this effort Wavelink. Wright was determined to "divisionalize" everything and didn't want hybrid manufacturing to be centralized, which Dayton was lobbying for. Dan Wright, the Group's GM at the time, decided to pull Dayton out of hybrids, and that Wavelink operations would be separated out of Modular, but would not be called a division, but just a group. It became known as the Telcom Systems Group. While Dayton continued to hold the title of VP of Engineering, Wright thought that this second hat, as a group, instead of a division manager, would reign in some of Birney's influence.

Dayton reported to Wright directly. Curiously not to Jerry Sakai, who ran MPD, and had been the one originally sold on the idea. Dayton was not looking for the job. Mountanos was very upset because the optics were such that it appeared to him that Birney had lobbied for his job. Pete Mountanos had set up the Wavelink business and had it running and then Wright arbitrarily put Birney in charge of it. Mountanos retired and expatriated himself to Thailand.

In the television realm the Wavelink group only had modest success, as digital systems back then were always expensive. Additionally, broadcasters at the time had no interest in fiber, and at the same time the group had no way to sell to telcos. But besides a few high-profile projects for ABC, plus a few others, television folks were not interested at the time in replacing copper cabling with fiber. It was the telco industry that was pushing for fiber connectivity. Wavelink had some modest success and sold eight systems to Telcos.

After the initial ABC Olympics audio system, early products were all analog, both video and audio in and out, and transmission down the fiber. Early products were the 3290 (video only) and 3291 (video and audio) modules.

In 1985 the Group sold six 3290 systems that worked over a 1.2 Gb fiber link to Los Alamos. These six were each on a different fiber, and in those days, there were commonly 12 fibers in a bundle of fiber. By the late 80s Wavelink had a laser version and was doing 20-mile runs.

Another player that we will see throughout the rest of the series is Chuck Meyer. Chuck went to work for Wavelink, or the Telcom Group, as it was called by then, in 1986. There he worked with Jim Michener and Dave Hershberger. While Meyer was at the Group he worked on another digital audio project, an audio multiplexer that would allow transmission through T1 telco lines. But Chuck didn't think he was a good fit at the Group and left in 1990 and went to work for Applied Design Labs with a person he had worked with

earlier, Ron Milner, the founder of the company. Both Milner and Meyer had worked at Cyan Engineering. They did work for Nolan Bushnell of Atari fame. But his and Dayton's paths would continue to cross in the future.

As we will see shortly, in 1989 Birney Dayton left to found NVISION, Michael Pugh became head of the Telcom Group. He came from San Diego where he had worked for a fiber optics developer, where he designed serial to parallel conversion ICs. He was recruited in 1989 but actually started in June 1990. His background made him a good fit to head the group's efforts.

The problem was that after a year Michael was eased out because people were uncomfortable with him being in charge of engineering, as his wife, Anna Greco, was in charge of marketing for the Telcom Group. The Group and Michael parted amicably. After GVG he then consulted with a company called Virtual Vision to do some chip design. He also consulted for Schelling robotics in Davis, CA. They were makers of underwater cameras that attach to remote vehicles. In addition, he went on to engineer for a workstation company and he was a representative on the fiber channel A/V committee. We will pick Michael's story back up in a later article.

Anna Greco, the other half of a two-engineer couple, also started at the Group in 1990 and spent 10 years with the company. She branched out at the Group from engineering into strategic marketing and business development for the Telcom Group. In 2000 when Tektronix sold Grass Valley, they kept the Telcom Group as it still meshed with Tektronix's business goals at the time, and she stayed on for a while. Like her husband, we will pick up her story again in a later article.

After Pugh, John Glass became the head of the Telcom group. Jim Michener was the lead engineer.

An opportunity presented itself to the group that turned into a disaster. Williams, a Tulsa energy company based in Tulsa, wanted

to run fiber through their oil pipeline network. This project became known internally as Excalibur. The Group signed a contract to provide that capability. The caveat was that it had penalty causes the Group would have to meet, if not the company would have to pay Williams. It turned out that to perform to the customer's specs the Group would have to create special ICs, or Application Specific ICs (ASICS).

A problem GVG had in designing ASICs was that instead of the most advanced modeling tools they had to use tools that Tektronix already had. These tools were analog in nature, almost like spice, analog design simulation software. BTW: Spice was partially developed in the Grass Valley area.has some connection to the area. The design simulations were being run on 386s of the day and were taking so long that the simulations would have to run overnight. At some point they managed to get some time on a Cray, but it was not enough to stave off disaster in time.

The ASIC at issue was to be comprised of digital circuitry. FPGAs, much cheaper and quicker to develop, could have been used to get the design working. Then port it to an ASIC. Instead, they opted to go straight to an ASIC each iteration, which quickly led to extremely high costs.

The Group couldn't make the product meet customer specs, and the company ended up paying over a million dollars in penalties.

Tektronix bought a company down in the bay area called LP communications that made a T1 tester. Tektronix had a division in Redmond that was making telco test equipment which was run by Danny Edmure. Dayton and Edmure, along with the LP heads, were able to convince Dan Wright to combine the three operations into one standalone entrepreneurial operation. It was argued that it would make it worthwhile to develop the market. Wright, as we have seen was big on breaking large organizations into smaller divisions, he pitched it to Friedley and added that all of Tektronix should be split off in this way. Friedley didn't take kindly to Dan's

proposal. Friedley was still running Tek's Communications division and Wright GV. It didn't happen.

While Wavelink was not a large part of the Group's sales efforts, it did end up having an out-sized effect on the company. It led to several key players in the company leaving. It also grew into a $12 million business by 1990, and then like the rest of the Group, started a downward slide throughout the 90s.

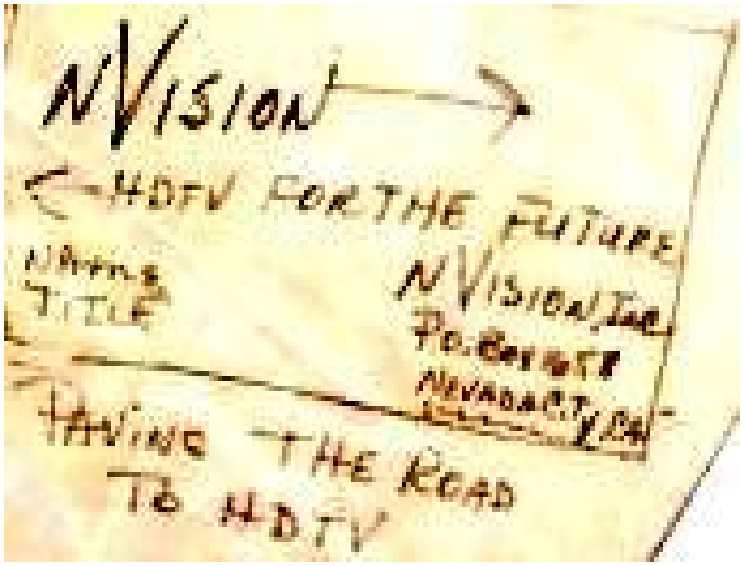
It gave GVG early internal experience with the issues of jitter, reclocking, and latency in digital optical systems. It also positioned the company for future digital products. GVG digital routers inherited some of its signal-path integrity from WaveLink development efforts.

NVISION Spinoff and Abandonment

Birney Dayton was an early proponent of HD. This was long before Grass Valley showed any interest in any digital formats. He was dismayed that the Group at times seemed to have no interest in how future technologies would disrupt their business model. He was a witness to the meeting they had with Sony in 1985. He saw what others were doing in the digital space. Besides the two digital islands in the company at the time, Dubner and the linage that started with the Kscope, it was analog and standard definition through and through.

Even when Bell Labs approached the Group to do R&D on HD, the majority of the company did not see the value. Dayton lobbied for some foray into digital, especially HD. He had the ear of Tom Long. Dayton considered Long a mentor. Long was able to see farther out in the future and thought some of Birney's arguments had merit, but also thought they might be too disruptive to setup a HD R&D operation inside the Group. He asked Birney if he could make a business out of his vision of the future. He said he could. Long arranged for Tektronix funding. This was at a time when many companies had Venture Capital funds. Tektronix's VC arm was called Tektronix Development Capital, or TDC. TDC's investment

was half in money, $2 million, and half in test equipment. Dayton promised Long that he wouldn't compete with the Group, which would be easy as the Group had no interest in HD. The company launched in 1989. This was the only Tektronix sanctioned spinoff ever from the Group.



The new company took the name of NVISION. N represented any line rate; 525, 1080, 1120, 2000, in a television picture, the VISION tag. The name was created in 1989 on a place mat from Michael's Restaurant by Birney and Roni Dayton and Helen MacMillian.

Founders Birney Dayton, Bill Amos and Guido Galli

Besides Dayton and his wife Roni, Bill Amos, and Guido Galli were the founders of the company. Bill Amos was at one time the head of sales for the Sony Umatic line of VTRs. Amos was a Philips salesman, selling camera imaging tubes, eventually ending up in the telcom industry, before Pete Mountanos brought him to Grass Valley, as he thought he make a good salesperson for Wavelink. After Mountanos left he got to know Birney Dayton. When Birney started NVISION he brought Bill along. Amos oversaw the new company's sales. Guido Gali oversaw manufacturing.

Galli had a doctorate in physical chemistry. He had several patents surrounding computer memory, (especially bubble memory), and ink jet printing. He had worked at IBM before moving to Intel. Birney had talked about going off to start his own company while at Grass Valley. Mountanos was also instrumental in Birney meeting Galli, as he had ties to a venture capitalist firm. Before Mountanos finally decided to leave, he was trying to get Birney to leave. His hope was that Galli could lead him to startup money.

Bob Plumber and Larry Thorpe of Sony were on the board. Birney knew both Thorpe and Plumber from his time on the ACATS committee. Plumber worked for Sarnoff Labs. Larry Thorpe was originally with RCA and was instrumental in the TK-47 camera we looked at in other places in this series. He came to Sony as their camera guru for Sony America. He was going to leave Sony for NVISION so that the fledgling company could also compete in HD cameras, but the Chairman of Sony, Morita himself, talked him into staying with Sony.

Jerry Sakai spent some time at NVISION. Galli had left the startup as he was not keen on the intricacies of small batch manufacturing, and Sakai naturally was as we seen in earlier articles. Another early member of the company was Chuck Meyer, who joined as a senior engineer. Initially Dayton was a bit leery of Meyer, because he did not stay long in his first stint with the Group. Meyer thought he was not a good fit in the Wavelink group. After stints in marketing Chuck eventually became head of engineering, and eventually towards the end of NVISION's run as a standalone company, its President.

First Clientele

From the get-go it became obvious that HD was not ready for primetime. But high-end television and audio production houses, along with Hollywood, were discovering a form of high-definition audio. AES audio. AES stood for the Audio Engineering Society, that had hammered out a digital audio standard. Many in the

industry found that digital audio was a much harder concept to grasp than digital video, albeit standard definition at this point. Many things were foreign when comparing analog audio to digital audio. For one thing, how levels were measured was different, there was much more ancillary data embedded in the digital audio signal than in video'. In addition, our ears are much more unforgiving, at least among audiophiles, to minor imperfections in digital audio than digital video.

Now to insure audio fidelity from a new sound phenomenon introduced with digital audio, "clicks and pops" when switching between audio sources, the audio had to be synchronized properly. Sync generators for audio? Some old timers found it blasphemy. But when correctly done AES digital audio made for much better sound.

Al Hart, a member of the nascent company came to Birney and said they needed to develop a timing generator to solve that problem. They developed a box called the NV1082. It locked to the video reference and generated a 48KHz AES clock signal. They sold that product for five years until Tektronix came out with a product that did video and audio timing all in the same box. In conjunction with that NVISION also produced a family of products that converted analog audio to/from AES. This was the start of the company's modular product line. Not in HD video products, but in the form of higher definition audio products.

Hollywood was a big customer of these products and used them mainly for digital audio mastery. Chuck Meyer said that he liked Hollywood customers, as they respect other creative types more than the hardnosed broadcasters generally do. NVISION did very well with the Hollywood types.

NVISION soon came out with a SDI video router, the 8256 for ABC. This was almost five years before the group introduced their own. It originally handled SD digital video, but soon was upgraded to HD. But the HD video market just wasn's there yet. It was still looked upon as a science experiment by many.

HD - Failure to Launch

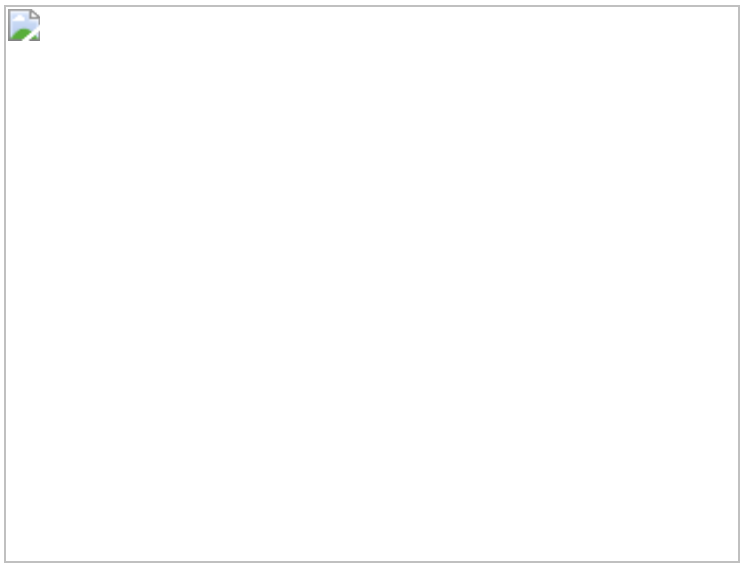
In 1992 at the Albertville Winter Olympics, HD was used for the first time to cover a large sporting event. It was a joint effort between Bosch, Philips, and Thomson, the joint company was known as BTS. All four of these entities would come to be a big part of the Grass Valley story. BTS assembled nine HD production trucks for the event, ranging from two 6 camera vans, and one 4 camera van, two 2 camera vans, an edit truck, and two slow motion units, plus a master control unit. They also built a two-camera studio facility.

This HD system was still analog, not digital. Quality was better than standard definition. But not enough to justify the cost. Receivers and monitors were still CRT based, which made them big, heavy and extremely expensive. Also, many thought the new 16:9 aspect ratio (4:3 was the traditional one) was too exotic. But outside of a few demonstration type projects, few were interested in making the investment that HD required. Plus whom would watch it? There was no way to deliver it live to the home, and in 1993 HD receivers were in the $15,000 range, in 93 dollars. BTS disbanded the units in 1996.

While Sony had the deep pockets to patiently build up a need and demand for HD and it continued along that path. NVISION had no such resources. Casting about for products that would keep the doors open they thought about making a more advanced version an

audio product similar to a product that Dayton had worked on at the Group, which worked over fiber. But they soon found that there wasn't a market for it. But that work soon morphed into what was known as the NV2000. It moved six audio channels in a 6 MHz video channel. Chuck Meyers flew all over the US trying to sell it, with very limited luck. But there was another market that NVISION was about to stumble on. Chuck went to Modern Video Film in Burbank trying to sell the 2000. They said that they did not know what to do with it, but they mentioned another need. They said they had a need for a data or machine control router.

Facilities were looking for an easier way to reconfigure machine control in edit bays. At the time editing was not done on a laptop or even desktop computer. It consisted of two or more VTRs, maybe a video switcher, and audio mixer, and a stand-alone editor, generally the only computer in the room. The editor controlled the VTRs, and other equipment associated with the editor. Often what machine was currently under the control of an editor would need to be changed. Up until then that required either patching or physically disconnecting a cable from one machine and moving it to another.



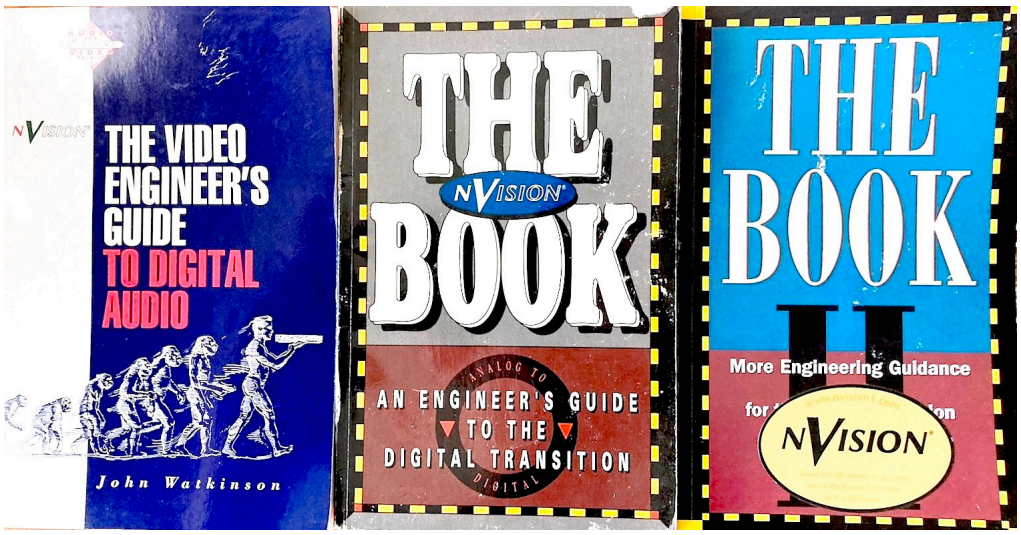
90's edit suite. Switcher bottom left, audio mixer bottom right. Keyboard and monitor for the editor on console. The three VTRs in an adjacent room were to limit the noise coming from the machines. Rack between the center and right VTRs held control interfaces for each thing controlled, in this case the VTRs,

video switcher, and audio mixer. Each interface was about 16 inches tall in the rack. The editing computer itself, which talked to each interface, was a DEC PDP-11 mini-computer.

Glen Meadows who was a big-time Nashville sound engineer, also wanted a data or machine control router, and he eventually called Frank Wells, an NVISION engineer, and said come on down, he had an idea for a solution to the issue. He asked why an analog video or AES router couldn't be modified to be a data router? Jim Varney and Bob Fry asked Meyer if they could make an audio router into a control data router. Together with Chuck and Bob Crab they simulated it with a 3512 audio router. They had a hit on their hands. NVISION sold data routers to everyone but Grass Valley.

The Book

Birney picked Chuck to define the digital audio product line for marketing. So, he worked on creating a catalog and application notes, which then led to the writing of the first "The Book."



There were three editions of "The Book", which rapidly became the bible for many engineers faced with harnessing digital audio. It made NVISION the de facto digital audio gurus.

While the application notes were written by Meyer and other NVISION engineers, John Watkinson, who wrote "The Art of Digital Audio" at about the time NVISION started, agreed to take NVISION's app notes and turn them into NVISION's "The Book"

in 1990. The Book starts off with shorter versions of his first two chapters from the "Art of" book. Whereas "Art of" book delves into the engineering weeds, the NVISION book stays at the practical technician level. The book was edited by Nigel Spratling, the VP of Marketing at the time.

The book positioned them as the digital audio company. The conversion rate to sales from the book was high, many trade magazines reran the app notes. One of those books made it's way to Sony Atsugi to help them get their machine control protocol correct in their product.

The second edition of the book appeared in 1995. It was put together by Meyers, who was VP of Engineering at the time, and it was all NVISION app notes in a chapter form. It had higher production value, glossy pages, and it only had a couple chapters on video, which showed how important audio and machine control was still to the company.

The final edition of the book was published in 1999. As Dolby was now central to how many digital audio signals were transmitted Steve Lyman of Dolby contributed, Geoff Ward wrote the Machine Control Chapter, Paula Gleicher did a Fiber Distribution chapter, Rob Bowdish generated many of the diagrams, and Jill Mahanna did editing.

No Tek Round Two

By 1992 NVISION, spun off three years earlier, needed another cash infusion. Jerry Meyer, the President of Tek at the time, had no interest in anything small. Meyer was known for having little patience, especially towards the Group. NVISION scrambled to find another investor, which they did. Dayton approached Jim Meadlock, who he had directed the Group to, to help with building Kscope boards, as we saw in a earlier article.

Jim Meadlock – 2019

Meadlock had ran Intergraph, started by former IBM engineers in 1969 as M&S Computing, Inc.. Jim Meadlock, his wife Nancy (the M in the name), Terry Schansman (the S), Keith Schonrock, and Robert Thurber were the founders. Thurber had been working with NASA and the U.S. Army in developing digital computing systems to provide real time missile guidance. In 1980 the company was renamed Intergraph Corporation.

One of Intergraph's major hardware projects was developing a line of workstations using a computer architecture created by Fairchild Semiconductor. They also developed their own version of UNIX for their workstation. In 1987 because the Fairchild product wasn't very popular, Intergraph bought the Fairchild division responsible for the chip to ensure its continued availability.

Their Unix product became a big money-maker, but not in a traditional way. In 1997, Intergraph brought suits against Intel and other computer hardware manufacturers claiming intellectual property infringement. The company secured major settlements with Intel, HP, TI and Gateway, racking in over $394M. In 2000, Intergraph exited the hardware business by selling it's existing graphics accelerator IP to 3Dlabs, and its workstation and server division to Silicon Graphics, thus becoming solely a software company.

On November 29, 2006, Intergraph was acquired by an investor group taking the company privately until 2010, when Intergraph was acquired by Hexagon AB.

Meadlock was born in 1933, and received his Bachelor of Science in Electrical Engineering, from North Carolina State University, in 1956. He was a department manager for IBM until he left to form

Intergraph, where he was Chairman, Board of Directors, and the chief executive officer for the company.

For an additional infusion of capital NVISION went straight to Tektronix's board, but the board said no. By then there was some resentment, both at Tektronix, and the Group that Tektronix had funded NVISION, and had not kept it inside Grass Valley. Jim Meadlock put money in, and watered Tektronix shares down. Meadlock wrote a personal check for $1 million. Tektronix held fast in choosing not to invest any more than their initial outlay. Eventually Meadlock virtually washed down Tektronix shares to 0.5%. Meadlock felt that you had to pay to play. Meadlock had about $4 million into NVISION when he was done.

Part of Meadlock's money was used on a down payment for a building that was originally a Blue Cross data center. The building was bought for about $750,000 and had $200,000 in improvements made. That is the same building seen in the first article, as it is the last building still associated with the Grass Valley Company in the area.

HD Finally Arrives

Finally in 1997 NVISION began the development of their first HD product, a router. At this time SMPTE was nearing the completion of its HD-SDI standard which was finalized in 1998. The standard was actually two standards. Setting the stage for the infamous 720p verses 1080i battle. Were more pictures per second, or higher resolution the answer?

ESPN and Fox, two networks at the time that were concentrating on their sports programming, liked more pictures per second, as it made for much better replay presentations. ABC and Disney also went with 720p, mainly to stay in lockstep with their ESPN subsidiary. The other three alphabet broadcast networks opted for higher spatial resolution, CBS, NBC, and PBS.

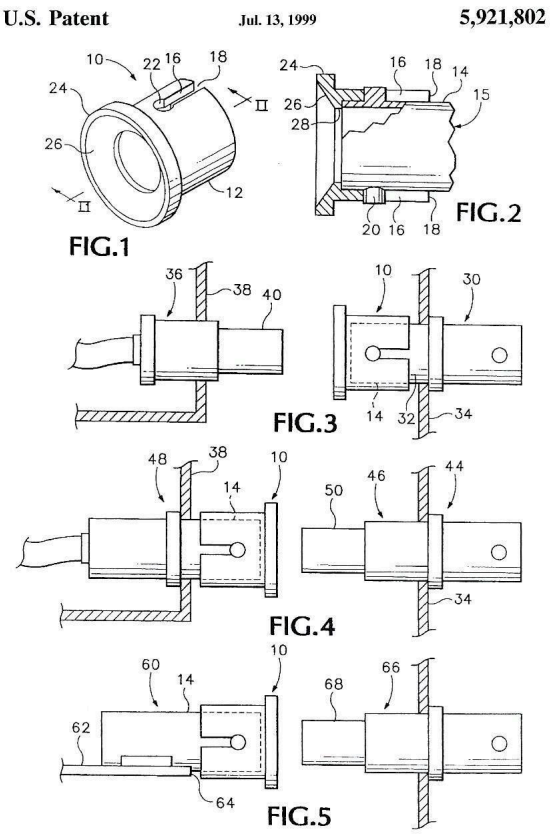
This division would continue until today. It is finally being solved by technology, which is allowing the best of each standard into a single standard (SMPTE ST2082) in 2018, also known as 1080p.

The HD transition started in earnest in late 2002 with ESPN's and Turner's decision to launch HD cable channels.

In 1997 Dayton allowed Meyer to spend $250,000 for HD test and development equipment. Gennum had developed a HD transceiver IC that did reliable HD re-clocking. Even with that the design of a router frame was more art than science, and internal connections for the router had to be carefully placed. Because of the high frequencies involved, the whole router cabinet was built as a RF cavity. Smaller HD routers worked better, as they had less dielectric and other losses, because they had shorter paths. At that time NVISION HD routers came in three sizes: 64 square (that is 64 inputs and 64 outputs), 128 square and 256 inputs by 128 outputs. The problem was they each had their own set of issues when it came to moving video data, with all its RF energy.

The engineering issues to produce a HD router were huge. At the time conventional wisdom, and expectations were such that there could be no active components on the backplane board, the board that all the cards plugged into. That is not that case today, but in the late 90s it was. Plus, because of the high frequencies involved, the tolerance for coax edge connectors were extremely tight, +/- 1mm! That meant that any coax connectors on the boards had to blind mate with the backplane input and output connections on the back of the router.

Bruce McChesney found an off-the-shelf connector that was flanged on one side and a normal BNC connector on the other. The flanged side would allow the board's connector to self-align into the connector when the board was plugged into the frame. NVISION designed an adapter that would mount over a BNC connector that did the same thing, as shown in the patent drawings. Chuck Meyer, Dan Reis, and Scott Matheson received a patent for it.



The router frame itself had to be made of aluminum as that material more closely matched the printed circuit boards thermal expansion rates. That and other processes to successfully build a reliable HD router NVISION decided to keep secret, and not patent. They felt that they were far enough ahead at the time that they elected to not patent the processes used and keep them as trade secrets.

NVISION, while not having a physical HD router in the run up to the 98 NAB, put together a notebook binder that essential showed and described how they could reliably build HD routers. The effort was enough for CBS to place an order before the convention. CBS then announced their purchase. This was done to get others on board. The intention was to keep NVISION in business.

NVISION sold its first five 6000 series HD routers in 1998. Two to CBS, one to Sony for a production truck, one to ABC, and one to PBS. By the turn of the century NVISION had only sold about 50 HD routers. At the time the big dollars were going to build websites and not to HD. This was the run up to the dot com bust.

Another early HD product, which was to foreshadow what was to come for the company was at the 1998 NAB. There it showed products that plugged into another company's frame, the Miranda Densitè. NVISION provided the audio multiplex cards for a fiber project that fit into Miranda's frame. There were only 10 customers. The product was used for a few special projects, plus the making of the movie 102 Dalmatians, an NBC soap opera in Los Angeles, and additional projects by Industrial Light and Magic.

Grass Valley Overtures

In 1999 NVISION got out marketed by Tim Thorsteinson and Grass Valley. Thorsteinson, was involved with the Group more than once. This was his first stint with the company. The problem he faced was that the Group still did not have any HD product to speak of. What the company had going for it was many in the industry thought HD would never be attractive enough for viewers to buy HD receivers. Also thrown into the mix was a decision that the new digital transmission system presented to broadcasters. It allowed for a full-throated HD program, or multiple SD programs at the time. On top of that, the broadcasters were forced to invest, on average a million and a half dollars to transition to the new digital standards by the FCC. So, the dilemma was multiple SD programs verses a single HD program. The question was which would recoup the investment back faster. Many thought more was better. But as always, for broadcasters, and many other program providers, the 800-pound gorilla was and still is sports. ESPN decided the direction most would end up taking when they mandated that all their vendors providing programming, would deliver it in HD. But that was still three years in the future at that point.

Besides not having HD product that was shipping yet, the Group wasn't doing digital audio yet. They were using NVISION audio cards in their master control switchers, and buying NVISION digital audio routers it a customer needed a digital audio routing layer. At one point Grass Valley sent Ken James over to NVISION

with a proposal. The Group offered to buy all NVISION's production output. That is the Group would be the company's sole customer. That was rejected out of hand.

So, Thorsteinson floated the idea internally at Grass Valley that the Group would buy NVISION outright. A number as high as $35 million was thrown around. Dayton and the other principles at NVISION rejected the overture, with the blessing of Meadlock. It would have been a horrible financial deal for everyone but Meadlock, as Dayton and company had only stock options in the company that had not vested yet. To end up back with the Group, they probably would have carried the options over into Tek stock, and at the time Tek's stock was headed downhill. Little did the NVISION folks know that soon those options would be in even greater danger.

So, Thorsteinson did the only thing he could to slow customers migrating to vendors offering HD product, especially NVISION. He started telling customers that they did not need HD yet. Simply buy SD gear from Grass Valley and they would swap it out when the customer needed to go HD. At the time NVISION's HD equipment was the same price as Grass Valley's SD. But still many had a long ongoing relationship with the Group, and NVISION was still a bit of an unknown quantity to many. Grass Valley had blown it, and this was the only recovery strategy they had. GV was working on HD (a router, switchers, and modular products) but at this time they had nothing that could ship yet.

Another potential NVISION suitor also sniffed around. Someone who would soon play a role in the Group's history, Terrance Gooding. In the end Dayton concluded that he just wanted to see NVISION's books.

Dot Com Bust

Just as HD was starting to gain some measurable traction, another phenomenon made the road much slicker. It started in 1993, when

Mosaic, the first of a slew of web browsers to follow, was launched. Now many more people were starting to regularly use the web. Now a new business model was born. Set up a website, grow quickly by building brand awareness, go public. Hopefully the investment from people buying the stock would allow the company to survive long enough, if its cash burn rate was low enough, until it figured out how to monetize its popularity. Most of the startups flamed out before that happened. The list is long. Napster, Pets.com, Kozmo, Broadcast.com, WebVan, are a few that came with the dot com run up and then disappeared. Some biggies today survived. Amazon was started in 94, Ebay in 95, Google in 98.

The ones that did make it through that time did so by initially carving out a goal: world's largest store, meeting place, or search engine. If they could show progress towards those goals, the investing public and financial institutions showered them with high stock valuations, and cheap capital. Those companies took the money and invested it into businesses that augmented the services they had, along with companies that actually made money.

Taking Amazon as an example, in its original business, that is selling books, and doing other e-commerce, it acquired 40 companies. But it also acquired 71 companies outside its original intended business. Today a number of those acquisitions form Amazon's Cloud Computing business, its most profitable sector.

As mentioned, most did not, but investors saw the meteoric rise of stocks in the sector and wanted to cash in. At the start of this run up Fed chairman Alan Greenspan in a 1996 used the term "irrational exuberance" in a speech addressing the burgeoning Internet bubble in the stock market. What helped fuel the run up was that the top income tax rate had dropped in 1997, and interest rates were low. More people felt they had the money to invest. Investment banks, which profited significantly from initial public offerings (IPO), fueled speculation and encouraged investment in technology.

As the bubble was reaching its climax dot-com insiders cashed out $43 billion between September 1999 and July 2000, twice the rate they'd sold at during 1997 and 1998. It peaked in March 2000. During that month alone there were almost 2500 venture capital deals, involving almost $35 billion dollars.

On March 20, 2000, Barron's featured a cover article titled "Burning Up; Warning: Internet companies are running out of cash, fast," which predicted the imminent bankruptcy of many Internet companies. Just one month after peaking Nasdaq had lost 34.2 percent of its value. From 1995 to 2000 Nasdaq rose over 500%, and by October 2002 had plunged 74% from its peak, giving up almost all of its gains. It was later estimated that between 2001 and early 2004, Silicon Valley alone lost 200,000 jobs. In the space of a decade, a group of people had gone from being young upstarts who "got it," to masters of the universe who were transforming the world, to completely redundant. Many have made the case that the dot-com era was doomed to failure simply because there were too many companies chasing what at the time were too few users.

There was an upside: All of the money that was poured into the tech companies during this time created an infrastructure and economic foundation that would allow the Internet to mature.

But that came at a cost. There was also a bubble in the telecoms industry that was called "the biggest and fastest rise and fall in business history" by The Economist. An example was Qwest. What became Qwest was founded in 1988 by Philip Anschutz, who owned the Southern Pacific Railroad at the time. He established a subsidiary called Southern Pacific Telecommunications Company and it perfected a way to lay fiber along railroad rights-of-way at the rate of eight miles per day. An unheard rate. It used a $1 million, 76-ton rail-mounted plow that laid the pipe next to the rail line at a depth of four to five feet. Qwest proceeded to create SONET OC-48 (2.5 Gbit/s) fiber rings around the country, all interconnected at numerous switching points along the ring. The first was close to Grass Valley, between Sacramento and Los Angeles.

An interesting anomaly has come back to bite companies like Qwest, and AT&T. In some situations and locales, the courts have ruled that the railroads generally do not own the land, they only have the right to operate trains on that land, not to lease the land for other uses. This has resulted in some large sums of money changing hands.

To fund the laying of two 78 strand fiber bundles per ring, Southern Pacific Telecommunications Company sold fiber strands in each bundle. The fiber network was 18,500 miles long. In 1995 the SP subsidiary was spun off and assumed the name of Qwest. It went public later that year. In 2000 it bought spun off baby bell U.S. West and re-branded it Qwest also. Qwest, like several other telcos thought the dot-com boom would continue and that all the fiber capacity would soon be in demand. It never happened and the majority of Qwest's fiber strands are still not in use.

The capacity was so great that the company ran a television ad in 1999 where a guy shows up at a seedy motel and inquires if the rooms have entertainment. The clerk replies "any movie ever made, any language, anytime." While true the qualifications were standard definition, and that the anytime meant that any desired movie would start every minute, not necessarily anytime.

The telecoms bubble and crash cost investors almost a trillion dollars. Another effect of a result of greed and excessive optimism, especially about the growth of data traffic fueled by the rise of the Internet. This would come to affect NVISION into the new century.

There was a downturn in the television industry as the dot-com run up was occurring. As we have mentioned already, over the air

digital TV was lighting up at this time. A good part of the broadcaster's budget was going to buy new transmitters, antennas, and towers. That was sucking up a major chunk of the broadcaster's technical budget during that time.

The other big obstacle that faced companies like NVISION was the web. Everyone, including broadcasters, from large ones to the few remaining "mom & pop" broadcasters, now had to have a website. Broadcast equipment vendors at the end of the century had customers saying they did not have money for new equipment outside of what was required to put their digital transmitter on the air, and at the same time to pay for website development. Between the two the outlay could be anywhere from $250K to north of two million.

While they were transmitting digital television, and were in the digital realm of the internet, nothing else had to be digital. Most broadcasters at the time simply kept their analog infrastructure and only converted it too digital where and when necessary. No new routers, switchers, or other infrastructure required. Another impediment was that for a while many thought that advertisers would move to websites and off TV, as the classifieds had moved from newspapers to Craigslist.

After venture capital was no longer readily available, the operational mentality of executives and investors completely changed. Supporting industries, such as advertising and shipping, scaled back their operations as demand for services fell.

There was one other initiative that was funneling money away from traditional equipment sales, and it was a cross between the Internet explosion and the increased connectivity from the telecoms. It came to be called "centralcasting." The concept was to centralize operations of stations in multiple markets in a central location. Many architectures or topologies were tried. These operations included centralizing master control, and traffic.

Traffic is the process of compiling all the commercials the station has sold, the programming it will be aired in, and generating a log, today it would be called a playlist, to orchestrate what was aired and when. Early on the log was used to select which video tapes or reals of film to load up, when to start playback of those, and then manually switch them to air. By the dot-com bust that log, still called a log at that point, was fed into an automation system, computers with various software which started tape, not so much film at that time, and controlled the switching of sources to air. Today it's a playlist that controls a video server that contains everything except what is done live, almost exclusively news in most local stations, or progams from the network.

Television traffic systems were literally an outgrowth of American Airlines original Sabre reservation system. Sabre's goal was to fill every possible seat for the highest price possible before the plane left the gate. The same principle was applied to television traffic. That is, sell every commercial spot, for the highest possible price before the time slot came and went. Thus, if you want to buy time on a local station at a precise time, say the opening segment of the local airing of Jeopardy, you will pay handsomely for it. So most who buy time on a station buy into a rotation. This means your spots will air at various times, some during prime time, and many in not so prime time, but you are guaranteed a certain number of airings in the better time slots. The traffic system is literally juggling where various spots are airing right up to the time the log, or playlist is generated. Back during this time, it was once a day and fed into the automation system. Today it can update the automation system throughout the day.

The increased Internet, or cloud bandwidth had station groups, that is companies that owned multiple stations, looking at centralizing master control and traffic functions, and stream out the various program streams to the various stations. Other station groups tried simple remote-control strategies. An early example was the stations owned by the New York Times. They literally used

PCAnywhere to control automation from a central site with rudimentary monitoring of each station.

Other stations, notably stations owned by Sinclair, went further than just master control and traffic. Often the positions eliminated from those two areas are often some of the lowest paid employees. So, Sinclair tried to centralize the news. Stories would be captured locally but then uploaded to a central production site. From there each local station's newscast would be put together and streamed back either live or even recorded ahead of time based on the various time zones the stations were in and how many newscasts the central facility could do at once.

This concept was much like voice tracking in radio, where a single DJ would record all the interstitial content, song intros, and other banter, ahead of time, for multiple stations. It's how Topeka could have a commanding Los Angeles 60s sounding DJ. These centralized talent and production crew experiments eventually mostly fell by the wayside.

In addition, video server and automation technology got to price points where it was cheap enough to leave the local content on local video servers. But the traffic systems have pretty much stayed central.

One final impediment was what came to be known as the Y2K problem. An article in 1993, interestingly near the start of the dot-com run up, by Peter de Jager was called "The information-age equivalent of the midnight ride of Paul Revere" by The New York Times. The problem many feared had to do with the cost of computer memory at the time, and as such to save memory space, often software, both the OS and applications, often truncated the date, eliminating the century part of the year, that is 1989, was stored as 89.

A couple of problems cropped up even before the year 2000 arrived. Applications that had to deal with years 2000 and on started displaying problems. Some programs that managed credit cards

with expiration dates past 1999 had problems. Most applications that had Y2K issues were fixed with software patches, as problems would only be encountered if dates were used in calculations.

Microsoft right before the 2000 New Year claimed the problem was over hyped. But like most industries broadcasters were concerned and that preoccupied some of their time, and capital. When the time arrived, only minor problems cropped up. Japan seemed to have more than their share of them. A few websites written in Java, reported the first day of the new century as 1 Jan 19100.

Besides the Y2K countdown NVISION, and the Group itself were in countdowns of their own.

All of this added up to a dearth of sales towards the tail end of the 90s. While NVISION was holding its own up until the last couple years of the century, and was actually growing in the mid-90s, all that had stopped, and NVISION was again burning through cash. Meadlock was now open to selling the company.

Sale to ADC

Right at the end of 1999, December 31st to be exact NVISION was sold to ADC for $19.7 million. The timing was for tax purposes. ADC had gone on a $373.1 million buying spree in 1999, acquiring 10 companies, NVISION included. ADC was chiefly known for patch panels and connectors focused on telecommunications. It had gotten into fiber in the 80s concentrating on video transmission.

In the 20 years leading up to the NVISION sale ADC had bought dozens of companies. It was trying to become a total provider of video services for the telecom industry. A lot of the funding was because of the explosive growth in DSL, and other high speed Internet connectivity to the home. That required a lot of equipment that ADC sold. But right before NVISION was bought that business was drying up due to the dot com bust.

Even though ADC's sales kept growing, its stock price took a sudden plunge in early 1998. The company reported a net loss of $13.2 million for the first quarter. The drop was attributed to a faltering performance in the company's broadband connectivity group. Although throughout the rest of that year the company continued to grow, and sales of $1.5 billion were achieved for the year. But early signs of fiber infrastructure over abundance were starting to show. The same restraint that was overtaking television equipment vendors, started doing the same in ADC's industry.

ABC at the time was in the process of accepting delivery of a NVISION router for KABC. ABC did not like ADC. NVISION did manage to sweet talk ABC into taking it.

Meadlock walked away with 12 million in cash. The others no longer had founder positions, just stock options from ADC. When the ADC stock augured into the ground soon after the sale Dayton saw $4 million in stock go down to $100,000 in about four weeks.

Jay Kuca went to work for NVISION right after the ADC purchase, having given up on the Group. He almost immediately saw the misdirection that ADC was inflicting. It bought NVISION because, as we will see on a larger scale in later articles, they were in an adjacent market to ADC's, but that did not mean they knew how that market worked.

From the start ADC did not know what to do with NVISION. They shut down NVISION's marketing and sales force and insisted on their own sales force selling into a market they knew nothing about. Bill Amos retired. Somewhat like the experience GVG had with Tektronix earlier. While television and telecom are both high tech, so is space flight, and the ADC sales force would not have fared well in that realm either. The company was in such a state of disarray with trying to integrate all the recent acquisitions that they built a 790,000 square-foot building in Minneapolis they never used.

While the strategic plan might have been to offer end to end solutions bridging the telecom, television, and broadcasting realms,

no one on the ground had any grasp of how to do that.

Soon the NVISION folks came to realize their existence was in trouble.

Within a year talks with what to do with NVISION's by their overlords, but the Groups also, started. Miranda Technologies was another vendor of video infrastructure products for the broadcast, audiovisual, videoconference, and video transport markets. The company was headquartered in Montreal. ADC approached Miranda about buying the company.

For about a year Miranda tried to buy NV from ADC. For NAB 2002 NVISION was a part of the Miranda Booth. Eventually ADC figured out that Miranda didn't have any money at the time and was just trying to get the company on the cheap. Unbelievably, ADC, not knowing what else to do with NVISION, just decided to shut it down. At the time NVISION had over 40 technology patents, and now it was facing extinction.

We will pick up the story in a later article.