Curriculum Vitae
John M. Strawn, Ph.D.
(contact information on last page)

Professional Profile

- Seasoned testifying expert witness with litigation experience (patent, copyright, trade secret, class action), skilled at explaining complex ideas to attorneys and juries.
- Several decades of involvement in software, digital audio, digital music, digital signal processing, and processor architecture.
- Successful independent software consultant in high-level languages and assembly language.
- Stanford Ph.D.
- Former Fulbright Scholar.
- Prolific author.
- Experienced manager with long-range research and development experience.
- Facile with foreign languages and working with people from outside the USA.

Professional Experience

S Systems, Inc. (1992-present; 1986-1988); *Owner and Full-time Consultant.*
- **Testifying Expert witness** in patent and copyright litigation relating to software and source code, digital devices, processor architecture, media, compression, signal processing and client/server interactions. See Expert Witness section, below.
- **Programming** hand-crafted audio and music software for signal processing, written in C, C++, JAVA, and especially assembly language for digital signal processing chips. Consulting on processor architecture and networking. See Consulting Assignments, below.

Yamaha Music Technologies USA; *1989-1991: President; 1987-1989: Vice President.*
- Helped establish, and managed, a nine-person Ph.D.-level research group, including site search, architectural design, construction, move-in, and hiring.
- Conducted original research on electronic musical instruments, software, user interfaces, micromachining, networking, and recent technological developments.
- Extensive experience designing scientific, engineering, and musical object-oriented applications, especially C++ (UNIX).
- Research on Yamaha's Vocaloid started in this group.
- Patent listed below.

Lucasfilm/Droid Works (1985-1986); *Programmer.*
- Full-time programming experience as an employee, designing signal-processing modules and writing (96-bit VLIW) microcode for the ASP/SoundDroid developed by James A. Moorer.
- Experience in audio and video post-production.
- Extensive work in C (Unix).
- Another six months full-time experience writing tightly packed assembly code for the TI

TMS32010 signal processor, especially for a two-channel hard-disk audio record playback unit that played without bugs on the exhibit floor of the National Association of Broadcasters convention, 1986.

Stanford University (1976-1985), *Doctoral Student.*

Nine years programming experience developing code in high-level languages (Algol, Fortran, SAIL) and PDP-10 assembly language for musical and audio signal processing applications during doctoral thesis work. My Ph.D. dissertation (*Modeling Musical Transitions*, 1985) involved original published research in spline fitting and pattern recognition, a 30,000-line two- and three-dimensional graphical editor for waveforms and spectra, implementation (with John Gordon) of the short-time Fourier transform, device drivers, and libraries for graphic user interfaces. Also part-time consulting work:

- SRI International (FORTRAN for mechanical engineering).
- Mattel Electronics (music in consumer electronic toys).
- IntelliGenetics (ALGOL-like code for biotechnology).
- Digital Keyboards (product specification and complete manuals for GDS and Synergy Synthesizers).

Revox (1972); *Summer intern*

Solder cables, write German- and Dutch-English translations, manufacture PC boards, assemble hardware.

Education and Training

When	Where	Degree
1985	Stanford University	Ph.D., CCRMA. Advisor: John Chowning. Graduate course work in music, computer and processor architecture, high-level and assembly-language programming, digital audio, digital signal processing, acoustics, psychoacoustics, and digital hardware. Dissertation on analysis of music instruments with the short-time Fourier transform. Software development experience listed elsewhere in this resume.
1975-1976	IBM Thomas Watson Foundation	Grant to study electronic music, Tokyo, Japan, 1976. Live performances on piano and Roland System 700 analog synthesizer. Also travel through Turkey, Iran, Afghanistan, Pakistan, India, Thailand, and Hong Kong.
1973-1975	Technical University, Berlin	Fulbright Scholar. Graduate-level coursework in music theory/history, audio engineering, electronics, information theory, cybernetics, Japanese; all coursework in German. Extensive recording studio and live concert sound reinforcement experience. PDP-11 and PDP-8 assembly and machine language. Travel throughout Europe.
1968-1973	Oberlin	B. Mus, double degree in organ performance and music theory. Programming in BASIC, FORTRAN, MUSIC V on an IBM 360 mainframe. Experience with analog synthesizers and digital music synthesis, Exchange semester, University of Hamburg, Germany, 1971, course work in German literature and psychology.

Expertise

- Seasoned testifying expert witness with litigation experience (patent, copyright, trade secret, class action), skilled at explaining complex ideas to attorneys and juries.
- Software analysis for litigation including patent, copyright, trade secret, software theft.
- Assembler, object-oriented, C, C++, HTML, XML, Java, Javascript, SQL.
- Implement/optimize signal processing algorithms: Fourier transform (FFT), discrete cosine transform (DCT), DTMF, speech synthesis.
- Port/optimize audio compression algorithms: AC-3, MP-3, AAC.
- Implement audio algorithms: reverberator, pitch shifter, sample rate converter, compressor, filter, flanger, 3-d audio (Dolby surround), dither.
- Implement music synthesis (additive, physical modeling, wavetable, FM).
- Create bug-free software from academic signal processing research.
- Work in floating- and fixed-point math.
- Extensive experience optimizing code in assembler
- PC, Mac, Unix.
- DSP processor architectures: Motorola 56000, 56300, and 56800 families; TI TMS320C10 and TMS320C54 family; Code Composer Studio; Analog Devices 21xx family and TigerSharc; VLIW; custom processors; I learn new processor architectures quickly.
- Embedded processors: Hitachi SH-DSP, SH3-DSP, SH-4, and SH-5; ARM7/ARM9; configurable processors (Tensilica).
- Processor architecture.
- Debugging hardware prototypes.
- Media networks, such as AES/EBU (IEC 60958), IEEE-1394/FireWire, AV/C, 61883, mLAN, and others.
- File downloading.
- Practical audio experience in live sound and in studios.
- Functionally bilingual in German; able to read French, Dutch; some Japanese

Expert Witness and Litigation Support Experience

Summary: 19 depositions to date, 3 times testimony at trial, 11 declarations filed in 18 Inter Partes Reviews (IPRs). Patent litigation, ITC investigations, Inter Partes Reviews, USPTO declarations, class action litigation, trade secret litigation, copyright litigation involving software. Expert reports, declarations, prior art research and analysis, infringement analysis (e.g., analyze devices, documents; source code analysis, source code comparison), claim charts, tutorials, Markman hearings. Technical areas include software and source code; computers, laptops, cell phones, mobile devices, handheld devices (e.g. medical); processor architecture; user interfaces; media: audio, music, speech, video; compression (e.g., MPEG, MP3); digital signal processing, mathematics, algorithms; file downloading, file streaming, client/server; protocols such as internet protocol (IP); video games. Links regarding specific cases are also available online (http://www.s-systems-inc.com/hi-tech-litigation-expert-witness/).

Testimony at Trial:

Microsoft v. Lucent.   Fish Richardson.
> **Two days testimony** at three-week jury trial, after **deposition** and **seven expert reports/declarations** on non-infringement, invalidity, inventor not included, defects in specification, and secondary considerations. Two patents related to audio compression and MP3 in Windows Media Player. Source code analysis (C, C++, assembler, machine code). Research. Analysis of German documents including dissertations. The Court ruled for Microsoft, finding non infringement on one patent and lack of standing on the other patent, as a matter of law, upheld on appeal. (CASD 3-02-cv-2060, CAFC 2007-1546, 2005 – 07).

Nice v. Witness.   Fish Richardson.
> Telephone call centers (telephony, hardware architecture, digital recording, functionality). **Expert reports** on invalidity and non-infringement, three patents. **Deposition, jury trial testimony.**   (DED 1-cv-311, 2007 – 08).

Motorola v. Apple.   Quinn Emanuel.
> Cell phone GPS. Analyze iPhone and Motorola Droid source code (C, C++, JAVA) and schematics. T**hree expert reports** and **two witness statements** relating to infringement, technical prong of domestic industry, and validity. **Deposition. Testimony at trial.** (ITC 337-TA-745, 2011).

Other Litigation Engagements:

Inter Partes Review for Amazon. Knobbe Martens.
> Patent US RE48,371, "Microphone Array System," owned by Vocalife. Invalidity **declaration** (159 pages) re 20 claims, covering 6 pieces of prior art and 8 grounds. (PTAB-IPR2021-01331, 2021 – present).

Harris Computer Corporation et al v. DSI Investments et al. English, Lucas, Priest & Owsley.
> Trade secret litigation regarding jail management software. Review source code (*e.g.,* javascript, visual basic, python), GitHub logs, user interfaces, database contents. **Expert Report**. **Supplemental Expert Report.** (WDKY 1:19-cv-00142, 2020 - present).

GREE v. Supercell. Kilpatrick Townsend & Stockton.
> For GREE, analyze source code (C++, Java) of SuperCell mobile games such as Brawl Stars, Clash of Clans, and Clash Royale to determine infringement of five GREE patents. Topics included user interfaces, game play, game character capabilities, graphics, and messages passed between mobile device and server. Jury verdict September 2020 found damages of $8.5 million, and willful infringement.   (EDTX 2-19-cv-00070 , 2-19-cv-00071, 2019-2020).

Inter Partes Reviews (two) for Spotify.   Sheppard Mullin.
> Two IPRs. Two patents owned by Excalibur related to fingerprinting audio, involving *e.g.* filtering, power measurements, time sequencing, database storage. First invalidity **declaration** re 19 challenged claims, 132 pages. (PTAB-IPR2020-00421, 2019-2020). Second invalidity **declaration** re 18 challenged claims, 159 pages (PTAB-IPR2020-00422, 2019-2020). Related district court case (DDE-1-19-cv-00165) settled 4 months after IPRs were filed, and IPRs were terminated before institution decision.

Dolby Laboratories Licensing Corp., et al. v. Adobe Inc. King & Spalding.
    Copyright claims regarding audio compression software (AC-3, E-AC-3). Analyze various
    source code collections, standards documents, copyright office filings for software, deposition
    testimony, technical documentation, object code libraries, and historical Windows
    applications. **Expert report, deposition.** (CAND-4-18-cv-01553, 2019 – 2020.)

Inter Partes Review for Panasonic.   Orrick.
    IPR. Patent owned by Cellspin Soft related to transferring photographs from a digital camera
    to a cell phone via Bluetooth, and from the cell phone over the Internet to an image publishing
    website. Invalidity **declaration** re 16 challenged claims, 119 pages; Reply **declaration**, 32
    pages. **Deposition.** All challenged claims determined to be unpatentable. (IPR2019-00131,
    2018 – 2020).

    Inter Partes Review for GoPro (Rimon Law) and Garmin (Erise IP).
    Declaration from Panasonic IPR above also submitted by GoPro and Garmin in separate
        PTAB-IPR2019-01108 (2019 – 2020).

JDS Technologies v. Avigilon.   Robins Kaplan.
    Analyze source code of both parties (Visual Basic, C++) regarding security camera patents.
    (MIED-2-15-cv-10385, 2018 – 19).

Inter Partes Reviews for Jaguar Land Rover.   Latham Watkins.
    IPR. Patent owned by Blitzsafe related to integrating a portable media device (e.g., cell phone,
    MP3 player) wirelessly (e.g., Bluetooth) with car multimedia system for playback and control.
    Invalidity **declaration** re 40 challenged claims, 140 pages. (IPR2018-00544). Second patent
    owned by Blitzsafe again related to car multimedia device integration. Research. Invalidity
    declaration re 32 challenged claims, 260 pages. (IPR2018-01203, 2017 – 19).

    Inter Partes Review for Daimler (Mercedes).   Quinn Emanuel.
    Declaration from first Jaguar IPR above also submitted by Daimler in separate IPR2018-
    01209 (2018 – 19).

MONKEYmedia v. Samsung. DLA Piper.
    Several patents relating to playback of interactive multimedia such as popup advertising or the
    movie editor's comments on Blu-Ray players, settop boxes, televisions, cell phones, laptops.
    Declaration and **deposition** for Markman. (TXED-2-17-cv-460, 2017 – 18).

Atlantic Recording Corp. v. Spinrilla. Lilenfeld PC.
    Analyze Ruby source code for hip hop music web site. Evaluate methods for identifying
    sound recordings. Engaged by defendants accused of copyright infringement. **Expert report,
    deposition.** (GAND 1-17-cv-431, 2017 – present).

Rogue Wave Software v. BTI Systems and Juniper Networks.   Katten Muchin Rosenman.
    Analyze Java source code involving graphic user interfaces and remote control of Internet
    hardware. Compare versions of source code. Reconstruct opposing party's source code from
    obfuscated deposit copy filed with US Copyright Office.   Engaged by defendants accused of
    copyright infringement. Two **expert reports**. (NYSD-1-16-cv-7772, 2017 – 19).

Two Inter Partes Reviews for <u>Samsung</u>.   Fish Richardson.
 Patent owned by Tivo related to real-time audio/video streaming, recording and playback, and
 DVR (set top box) architecture. Research. Two invalidity **declarations** re 2 challenged claims,
 each with separate prior art. (IPR2016-01524, 137 pages; IPR2016-01712, 112 pages).
 Related district court case (TXED-2-15-cv-1503) settled 2 months after 2nd IPR was filed, and
 IPRs were terminated before institution decision. (2016 – 17).

Artemetrx et al. v. <u>Archimedes et al</u>.   Coberly Law; Paine Bickers.
 Analyze SQL source code and databases involving pharmaceutical billing, engaged by
 defendants accused of misappropriation of trade secrets. (Davidson County Chancery Court,
 Nashville, TN, Case No. 16-0913-II, 2017).

Crest Audio v. <u>QSC Audio Products</u>.   Perkins Coie.
 Analysis relating to claim construction and non-infringement for two amplifier patents.
 (MSSD-3-12-cv-755, 2016 – 17).

Andrea v. Intervenor <u>Waves</u> (Israel) and Respondent <u>Dell</u>.   Denko, Coburn, Lauff.
 Patents related to noise reduction, adaptive filtering, and echo cancellation for speech in
 laptops. Source code analysis (C, C++). Compare versions of source code. **Expert report** on
 non-infringement, two patents. **Deposition**. (ITC 337-TA-949, 2015 – 16).

Blue Spike v. <u>Texas Instruments</u>, for lead defendant <u>Audible Magic</u>.   Orrick.
 Patents related to automatic recognition of video and audio based on signal processing and
 human perception. Source code analysis (C, C++, Visual Basic, SQL, XML). **Declaration**.
 Two expert reports, one on non-infringement (four patents), one comparing versions of
 source code. **Deposition**. (TXED 6-12-cv-499, 2014 – 16).

Inter Partes Review for <u>Verizon</u>.   Wiley Rein.
 Three patents owned by Solocron relating to cell phone ring tones. Research. Invalidity
 declaration re 17 asserted claims, 58 pages. (IPR2015-00349, 00350, 00364, 00376, 00380,
 00383, 00391). Related district court case (TXED-2-13-cv-1059) stayed four months after
 IPR filing, settled 1 month thereafter. IPRs terminated before institution. (2014 – 15).

Inter Partes Review for <u>Samsung.</u>   Greenberg Traurig.
 Patent owned by B. E Technology related to Internet targeted advertising, user interfaces, and
 client-server interactions. Research. Invalidity **declaration** (90 pages). **Deposition**. Two
 asserted claims determined to be unpatentable, upheld on appeal. (IPR2014-00044, CAFC-15-
 1888, 2013 – 16).

Adobe v. <u>Wowza</u>.   Kirkland & Ellis; Irwin IP; Fliesler Meyer.
 Five patents related to protocols for client/server real-time video and audio streaming. JAVA
 source code analysis. Analysis of media packets and headers down to the bit level, and
 client/server interactions. **Deposition** related to Markman. **Expert report** and **deposition** on
 noninfringement. (CAND 3-11-cv-2243, 2011 – 14).

THAT Corporation.   McDermott Will Emery
Application relating to audio in television. Prosecution had lasted 8 years. Three months after my **declaration** regarding non-obviousness was submitted, US 8,908,872 issued. (2013 – 14).

SmartPhone v. ZTE.   Novak Druce.
Three patents relating to Android cell phone user interface, Internet protocols, client/server operations. Source code analysis (C, JAVA, XML). Two **expert reports** for invalidity and non-infringement. **Deposition**. (EDTX 6:12-cv-350, 2013 – 14).

SmartPhone v. LG.   Morgan Lewis Bockius
Two patents relating to Android cell phone user interface, automatic call detection, client/server operations. Research. Review cell phone hardware and software architecture. **Expert report** for invalidity citing 14 pieces of prior art. **Deposition**. (EDTX 6:10-cv-74, 2012 – 13).

SmartSound v. Avid.   Quarles Brady.
Automated composition of sound tracks for video. Source code analysis, two patents (C++, XML) regarding infringement.   (WIWD 3-12-cv-223, 2011 – 12).

LSI v. Vizio. Jones Day.
Digital memory and MPEG audio. Invalidity and non-infringement analysis for four patents. Settled before Markman. (CACD 8:10-cv-1602, 2012).

Move v. Real Estate Alliance.   Alston Bird.
Real estate sales website. Source code analysis (JavaScript, HTML, XML, SQL). **Two expert reports** on infringement, two patents. **Deposition**. (CACD 2-07-cv-2185, 2008 – present).

HTC v. Apple.   Finnegan Henderson.
Cell phone user interface, memory, and caller ID. **Expert report** relating to technical prong of domestic industry for 24 HTC Windows Mobile cell phones. Supplemental **Expert Report**. Consulting expert relating to iPhone, iPad, and iPod touch concerning validity and power management. (ITC 337-TA-721, 2010 – 11).

Fair Isaac v. Actimize and NICE.   Robins, Kaplan..
Credit card scoring. Source code analysis for infringement (C++, Java, XML, scripting language). (DED 1-09-cv-688, 2010 – 11).

Affinity v. Alpine, JVC Kenwood, et al.   Orrick.
User interface and functionality of car audio, marine audio, and home theater products that connect to iPod/iPhone. **Expert report** on non-infringement, two patents. **Deposition**. (TXED 9-08-cv-171, 2010).

In re Apple & ATTM Antitrust Litigation   Wolf Haldenstein.
Analyze iPhone source code for plaintiffs. **Expert report** and various **declarations**, in particular regarding class certification. **Deposition**. (CAND 5:07-cv-5152, 2009).

TouchTunes v. <u>Rowe</u> et al. McAndrews Held Malloy.
　　Patent litigation involving compression, music jukeboxes, song selection. **Declaration**. (NYSD-1-07-cv-11450).

<u>Konami</u> v. Harmonix.　Paul Hastings.
　　Analyze Rock Band video game source code (Playstation 2, PS3, Wii, XBox). **Expert reports** on infringement and validity, three patents. **Two-day deposition**. (TXED 6-08-cv-286, 2008 – 10).

<u>SanDisk</u> v. LSI.　Jones Day.
　　Research. Attend tutorial and Markman hearing regarding MP3. (CAND 3:09-cv-2737, 2009 – 10).

<u>Samsung </u>v. Kodak.　Weil Gotshal.
　　Digital cameras in cell phones. Analyze Samsung cell phone source code (C, C++) for infringement relating to digital cameras. Study baseband chip documentation from Qualcomm, Philips, Agere, Texas Instruments; analyze register-level code for camera image sensors from Samsung, Sony, Micron, Omnivision; Windows Mobile 5 and 6 device drivers; Qualcomm BREW 2 and BREW 3 cell phone OS. Four patents involving Bayer subsampling, pixel interpolation; and standard digital optical concepts such as RGB, YUV, YCbCr, EXIF, and JPEG. (ITC 337-TA-671, 2009).

Voice Domain v. <u>Philips</u>.　Finnegan Henderson.
　　Declarations for Markman hearing on hand-held consumer devices, three patents. (OKWD 5-08-cv-701, 2009).

<u>THAT</u> Corporation.　McDermott Will & Emery
　　Declaration to USPTO involving non-obviousness for audio in television, regarding US Patent Application 09/638,245, BTSC Encoder. (2009)

Seer Systems v. <u>Yamaha</u>.　Morrison Foerster.
　　Analyze and provide **prior art** for music synthesis. (CAND 3-06-cv-7736, 2007).

DTL v. <u>Cingular Wireless</u>.　Mayer Brown.
　　Microphone in cell phones. Research, claim charts, invalidity. (TXED 2-06-cv-156, 2006 – 07).

<u>Health Science Products and Kairos</u> v. Sage.　Meyer & Associates, Columbus, Ohio.
　　For class action plaintiffs, analyze database software before and after release of ACT 2005. (GAND 1-2005-cv-3329, 2007).

<u>Digeo</u> v. Audible.　Black Lowe Graham.
　　Internet file downloading. **Source code analysis** (C, C++). Apple iPod, Creative MuVo MP3 player. Three **expert reports** regarding Markman, validity and infringement. **Deposition** for Markman hearing. (WAWD 2-05-cv-464, 2005 – 06).

MediaTek, ASUSTek & ASUS v. <u>Sanyo</u>.   Ropes Gray.
  Prepare invalidity claim charts on 24 hour notice. Assist in preparation of tutorial. (TXED 6-05-cv-323, 2006).

Information Technology Innovation v. <u>Motorola</u> et al..   Wilmer Hale.
  Provide and supervise an expert witness colleague who prepared an expert report on non-infringement. (ILND 04-C-7121, 2006).

Antor v. Apple, <u>Microsoft</u>, RealNetworks. Weil Gotshal.
  Provide and analyze **prior art** regarding file downloading. (TXED 2-03-cv320, 2004 – 05).

Trop, Pruner & Hu.
  Provide and analyze **prior art** involving signal processors. (2005).

<u>Intergraph</u> v. Dell et al.   Robins Kaplan.
  Provide and analyze **prior art** for hardware architecture, virtual memory and cache memory. (TXED 2-02-cv-312, 2003).

Lucent vs. <u>Young Chang/Kurzweil.</u> Cesari McKenna.
  Provide and analyze **prior art** for music synthesis, digital hardware, software, architecture. (MAD 1:97-cv-10310, 1997 – 98).

L.C. Concept v. <u>Digital Theater Systems (DTS).</u> Small, Larkin.
  Provide and analyze **prior art** for cinema sound equipment in USA and Germany. (1994).

Consulting Assignments

Summary: Software in high-level languages (e.g. C, C++, Java, Fortran), assembly language (digital signal processors, embedded processors, custom processors), and Matlab, for signal processing applications, often related to audio and music. Related projects such as processor design, mergers and acquisitions, feasibility studies, and standards work. Links regarding specific assignments are also available online (https://www.s-systems-inc.com/dsp-consulting/).

From:	2011	**Client: iZotope**
To:	2011	Boston
	Duties:	Port iZotope's pitch correction effect from C++ source code to Avid TDM environment in Motorola 56000 family assembly language.

From:	2009	**Client: Congruity**
To:	2009	Palo Alto
	Duties:	For this music industry startup, create audio effects in Motorola/Freescale DSPM56364 assembly language. Write and debug code without access to hardware, working only with software tools. Initial delivery of code ran bug-free in target hardware.

From:	2008	**Client: DTS Digital Cinema (now Datasat Digital Entertainment)**
To:	2008	Location: Agoura Hills, CA
	Duties:	For DTS Digital Cinema/DataSat's XD20 Media Player eight-track cinema

media player, port DTS Coherent Acoustics decode (two versions, one 8-channel, one stereo), DTS Digital Cinema 8-channel decode, and DTS Neo6 5.1 decode from DTS Digital Cinema's existing XD10 cinema media player. Responsible for approximately 25,000 lines of assembly-language source.

From:	2007	**Client: Berkeley Design Technology, Inc.**
To:	2008	Location: Oakland, CA
	Duties:	Contribute to research and writing of the following articles on processor architecture at BDTI's website Inside DSP (for links see http://www.s-systems-inc.com/dsp-consulting):

- TI Offers OMAP3 Application Processors to the Mass Market
- Avnera releases ASSPs for wireless audio applications
- XMOS Introduces Low-cost Multi-core Chip Family with Programmable I/O
- VeriSilicon's New Silicon IP Solution for HD Audio
- Behind the scenes: Dolby's acquisition of Coding Technologies
- Tips and Tricks for Debugging Audio

Other BDTI assignments are listed below.

From:	1995	**Client: Yamaha**
To:	2007	Location: Hamamatsu, Japan
	Duties:	Chair, AES standards working group SC-02-12 on digital audio networking via IEEE-1394 (Firewire), with the support of Yamaha. Involved a trip to AES conventions twice a year, including one in Europe. Past member, IEC TC100 TA4, Digital System Interfaces. Various public appearances worldwide and various company site visits to discuss multimedia networking, audio over 1394 and Yamaha's mLAN.

From:	2005	**Client: Sonic Network (now SoniVox)**
To:	2006	Location: Somerville, MA
	Duties:	For this well-known provider of wavetables, synthesis software, and cell phone ring tones (among others), provide and supervise subcontractors for these projects:

- Design and implementation of filters for sample rate conversion;
- Design and implementation of filters following the DLS-2 specification (used in cell phones for ring tones);
- Port synthesizer code to Tensilica HiFi2 audio engine.

From:	2005	**Client: Audio Research Labs**
To:	2005	Location: Scotch Plains, NJ
	Duties:	For ARL founder Schuyler Quackenbush provide and supervise a subcontractor to design and implement a digital filter algorithm in Motorola 56K assembly language.

From:	2004	**Client: Verance**
To:	2005	Location: San Diego, CA
	Duties:	Working closely with Verance R&D staff, implement the Verance Content Management System/Audio-Visual (VCMS/AV) watermarking technology for motion picture sound (now known as Cinavia) in Motorola 56300 assembler in the TC Electronics M6000 environment. In use in major film studios starting early 2005. Travel at client's request to TC Electronics headquarters in Denmark to facilitate integration. Provide and supervise a subcontractor to assist with filter design and implementation. More than 30,000+ lines of 56K assembler source code, several hundred pages of documentation, a dozen CD-ROMs of debugging data and lab notebooks.

From:	2004	**Client: Bias**
To:	2006	Location: Petaluma, CA
	Duties:	For this well-known provider of audio software, provide and supervise a subcontractor to port a complicated digital signal processing algorithm into the DigiDesign TDM Environment, in Motorola 56K assembly language.

From:	2002	**Client: Universal Audio**
To:	2004	Location: Santa Cruz, CA
	Duties:	For this well-known manufacturer of audio plugins, port two audio processing algorithms (Pultec filter, LN1176 stereo compressor) from C/C++ to Motorola 563xx assembler in the DigiDesign ProTools TDM environment, including numerical approximation and streamlining the original C/C++ implementation. Publicly released 2004. Contribute extensively also to port of an extremely complicated high-end reverberator, and to another equalizer.

From:	2003	**Client: Stretch**
To:	2004	Location: Mountain View, CA
	Duties:	For this software configurable processor startup, study how to port MPEG-2 AAC and MP-3 decode reference C++ code to 16- and 32-bit integerized C. Do the same for MP-3 encode based on publicly available source. Learn their software configurable architecture well enough to write optimizations.

From:	2003	**Client: Language Scientific (formerly RIC)**
To:	2003	Location: Cambridge, MA
	Duties:	For this major translation house, proofread German-English translations involving, among other things, audio compression (including German-language doctoral dissertations).

From:	2003	**Client: Analog Devices**
To:	2003	Location: Santa Clara, CA (Audio Rendering Technology Center)
	Duties:	Port music synthesis algorithms to ARM7TDMI assembler, following ARM's C calling conventions.

From:	2002	**Client: Dorrough Electronics**
To:	2003	Location: Chatsworth, CA
	Duties:	Implement in C and Analog Devices Sharc 21161 assembler a novel scheme based on their patented technology to improve the perceived loudness of audio signals sent over broadcast. Provide a subcontractor who made significant contributions to filter design.

From:	2002	**Client: Analog Devices**
To:	2002	Location: Wilmington, MA (Ray Stata Technology Center)
	Duties:	After an on-site visit to learn more about the technology and meet the team, I made recommendations on changes to architecture for a new version of an idiosyncratic signal processing chip. I also provided code examples for the new architecture.

From:	2001	**Client: Tensilica** (now part of Cadence)
To:	2002	Location: Santa Clara, CA
	Duties:	For this configurable processor IP core provider, implement a highly optimized version of the modified discrete cosine transform (MDCT) for audio compression. Extensive investigation of theory and variants of the MDCT. Also port MPEG-2 low-complexity AAC decode and MP3 encode from Thomson reference C++ code to 16-bit integerized C. Prepare various optimizations closer to the hardware than C++ usually allows.

From:	1999	**Client: Berkeley Design Technology, Inc.**
To:	2001	Location: Oakland, CA
	Duties:	- For BDTI's Buyer's Guide to DSP Processors, 2001 Edition, contribute major portions of the text analyzing processor architectures including the Analog Devices TigerSharc, and contribute also to the analyses of Motorola 56300, 56800, and 56800E processors; verification and in some cases re-writing assembly-language implementations of BDTI's benchmarks; - Prepare written analyses of Hitachi SH-DSP, SH3-DSP, SH-4, and SH-5 processor architectures. This again included verification and in some cases re-writing assembly-language implementations of BDTI's benchmarks; - Implement assembly-language routines related to multimedia compression in ARM7/ARM9 processor assembly language; - See also presentations, below.

From:	1995-6	**Client: Audio Precision**
And	1998-9	Location: Portland, Oregon
	Duties:	For their System 2 audio measurement device, developed double-precision FFT in assembler for Motorola 56002, including (Microsoft) C code to study where to maintain double-precision. Also, extensive code for AES/EBU and square wave measurement test suite, including jitter and eye pattern (assembling bit map for display in 56002 data memory space). 28K+ lines of assembler source. 1998-1999: Revise Audio

Precision System 2 code for new 96 kHz Cascade hardware (Motorola 56303).

From:	1997	**Client: Euphonics (later part of 3COM)**
To:	1999	Location: Boulder, CO
	Duties:	Implement Dolby AC-3 audio compression decoder in 16-bit integer assembler on new Analog Devices 16-bit integer AD1818 (PCI SoundComm). 20K+ lines of assembler source. Passed first round of Dolby testing on first try. Integrate with Euphonics' Real-Time Kernel.

From:	1996	**Client: Digital Technics (DTI)**
To:	1997	Location: Baltimore, MD.
	Duties:	Implementation of CCITT R2 encoder/decoder (similar to DTMF) in Motorola 56002 assembly language, based on Goertzel algorithm. 13K+ lines assembler. Deployed in the field in Asia and South America.

From:	1996	**Client: VM Labs**
To:	1996	Location: Los Altos, CA
	Duties:	For this multimedia chip startup, provide detailed critique of their proprietary DSP chip architecture.

From:	1993	**Client: Oculix**
To:	1995	Location: Switzerland
	Duties:	Motorola DSP 56000 assembler for numerical and FFT analysis of real-time data gathered by laser from the human eye. Based on NeXT Machine. 150K source.

From:	1993	**Client: Centigram Communications Corporation.**
To:	1994	Location: Silicon Valley CA (apparently now part of SS8 Networks)
	Duties:	Port TruVoice speech synthesis code from TI TMS320E17 assembly language to Motorola DSP 56002 assembly language on Motorola PC Media card; port to Analog Devices ADSP 2115 assembly language on Echo Personal Sound System.

From:	1993	**Client: Atari**
To:	1994	Location: Sunnyvale, CA
	Duties:	Implement physical modeling music synthesis techniques on custom RISC/DSP chip inside Jaguar game console. Recommend improvements to new custom DSP architecture.

From:	1993	**Client: Euphonics**
To:	1993	Location: Boulder, CO
	Duties:	For this software music synthesizer company, write C routines to emulate certain hardware elements in the target architecture. This allowed the company to study aspects of caching parameter updates, for optimizing real-time performance.

From:	1993	**Internal Project**
To:	1993	Location: Bay Area, CA
	Duties:	For a research project involving DSP architecture, write a series of Java classes to emulate the typical components of a DSP chip.

From:	1987	**Client: Shure**
To:	1988	Location: Evanston (now Niles), IL
	Duties:	Working from the written specification for a proprietary algorithm, develop C and TI TMS 32010 assembly language for a multi-channel consumer audio product prototype.

From:	1987	**Client: NeXT, Inc.**
To:	1988	Location: Silicon Valley, CA
	Duties:	Developed, debugged, and documented more than 50 routines in the Motorola DSP 56000 assembly language vector library (with Julius O. Smith; source code printout is 2" thick, available on my web site). Worked off-site for over a year before NeXT was publicly released, maintain secrecy about the fact that NeXT would include a separate signal processor chip.

From:	1986 or 1987	**Client: Sonic Solutions**
To:	1986 or 1987	Location: San Francisco CA
	Duties:	As one of the first consultants hired by Sonic Solutions (located in their first office in San Francisco), port their C-language noise-reduction code from one flavor of Unix to another.

Other experience:
● Studies of micromachining and nanotechnology.
● Experience with the Star Semiconductor SPROC chip, the IBM MWAVE chip and operating system, OS-9, and Spectron's SPOX operating system.

Patents

Patent Number	Date Issued	Title
5,569,871	October 29, 1996	Musical tone generating apparatus employing microresonator array (co-inventor; micromachining)

As Vice-President and President of Yamaha Music Technologies Inc., I supervised the work that lead to US 5,245,130, 5,288,938, 5,386,568, 5,422,956, 5,536,902, and 5,541,358. Links available online (http://www.s-systems-inc.com/resume/).

Teaching appointments

From:	2003	**University of Colorado at Denver, College of Arts & Media**
To:	2008	Denver, CO
	Position:	*Lecturer, College of Arts & Media*

Duties: Teach special topics course on audio data compression to upper-level undergraduate and graduate students.

Major Publications
(Links and PDFs available online, http://www.s-systems-inc.com/resume/)

- "Approximation and Syntactic Analysis of Amplitude and Frequency Functions for Digital Sound Synthesis." *Computer Music Journal* 4(3):3-22, 1980.
- *Modeling Musical Transitions.* Ph.D. Thesis, Stanford University, 1985. 243 pp.
- (with C. Roads). *Foundations of Computer Music.* MIT Press, 1985. 600 pp.
- *Digital Audio Engineering: An Anthology.* Madison, WI: A-R Editions, 1985. 144 pp.
- *Digital Audio Signal Processing: An Anthology.* Madison: A-R Editions, 1985. 283 pp.
- "Orchestral Instruments: Analysis of Performed Transitions." *Journal of the Audio Engineering Society* 34(11):867-80, 1986.
- "Editing Time-varying Spectra." *Journal of the Audio Engineering Society* 35(5):337-51, 1987.
- "Analysis and Synthesis of Musical Transitions Using the Discrete Short-time Fourier Transform." *Journal of the Audio Engineering Society* 35(1/2):3-14, 1987.
- "Implementing Table Lookup Oscillators for Music with the Motorola DSP56000 Family." Presented at the 85th Convention of the AES, 1988. Preprint No. 2716.
- "Digital Audio Representation and Processing." *Multimedia Systems*, edited by John F. Koegel. ACM and Addison-Wesley, 1993.
- "Technological Change: The challenge to the audio and music industries" (written version of AES keynote address). *Journal of the Audio Engineering Society,* March 1997.
- "AES White Paper: Networking Audio and Music using Internet2 and Next Generation Internet Capabilities." (with James Grunke, Ben Novak, Bruce Pennycook, Zack Settel, Phil Wiser, and Wieslaw Woszczyk). *Journal of the Audio Engineering Society* 47(4):300-310, April 1999. Presented (with Betsy Cohen and AES President Marina Bosi) to White House National Economic Council, December 1998.
- (with Yamaha's Mike Overlin). "Playing with Fire," *Electronic Musician*, May 2003, pp. 31-38 (on audio networking over 1394).

Presentations

- (with Perkins Coie partner Thomas Millikan). "What Happens in a Patent Lawsuit" (introduction to the stages of patent litigation). DesignCon 2018; Audio Engineering Society Convention 2016, 2017, 2018.
- Keynote Speaker, November 1996 Audio Engineering Society Convention.
- Four-hour presentation on audio compression, given first at Embedded Processor Forum, June, 2000; revised to include audio and music, presented at Microprocessor Forum, October 2000; revised with emphasis on streaming audio and presented at Embedded Processor Forum, June, 2001. (For client BDTI).
- Technical presentations and session chair at various conferences such as Audio Engineering Society, Acoustical Society of America, International Computer Music Conference, DSP World.
- Further presentations, slide, and handouts available online (www.s-systems-inc.com/resume)

Professional Associations and Achievements

- Fellow (1996) and Life Member, Audio Engineering Society (AES).
- Convention Co-chair, 2008 AES Convention, San Francisco.
- Convention Chair, 2006 AES Convention, San Francisco.
- Convention Chair, 2004 AES Convention, San Francisco. Recipient of an Anderton Award, Pro Sound News, December 2004, p. 30.
- Technical Papers co-chair, 2002 AES convention, Los Angeles.
- Technical Papers chair, 1992 AES Convention, San Francisco (first AES San Francisco Convention).
- Conference Chair, 1987 AES International Conference on Music and Digital Technology (Los Angeles).
- Elected member of the AES Board of Governors, 1992-1994; again 2005-2007.
- Chair, AES Convention Policy Committee, 2006-2008.
- Former member of review board, *Journal of the Audio Engineering Society.*
- Assistant Editor, *Computer Music Journal,* (MIT Press), 1978-1982.
- Co-founder (1980), International Computer Music Association.
- Founder and Series Editor (1984-1996), *The Computer Music and Digital Audio Series*.
- Honorary Member (1998-2019), The Midi Association, formerly Midi Manufacturers Association (MMA).
- Conference paper reviewer for many International Computer Music Conferences (ICMC).
- Member, Acoustical Society of America. Life Senior Member, IEEE.

Further qualifications

Functionally bilingual in German. Reading ability in French, Dutch. Some experience with Spanish, Italian, Japanese, Latin. Separate list of foreign language experience and sample translations available online (http://www.s-systems-inc.com/technical-translation). Extensive experience traveling abroad and communicating with foreigners.

Other activities

I currently enjoy spending time with my family, hiking, and weightlifting. In earlier years I have especially enjoyed travel, aikido, operating a Maerklin Z-gauge model railroad, performing a wide variety of folk and classical music, and attending musical events. Member of Toy Train Operating Society of America.

References

Full vita and references from industry, academia, and lawfirms available on request.

Contact Information

(My online resume, http://www.s-systems-inc.com/resume, has links relating to items listed here.)

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