Curriculum Vita — Chris Heegard

Personal Information

Born October 4, 1953 in Pasadena, CA.

Citizen of USA.

Google Voice: (541) 946-3325

Links: Twitter / Facebook / LinkedIn

Heegard Consulting

17179 La Brisa Ct., Sugarloaf, Florida 33042

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WWW: Chris Heegard's Biography

Rancho Alantro, LLC

79873 Sears Rd., Cottage Grove, OR, 97424

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E-mail: heegard@hznut.com

WWW: Rancho Alantro / Ranch Weddings / Hazelnuts

Education

9/78 - 6/81 Ph.D. in Electrical Engineering, Stanford University, Stanford, California.

6/75 - 6/76 M.S. in Electrical and Computer Engineering, University of Massachusetts, Amherst, Massachusetts.

9/71 - 6/75 B.S. in Electrical and Computer Engineering, University of Massachusetts, Amherst, Massachusetts.

Work Experience

6/01 - now Independent investor, technical consultant and expert witness, cattle rancher (Black Angus, Red Angus and Charolais), hazelnut producer and wedding host.

9/00 - 9/02 CTO, Home and Wireless Networking, Texas Instruments, Santa Rosa, California.

1/98 - 9/00 CEO and Principal Scientist, Alantro Communications, Inc. Santa Rosa California. Alantro Communications was a fabless semiconductor company specializing in physical-layer communications with a particular expertise in forward error correction (FEC). The technology is vital in: high-speed wireless local area networking (IEEE 802.11/WiFi), cable modems, digital-tv, digital subscriber line and satellite & terrestrial wireless.

1/89 - now Founder and chief scientist for Native Intelligence, a digital communications software company.

9/81 - 12/99 Faculty, School of Electrical Engineering, Cornell University. Taught courses in analog and digital communications, error-correcting coding, information theory, detection and estimation theory, introduction to digital systems and audio engineering laboratory: an introduction to audio signal processing. Research in the areas of: turbo coding, coded modulation and trellis group codes, algebraic coding theory and algorithms, applications of symbolic computation to coding theory, magnetic and optical data recording, sequence estimation algorithms, analog source coding and data compression, audio and video signal processing, and information theory. The senior advisor of 18 graduated Ph.D. students.

2/88 - 5/88 Visiting Associate, California Institute of Technology, Pasadena, California.

9/87 - 5/88 Visiting Scientist, IBM Almaden Research Center, San Jose, California.

9/78 - 6/81 Research Assistant under the supervision of Professors Thomas Cover and Abbas El Gamal. Research in a variety of topics in coding, information theory and statistics. Ph.D. thesis titled, *Capacity and Coding for Computer Memory with Defects*. This work answers questions concerning the capacity of defective computer memory and the description of algebraic error-correcting codes for combating defects.

9/76 - 9/78 Research and Development Engineer, Linkabit Corp., 3033 Science Park Rd., San Diego, California 92121. This work involved several development projects related to satellite communications. One major project was the computer simulation and hardware implementation of a packet satellite PSK modem. The major demodulation algorithms were performed via a bipolar microprocessor with a microprogram architecture. This modem connects the ARPANET to Europe and formed the basis of a commercial product for Linkabit. A second major area of my involvement was the development of several sequential decoders for convolutional codes.

6/75 - 6/76 Research Assistant under the supervision of Professor Jack K. Wolf. This research involved the investigation of a coding scheme for the Gaussian broadcast channel.

Consulting

2023 Law offices, *Fish & Richardson LLP*, Wilmington, DE. Patent infringement case: "TexasLDPC Inc. v. Broadcom Inc., LSI Corp., AVAGO Technologies U.S. Inc." Expert witness for TexasLDPC; ECC technology.

2017-2023 Law offices, *WilmerHale* (Wilmer Cutler Pickering Hale and Dorr LLP). Law offices, *Weil, Gotshal & Manges LLP*, Houston, TX. Patent infringement case: "Alacritech Inc. v. Dell Inc." Expert witness for Intel; Networking technology. Stayed 2017, reactivated 2022.

2020-2021 Law offices, *Winston & Strawn LLP*, Menlo Park, CA. ITC Patent infringement case: "Overhead Door Corporation and GMI Holdings Inc. v. The Chamberlain Group, Inc." Expert witness for CGI; Garage Door Wireless technology. Investigation No. 337–TA–1209. Tesified at trial. Resolved.

2020 Law offices, *Weil, Gotshal & Manges LLP*, Washington DC. Patent infringement case: "ParkerVision, Inc. v. Apple Inc. et al." Expert witness for Apple; Wireless transmission technology. Stayed.

2019-2020 Law offices, *ADSERO IP LLC*, Littleton, CO. Patent infringement case: "Red Rock Analytics, LLC v. Apple Inc." Expert witness for Apple; Wifi technology. Settled.

2019 Law offices, *McGuireWoods LLP*, Dallas TX. Patent infringement case: "Uniloc USA, Inc. and Uniloc Luxembourg S.A., v. Huawei Device USA, Inc. and Huawei Device Co., Ltd." Expert witness for Huawei; Cellphone technology. Settled.

2015-2019 Law offices, *Alston & Bird LLP*, East Palo Alto, CA, and, Law offices, *Bradley Arant Boult Cummings, LLP*, Birmingham, AL. Patent infringement case: "TQ Delta, LLC, v. ZyXEL Communications, Inc. and , ZyXEL Communications, Corp." Expert witness for ZyXEL; DSL technology. Settled.

2016-2018 Law offices, *Pillsbury Winthrop Shaw Pittman LLP*, San Diego, CA. and Law offices, *McGuireWoods LLP*, Richmond, VA. Patent infringement cases: "Cellular Communications Equipment LLC, v. Apple Inc., et. al." Expert witness for ZTE, HTC and Sprint; Cellphone technology. Settled.

2017 Law offices, *McGuireWoods LLP*, Richmond, VA. Patent infringement case: "Preferential Networks IP, LLC v. Sprint Spectrum L.P., Virgin Mobile USA, L.P., and Boost Mobile LLC" Expert witness for Sprint; Networking technology. Settled.

2015-2017 Law offices, *Baker & Hostetler LLP*, Cincinnati, OH. Patent infringement case: "LSI Corporation, Agere Systems, LLC and Avago Technologies General IP (Singapore) Pte. Ltd., v. Funai Electric Company, Ltd., Funai Corporation, Inc., Funai Service Corporation, And P&F USA, Inc.," Expert witness for Funai; WiFi technology. Settled.

2015-2016 Law offices, *Kenyon & Kenyon LLP*, New York, NY. Patent validity case: "Arris Group, INC. Petitioner v. C-Cation Technologies, LLC Patent Owner," Expert witness for C-Cation; Cable modem technology; IPR (USPTO). Concluded.

2015 Law offices, *Jones Day*, Dallas, TX. Patent infringement case: "Wi-Lan Inc. v. Kyrocera Communications, Inc.," Expert witness for Kyrocera; WiFi technology. Settled.

2014-2016 Law offices, *Kenyon & Kenyon LLP*, New York, NY. Patent infringement case: "C-Cation Technology, LLC. v. Time Warner et al.," Expert witness for C-Cation; Cable modem technology. Stayed.

2014 Law offices, *Quinn, Emanuel, Urquhart & Sullivan LLP*, Washington, DC. ITC Patent infringement case: "ViXS Systems Inc. v. DirecTV, LLC" Expert for DirecTV; Multimedia technology. Settled.

2013-2014 Law offices, *Fish & Richardson LLP*, Dallas, TX. and Law offices, *McDermott Will & Emery*, Boston, MA. Patent infringement case: "NXP B.V. v. Research In Motion (Blackberry), Ltd., et al.," Expert witness for Blackberry; WiFi technology. Tesified at trial.

2013 Law offices, *Kirkland & Ellis LLP*, Chicago, IL. Patent infringement case: "Zenith Electronics LLC, et al. v. ViewSonic Corp.," Expert for Viewsonic; HDTV technology.

2013 Law offices, *Kenyon & Kenyon LLP*, New York, NY. Patent infringement case: "C-Cation Technology, LLC. v. Comcast et al.," Expert witness for C-Cation; Cable modem technology. Settled.

2012-2013 Law offices, *Weil, Gotshal & Manges LLP*, Redwood Shores, CA. Licensing arbitration case: "Interdigital Technology, et al. v. Apple Inc.," Expert witness for Apple; Cellphone technology. Tesified at trial.

2012-2013 Law offices, *McDermott Will & Emery*, Washington, D.C. and *Finnegan, Henderson, Farabow, Garrett & Dunner LLP*, Washington, D.C. and *Quinn, Emanuel, Urquhart & Sullivan LLP*, New York, NY. Patent infringement case: "LSI Corp and Agere Systems Inc. v. Funai Electric Company, Ltd. et al." Expert witness for Funai, RealTek and MediaTek/RAlink; WiFi technology. Testified at trial.

2012-2013 Law offices, *Reed Smith LLP*, San Francisco, CA. Patent infringement case: "Ericson Inc. et al v. D-Link Corp. et al, Inc." Expert witness for the defense: Netgear, D-Link, Acer, Gateway, Toshiba; WiFi technology. Testified at trial.

2011-2013 Law offices, *Covington & Burling LLP*, San Francisco, CA and *Weil, Gotshal & Manges LLP*, Redwood Shores, CA. Patent infringement cases: "Motorola Mobility, Inc. v. Apple, Inc." and "Apple Inc. and NeXT Software, Inc. v. Motorola, Inc. and Motorola Mobility, Inc." Expert witness for the defense of Apple; WiFi and Cellphone technology.

2012 Law offices, *Akin Gump Strauss Hauer & Feld LLP*, Dallas, TX. Patent infringement case: "Hitachi Consumer Electronics Co. Ltd., et al. v. Top Victory Electronics (Taiwan) Co. Ltd., et al.," Witness (inventor) for Vizio (countersuit); Inventor on 5 patents, Cable DTV technology. Withdrawn.

2011-2012 Law offices, *WilmerHale*, Palo Alto, CA. Patent infringement cases: "Apple, Inc. v. Samsung Electronics Co." Expert witness for the defense of Apple; Cellphone technology.

2010-2012 Law offices, *Jones Day*, Washington, DC. ITC Patent infringement case: "Vizio, Inc., v. Coby Electronics Corp. et. al." Witness (inventor) for Vizio; Inventor on 5 patents, Cable DTV technology. Settled.

2010-2012 Law offices, *Robins, Kaplan, Miller & Ciresi, LLP*, Minneapolis, MN and *Irell & Manella LLP*, Century City, CA. Patent infringement case: "Tivo, Inc. v. Verizon Communications, Inc." Expert witness for the defense of Tivo; DTV and DVR technology.

2009-2011 Law offices, *Jones Day*, Washington, DC. Patent infringement cases: "Vizio, Inc., v. LG Electronics" and "Vizio, Inc., v. Funai Electric" Witness (inventor) for Vizio; Inventor on 6 of 7 patents, DTV technology. Settled.

2009 Law offices, *Hogan & Hartson L.L.P.*, New York, NY. Patent infringement cases: "Symbol Technologies, Inc. et al. v. Aruba Networks, Inc." and "Commil USA, LLC v. Cisco Systems, Inc. et al." Expert witness for Motorola; WiFi products.

2008 – 2009 Law offices, Law offices, *Quarles & Brady LLP*, Madison, WS and *Faegre & Benson LLP*, Minneapolis, MN. Patent infringement case: "Fujitsu, et al. v. Netgear". Expert witness for the defendant, Netgear; WiFi products. Resolved by summary judgement.

2009 Law offices, *Womble Carlyle Sandridge & Rice, PLLC*, Wilmington, DL. Patent infringement case: "Rembrandt Data Technologies, LP, v. AOL LLC, et. al.". Expert witness for the plaintiff, Rembrandt; dial-up modems.

2008 Law offices, *McDermott Will & Emery*, Washington, DC. Patent infringement case: "CIF Licensing, LLC, d/b/a GE Licensing v. Agere Systems Inc.". Expert witness for the plaintiff, GE; dial-up modems.

2007 - 2008 Law offices, *McDonnell, Boehnen, Hulbert & Berghoff LLP*, Chicago, IL. Patent infringement case: "Zenith Electronics Corporation v. Polaroid Corporation and Petters Group Worldwide LLC, et al,". Expert witness for the defendant, Polaroid; High Definition Television (HDTV).

2005 - 2009 Law offices, *Skadden, Arps, Slate, Meagher & Flom LLP*, Palo Alto, CA and *Keker & Van Nest LLP*, San Francisco, CA. Patent infringement case: "Intel Corporation and Dell, Inc. v. Commonwealth Scientific and Industrial Research Organisation". Expert witness for plaintiff, Intel; Wireless LAN (WiFi). Settled.

2004 - 2008 *WiQuest Communications Inc.*, Allen TX. Technical advisory board. Development of high performance UWB (ultra-wideband) transmission.

2005 *Keyeye Communications*, Sacramento CA. Advice on 10 Gbps Ethernet.

2003 - 2004 Law offices, *Weil, Gotshal & Manges LLP*, New York, NY. Patent infringement case: "Agere Systems, Inc. v. Broadcom Inc." Expert witness for the defendant, Broadcom; Trellis coding for cable TV.

1998 - 1999 Law offices, *Irell & Manella LLP*, Century City, CA. Patent infringement case: "Stanford Telecommunications, Inc. v. Broadcom Inc.". Expert witness for defendant, Broadcom; Digital Modulator for cable TV.

1997 *Aironet* – high speed wireless local area networks.

1997 *Xetron* – digital audio broadcasting on the AM band.

1997 *Aetherworks* – data modem, v.mach, development.

1996 - 1997 *Level One Communications* – data modem standards (HDSL2) development.

1996 *Next Level Communications* – data modem standards (VDSL) development.

1995 - 1996 *MarketWare Inc.* – A software FSK telephone demodulator.

1991 - 1996 *General Instrument* – The design and development of advanced, digital, cable TV transmission for "500" video channels and "cable modems". This worked led to the development of the ITU-T J.83-Annex B (J.83b) standard used in digital cable TV and for the downstream in *DOCSIS*.

1994 - 1995 Law offices, *Sughrue, Mion, Zinn, Macpeak & Seas*, Washington DC. Patent infringement case: "IBM vs Conners Peripheral, Inc.". Expert witness for the plaintiff, IBM; Reed-Solomon codes.

1994, 1996 Hybrid Networks Inc., Cupertino, California. The development of 4-VSB cable network modem.

1993 - 1994 Primary Access, San Diego, California. The development of trellis coded, DSP based telephone modem v.34.

1990 - 1991 General Instrument – VideoCipher Division, San Diego, California. The design and development of advanced, digital, HDTV transmission system for the FCC standards competition. Introduced the idea of concatenated coding for HDTV, combining trellis coding, interleaving and Reed-Solomon coding. This became part of US based ATSC HDTV standard.

1989 - 1991 Primary Access, San Diego, California. The development of trellis coded, DSP based telephone modems (v.32 & v.32bis).

1988 - 1991 Codenoll Technology, Yonkers, New York. The development and standardization of modulation and error-control for passive star, optical EtherNet based LANs.

1987 - 1990 Imprimis, Minneapolis, Minnesota. Modulation and coding for recording systems.

1982 - 1989 Eastman Kodak Co., Rochester, New York and Spin Physics division of Kodak in San Diego. The development of high density, digital magnetic recorders.

1984 - 1985 Anadrill - Schlumberger, Sugarland, Texas. Modem development.

1984 Digital Transmission Systems, Atlanta, Georgia. Sequential decoder for binary convolutional codes.

Patents

1. Method, apparatus and system for using guard tones in OFDM systems for increasing data rates and improving robustness, *No. 8,548,073* (with Nadeem Ahmed and Brian Joseph) (Also: EP2266245).

2. System, method, and computer-readable medium for multilevel shaping for wireless communication systems, *No. 8,396,142* (with Nadeem Syed Ahmed and Brian Joseph) (Also: EP2151077).

3. Methods and apparatus for self-inverting turbo code interleaving with high separation and dispersion, *No. 7,508,877*, *No. 7,505,526* and *No. 7,505,525* (with John T. Coffey).

4. Separate self-synchronizing packet-based scrambler having replay variation, *No. 7,227,949* (with Richard G. C. Williams).

5. Method of increasing data rate in a wireless data communication network via clock switching, *No. 7,184,412* .

6. Reliable decision directed adaptation in a communication system employing forward error control, *No. 7,113,556* (with Stanley K. Ling).

7. Methods and apparatus for self-inverting turbo code interleaving with high separation and dispersion, *No. 7,082,168* (with John T. Coffey).

8. Phase-locked loop initialization via curve-fitting, *No. 6,993,095* (with Peter A. Murphy).

9. Joint equalization and decoding using a search-based decoding algorithm, *No. 6,961,392* (with Matthew B. Shoemake).

10. Packet binary convolutional codes, *No. 6,823,488* (with Matthew B. Shoemake).

11. Decision-directed adaptation for coded modulation , *No. 6,782,046* (with Stanley K. Ling & Eric J. Rossin).

12. Fast search-based decoding scheme, *No. 6,701,483* (with Matthew B. Shoemake & Scott Petler).

13. Variable rate constellation precoding, *No. 6,532,267* .

14. Concatenated trellis coded modulation and linear block codes, *No. 6,160,854* (with David Rowe).

15. Concatenated trellis coded modulation and linear block codes, *No. 5,790,570* (with David Rowe).

16. Randomizer for byte-wise scrambling of data, *No. 5,745,522* .

17. Synchronization and error detection in a packetized data stream, *No. 5,703,887* (with Andrew J. King, Sydney Lovely & Thomas J. Kolze).

18. Rotationally invariant trellis coding incorporating transparent binary convolutional codes, *No. 5,621,761* .

19. Quadrature amplitude modulated data for standard bandwidth television channel, *No. 5,511,096* (with Zheng Huang).

20. Punctured convolutional encoder, *No. 5,511,082* (with Stephen K. How).

21. Method and apparatus for communicating digital information such as compressed video using trellis coded QAM, *No. 5,321,725* (with Woo Paik, Scott Lery, Edward Krause & Jerrold Heller).

22. Method and apparatus for communicating digital data using trellis coded QAM, *No. 5,233,629* (with Woo Paik & Scott Lery).

23. Collision detection using code rule violations of the Manchester code, *No. 5,162,791* .

Awards

- Texas Instruments Fellow, September 2000.
- NSF Research Grant, September 1998-2001.
- NSF Research Grant, September 1995–98.
- Appointed to the Editorial Board of Applied Algebra and Error Correcting Codes (Springer), 1995.
- Elected Fellow of the IEEE, January 1995 ("For development and analysis of families of efficient channel codes").
- MSI Research Grant, July 1993–94.
- NSF Research Grant, September 1992–95.
- NSF Research Grant, October 1989–92.
- AT&T Equipment Grant, October 1989–90.
- IBM Research Grant, January 1989–91.
- NSF Research Grant, February 1988–90.
- NSF Equipment Grant, August 1987–88.
- CDC Research Grant, July 1986–89.
- AT&T Research Grant, July 1986–89.
- IBM Faculty Development Award, June 1984–86.
- NSF Presidential Young Investigator Award, February 1984–89.
- NSF Research Initiation Grant, May 1982–4.
- Scholarship for NATO ASI, August 5-20, 1980, Norwich, England.

Courses

University Courses

Undergraduate–

- ENG150 - Freshman Seminar
- EE230 - Introduction to Digital Systems
- EE232 - Introduction to Digital Systems (lab)
- EE320 - Audio Engineering Laboratory: An Introduction to Audio Signal Processing
- EE467 - Communications Systems I
- EE468 - Communications Systems II

Graduate–

- EE561 - Error Control Coding
- EE562 - Information Theory
- EE564 - Detection and Estimation Theory
- EE567 - Topics in Digital Communications

Short Courses

- *The Theory and Practice of Turbo Error Control,* with Stephen Wicker, ICC, June 11, 1998.
- *Introduction to Digital Television,* Lead-off lecture, ISSCC, February, 1996.
- *Transmission of Multi-Media Information and Data,* with Andrew King, GI-ISC UCLA, August 2–4, 1995.
- *Digital Transmission for Multi-Media and the Information Superhighway,* with Professor Jerry Gibson, Texas A&M and Andrew King, GI-ISC UCLA, August 8–10, 1994.

Professional Service

- External Advisory Board, NSF Center for Science of Information, 2011-2012.
- Member of NSF review panel, STC, Dec 2009.
- Member of NSF review panel, CISE, Apr 2005.
- Member of NSF review panel, STC IPP, May 2004.
- Member of NSF review panel, CCR COV, June 2003.
- Member of NSF review panel, ITR, May 2003.
- Session organizer, "Coded Modulation", 1998 IEEE International Workshop on Information Theory, Killarney, Kerry, Ireland, June 22–26, 1998.
- Second Past President, 1996, First Past President, 1995, President, 1994, First Vice President, 1993, Second Vice President, 1992, IEEE Information Theory Society.
- Co-Chairman, 1994 IEEE International Symposium on Information Theory, June 27–July 1, 1994, Norway.
- Co-Chairman, 1993 IEEE-Information Theory Workshop on Coding,
- System Theory, and Symbolic Dynamics, October 18–20, 1993, Mansfield, Massachusetts.
- Organizer and Chairman, 1989 IEEE/CAM Information Theory Workshop, Cornell University, June 25–29, 1989.
- Re-elected to the Board of Governors, IEEE Information Theory Group, 1989–91.
- Program Committee, IEEE International Symposium on Information Theory, Ann Arbor, Michigan, October 1986.
- Elected to the Board of Governors, IEEE Information Theory Group, 1986–8.
- Co-chairman, Annual Cornell Summer Workshop on Systems, Control and Communications, 1985–8.
- Publicity Chairman, IEEE International Symposium on Information Theory, Brighton, England, July 1985.
- Secretary, IEEE Information Theory Group, 1984–5.
- Chairman, Ithaca Section of IEEE, 1983–84.

Thesis Supervised

1. Mehul Motani, *Information Theory and Coding for Spread Spectrum Communication Systems,* Ph.D., July 2000
2. Matthew Shoemake, *Turbo Codes: Bounds and Applications,* Ph.D., August 1999
3. Subramanyan Rao, *A Transform Approach to Cascaded Linear Block Codes,* Ph.D., August 1999
4. Kenneth Andrews, *Turbo Codes and Interleaver Design,* Ph.D., August 1999
5. Ivelisse Rubio, *0-Dimensional Ideals with Applications to Coding Theory,* Ph.D., January 1998
6. Matthew Shoemake, *Topics in Turbo Coding,* M.S., May 1997
7. David Rowe, *Punctured Convolutional Encoders,* Ph.D., January 1997
8. Subramanyan Rao, *Performance of Cascaded Reed-Solomon and Algebraic Geometry Codes in Concatenated Coding Systems,* M.S., May 1997
9. Eric J. Rossin, *The Design and Analysis of Trellis Group Codes,* Ph.D., August 1995
10. David Rowe, *Analyzing Trellis Codes for Geometrical Uniformity with a Focus on the V.34 Standard,* M.S., January 1995
11. Talal Shamoon, *High Fidelity Audio Compression Algorithms,* Ph.D., September 1994
12. Nagabhushana T. Sindhushayana, *Applications of Symbolic Dynamic Groups to Trellis Group Codes,* Ph.D., September 1994
13. Keith Saints, *Algebraic Methods for the Encoding and Decoding Problems for Multidimensional Cyclic Codes and Algebraic-Geometric Codes,* Ph.D., September 1994
14. Andrew Glenn Rudnick, *FIR Filter Banks with Rational Sampling Factors,* M.S., January 1993
15. Nagabhushana T. Sindhushayana, *Symbolic Dynamics, Automata Theory and the Theory of Coding: A Comparative Study and Applications,* M.S., January 1992
16. Mignon Belongie, *Runlength Codes Based on Variable Length Graphs,* Ph.D., January 1992

17. Rajeev Krishnamoorthy, *Algorithms for Capacity Computations and Algebraic Cascade Coding with Applications to Data Storage,* Ph.D., August 1991

18. Rajeev Krishnamoorthy, *Reliability and Yield: Error Control in Semiconductor RAMs,* M.S., August 1989

19. Panagiotis Gallopoulos, *The Power Spectrum of Constrained Binary Modulation Codes,* Ph.D., May 1989

20. Kenneth James Kerpez, *Maximum Entropy Probability Applied to Code Design and Characterization,* Ph.D., January 1989

21. Alexandra Dual-Hallen, *Detection Algorithms for Intersymbol Interference Channels,* Ph.D., August 1987

22. Thomas Edward Fuja, *On the Structure and Decoding of Cross Parity Check Codes for Magnetic Tape,* Ph.D., May 1987

23. Howard L. Dyckman, *Bounds on the Capacity of Channels with Memory with Application to Magnetic Recording,* Ph.D., May 1987

24. Kenneth James Kerpez, *The Rate-Distortion Function of a Binary Symmetric Source when Side Information May Be Absent,* M.S., June 1986

25. Ting-Ann Lee, *A New Class of Codes Designed for Partial Response Channels,* Ph.D., May 1986

Industrial Support

The following companies have provided research support: IBM, AT&T Information Systems, Control Data Corporation, Hewlett Packard, Sanders Associates and ARGO - Systems.

Societies and Organizations

IEEE, Eta Kappa Nu.

Computer Languages

Bash, Python, Perl, HTML/CSS, TeX, MatLab, C, Fortran.

Publications of Chris Heegard

Books

1. Chris Heegard, John (Seán) T. Coffey, Srikanth Gummadi, Peter A. Murphy, Ron Provencio, Eric J. Rossin, Sid Schrum, and Matthew B. Shoemake, "Evolution of 2.4 GHz Wireless LANs," Chapter 2 of "Wireless Local Area Networks - The New Wireless Revolution," B. Bing, Editor, John Wiley, 2002. [www]

2. Chris Heegard and Stephen Wicker, "Turbo Coding," ISBN: 0-7923-8378-8, Kluwer Academic Press, January 1999. [www]

Refereed Publications

1. Chris Heegard, John (Séan) T. Coffey, Srikanth Gummadi, Eric J. Rossin, Matthew B. Shoemake and Michael Wilhoyte "Combined Equalization and Decoding for IEEE 802.11b Devices," Vol. SAC–21, No. 2, *IEEE Selected Areas in Communications*, February 2003. [www]

2. Chris Heegard, John (Séan) T. Coffey, Srikanth Gummadi, Peter A.Murphy, Ron Provencio, Eric J. Rossin, Sid Schrum, and Matthew B. Shoemake, "High Performance Wireless Ethernet," *IEEE Communications Magazine*, November 2001. [www]

3. Chris Heegard and Andrew King, "FIR Parity Check Codes," *IEEE Transactions on Communications*, Vol. COM–48, No. 7, July 2000. [www]

4. Ian Blake, Thomas Høholdt, Victor Wei and Chris Heegard, "Algebraic Geometry Coding," (special issue celebrating the 50th anniversary of Information Theory), Vol. IT–44, No. 6,pp. 2596 - 2618 *IEEE Transactions on Information Theory*, October 1998. [www]

5. John H. Little, Keith Saints and Chris Heegard, "On the Structure of Hermitian Codes," *Journal of Pure and Applied Algebra.*, 1997. [www]

6. Chris Heegard, John H. Little and Keith Saints, "Systematic Encoding via Gröbner Bases for a Class of Algebraic Geometric Goppa Codes," Vol. IT–42, No. 6, *IEEE Transactions on Information Theory*, November 1995. [www]

7. Keith Saints and Chris Heegard, "Algebraic-Geometric Codes and Multidimensional Cyclic Codes: A Unified Theory and Algorithms for Decoding Using Gröbner Bases," Vol. IT–42, No. 6, *IEEE Transactions on Information Theory*, November 1995. [www]

8. Eric J. Rossin, Nagabhushana T. Sindhushay and Chris Heegard, "Trellis Group Codes for the Gaussian Channel," Vol. IT–41, No. 5, *IEEE Transactions on Information Theory*, September 1995. [www]

9. Chris Heegard, Scott A. Lery and Woo H. Paik, "Practical Coding for QAM Transmission of HDTV," *IEEE Journal on Selected Areas in Communications*, Vol. SAC–11, January 1993. [www] (Reprinted in *Digital Video: Concepts and Applications Across Industries*, Edited by Theodore S. Rzeszewski, IEEE Press, 1995.)

10. Chris Heegard and Lawrence Ozarow, "Bounding the Capacity of Saturation Recording: the Lorentz Model and Applications," *IEEE Journal on Selected Areas in Communications*, Vol. SAC–10, January 1992. [www]

11. Chris Heegard, Alexandra Duel-Hallen and Rajeev Krishnamoorthy, "On the Capacity of the Noisy Run-Length Channel," *IEEE Journal on Selected Areas in Communications*, Vol. SAC–10, January 1992. [www]

12. Kenneth Kerpez, Ayis Gallopoulos and Chris Heegard, "Maximum Entropy, Charge Constrained, Run-length Codes," *IEEE Transactions on Information Theory*, Vol. IT–37, May 1991. [www]

13. Chris Heegard, Brian Marcus and Paul Siegel, "Variable Length State Splitting with Applications to Average Run-length Constrained (ARC) Codes," *IEEE Transactions on Information Theory*, Vol. IT–37, May 1991. [www]

14. Thomas Fuja and Chris Heegard, "Focused Codes for Channels with Skewed Errors," *IEEE Transactions on Information Theory*, Vol. IT–36, No. 4, pp. 773-783, July 1990. [www]

15. Thomas Fuja, Chris Heegard and Mario Blaum, "Cross Parity Check Convolutional Codes," *IEEE Transactions on Information Theory* Vol. IT–35, No. 6, pp. 1264-1276, November 1989. [www]

16. Ayis Gallopoulos, Chris Heegard and Paul Siegel, "The Power Spectrum of Run-Length Limited Codes," *IEEE Transactions on Communications*, Vol. COM–37, No. 9, September 1989. [www]

17. Alexandra Duel-Hallen and Chris Heegard, "Delayed Decision-Feedback Sequence Estimation," *IEEE Transactions on Communications*, Vol. COM–37, No. 5, pp. 428-436, May 1989. [www]

18. Thomas Fuja, Chris Heegard and Rodney Goodman, "Linear Sum Codes for Random Access Memories," *IEEE Transactions on Computers*, Vol. C–37, No. 9, pp. 1030-1042, September 1988. [www]

19. A. Robert Calderbank, Chris Heegard and Ting-Ann Lee, "Binary Convolutional Codes with Application to Magnetic Recording," *IEEE Transactions on Information Theory*, Vol. IT–32, No. 6, pp. 797-815, November 1986. [www]

20. Tom Fuja and Chris Heegard, "Row/Column Replacement for the Control of Hard Defects in Semiconductor RAM's," *IEEE Transactions on Computers*, Vol. C–35, No. 11, pp. 996-1000, November 1986. [www]

21. Chris Heegard and Toby Berger, "Rate-Distortion When Side Information May Be Absent," *IEEE Transactions on Information Theory*, Vol. IT–30, No. 6, pp. 727–734, November 1985. [www]

22. Chris Heegard, "On the Capacity of Permanent Memory," *IEEE Transactions on Information Theory*, Vol. IT–30, No. 1, pp. 34–42, January 1985. [www]

23. Chris Heegard, "Partitioned Linear Block Codes for Computer Memory with "Stuck - at" Defects," *IEEE Transactions on Information Theory*, Vol. IT–29, No.6, pp. 831–842, November 1983. [www]

24. Chris Heegard and Abbas El Gamal, "On the Capacity Computer Memory with Defects," *IEEE Transactions on Information Theory*, Vol. IT–29, No. 5, pp. 731–739, September 1983. [www]

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1. Chris Heegard, "High Performance Wireless Local Area Networks (WLAN) in the ISM, 2.4GHz, Band," Wireless Symposium/Portable by Design, Chicago Il, September 26-29, 2000.

2. Mehul Motani and Chris Heegard, "Computing Weight Distributions of Convolutional Codes via Shift Register Synthesis," 13th AAECC Symposium On Applied Algebra, Algebraic Algorithms, and Error-Correcting Codes,Hawaii (USA), November 15-19, 1999.

3. Matthew Shoemake, Chris Heegard and Eric Rossin, "Turbo Codes for High Order Constellations," IEEE Information Theory Workshop, Killarney, Kerry, Ireland, June 22–26, 1998.

4. Chris Heegard, "Turbo Coding for Magnetic Recording," IEEE Information Theory Workshop, San Diego, CA, February 8 – 11, 1998.

5. David Rowe and Chris Heegard, "Balanced Concatenated Trellis Coded Modulation and Reed-Solomon Codes," 1996 Internation Symposium on Information Theory and it's Applications, Victoria, British Colombia, CANADA, September, 1996.

6. Nagabhushana T. Sindhushay and Chris Heegard, "A Source Coding Theorem for Stationary Sources Parsed with Trees," 1994 Conference on Information Sciences and Systems, Princeton University, March, 1994.

7. Talal Shamoon and Chris Heegard, "A Rapidly Adaptive Lossless Compression Algorithm for High Fidelity Audio Coding," 1994 DCC, Snowbird Utah, March, 1994.

8. Chris Heegard and Eric J. Rossin, "Trellis Codes, Symbolic Dynamics, and Isometries," *DIMACS Series in Discrete Mathematics and Theoretical Computer Science, Coding and Quantization*, Robert Calderbank, G. David Forney Jr., Nader Moayeri, Editors, Volume 14, 1993.

9. Keith Saints and Chris Heegard, "On Hyperbolic Cascaded Reed–Solomon Codes," Tenth International Symposium on Applied Algebra, Algebraic Algorithms, and Error Correcting Codes (AAECC-10), San Juan de Puerto Rico, May 10-14, 1993.

10. Eric Rossin, Mitchell D. Trott and Chris Heegard, "Geometrically Uniform, Rotationally Invariant 4-Dimensional Trellis Codes," 1993 Conference on Information Sciences and Systems, Johns Hopkins University, March, 1993.

11. Nagabhushana T. Sindhushay and Chris Heegard, "Finding the Minimal Graph for a Shift of Finite Type from a Forbidden Word List," 1993 Conference on Information Sciences and Systems, Johns Hopkins University, March, 1993.

12. Eric Rossin and Chris Heegard, "Rotationally Invariant Trellis Codes with a Linear Structure," 1992 Conference on Information Sciences and Systems, Princeton University, March, 1992.

13. Talal Shamoon and Chris Heegard, "High-Fidelity Audio Compression: Fractional-Octave Wavelets and Adaptive Quantization," 1992 International Conference on Acoustics, Speech and Signal Processing, San Francisco, California, March, 1992.

14. Mignon Belongie and Chris Heegard, "Pairwise Charge Constrained Run Length Codes," 1991 Conference on Information Sciences and Systems, Johns Hopkins University, March, 1991.

15. Alexandra Duel-Hallen and Chris Heegard, "Spectra of Cyclostationary Run-length Limited Codes," 1991 Conference on Information Sciences and Systems, Johns Hopkins University, March, 1991.

16. Rajeev Krishnamoorthy and Chris Heegard, "Structure and Decoding of Reed-Solomon Based Cascade Codes," 1991 Conference on Information Sciences and Systems, Johns Hopkins University, March, 1991.

17. Talal Shamoon and Chris Heegard, "Audio Compression via Wavelets and Multiresolution Filtering," 1991 Conference on Information Sciences and Systems, Johns Hopkins University, March, 1991.

18. Chris Heegard, "Trellis Codes for Recording," 1988 IEEE Military Communications Conference, San Diego, October 23–26, 1988.

19. Tom Fuja and Chris Heegard, "Asymptotic Bounds for Focused Error Control Codes," 26'th Annual Allerton Conference on Communication, Control and Computing, September 28–30, 1988.

20. Chris Heegard and Alexandra Duel-Hallen, "On the Capacity of the Noisy Run-Length Channel," 1988 IEEE International Workshop on Information Theory, Bejing China, July, 1988.

21. Tom Fuja and Chris Heegard, "Focused Error Control Codes," 1988 Conference on Information Sciences and Systems, Princeton University, March 16–18, 1988.

22. Chris Heegard, Rasmik Karabed and David Neuhoff, "Transmission of Sources over Noiseless Channels," 1988 Conference on Information Sciences and Systems, Princeton University, March 16–18, 1988.

23. Chris Heegard, "A Pair Of Information Theoretic Lemmas With Application To Run-Length Coding," 25'th Annual Allerton Conference on Communication, Control and Computing, September 30–October 2, 1987.

24. Chris Heegard and Mignon Belongie, "Combined Algebraic and Run-Length Limited Codes," 5th International Conference on Applied Algebra, Algebraic Algorithms and Error Correcting Codes, Menorca, SPAIN, June 15–19, 1987.

25. Alexandra Duel and Chris Heegard, "Signal Processing in Digital Recording: The Delayed Decision-Feedback Sequence Estimation Algorithm," SPIE Conference, San Diego, August 18–22, 1986.

26. Alexandra Duel and Chris Heegard, "Delayed Decision Feedback Sequence Estimation for QAM and Trellis Coded Systems," 1986 Conference on Information Sciences and Systems, Princeton University, March 19–21, 1986.

27. Chris Heegard, "Filtered Trellis Codes — A Study of Distance Properties of Magnetic Recording Codes," 2'cd IASTED International Conference — TELECON'85, Rio de Janeiro, Brazil, December 10–13, 1985.

28. Alexandra Duel and Chris Heegard, "Delayed Decision-Feedback Sequence Estimation," 23'rd Annual Allerton Conference on Communication, Control and Computing, October 2–4, 1985.

29. Thomas Fuja, Chris Heegard and Rodney Goodman, "The Structure and Complexity of Linear Sum Codes," 23'rd Annual Allerton Conference on Communication, Control and Computing, October 2–4, 1985.

30. Ting-Ann Lee and Chris Heegard, "An Inversion Technique for the Design of Binary Convolutional Codes for the $1 - D^N$ Channel," 1985 Conference on Information Sciences and Systems, Johns Hopkins University, March 27–29, 1985.

31. Chris Heegard and Ting-Ann Lee, "New Modulation Codes for Magnetic Recording," 22'cd Annual Allerton Conference on Communication, Control and Computing, October 3–5, 1984.

32. Chris Heegard, "An Efficient Encoder for Algebraic Optical Disk Codes," 1984 Conference on Information Sciences and Systems, Princeton University, March 14–16, 1984.

33. Chris Heegard, C. Richard Johnson and James P. Lyons, "Quantizer Effects in RML-Based ADPCM," Conference on Decision and Control, San Antonio, Texas, December 14–16 1983.

34. Chris Heegard and Toby Berger, "The Binary and Gaussian Rate-Distortion Functions for a Degraded Source Network," 21'st Annual Allerton Conference on Communication, Control and Computing, October 5–7, 1983.

35. Chris Heegard, "On the Capacity of Permanent Memory," 1983 Conference on Information Sciences and Systems, Johns Hopkins University, March 23–25, 1983.

36. C. Richard Johnson, Jim P. Lyons and Chris Heegard, "A New Parameter Estimation Structure Applicable to ADPCM," 1983 International Conference on Acoustics, Speech and Signal Processing, Boston, Massachusetts, April 14–16, 1983.

37. Chris Heegard, "Codes for Optical Data Storage," SPIE Topical Meeting on Optical Data Storage, Lake Tahoe Nevada, January 19–22, 1983.

Papers Presented

1. Mehul Motani, Venugopal V. Veeravalli and Chris Heegard, "On Capacity and Spreading in CDMA Systems," 2000 IEEE Information Theory Symposium, Sorrento, ITALY, June, 2000.

2. Mehul Motani, Venugopal Veeravalli and Chris Heegard, "On Multiple Access Spread Spectrum Systems," Second International Conference on Information, Communications & Signal Processing (ICICS'99), 7-10 December 1999, Hotel Mandarin, Singapore.

3. Kenneth Andrews,Chris Heegard and Dexter Kozen "Interleaver Design Methods for Turbo Coding," 1998 IEEE Information Theory Symposium, Cambridge, MA, August, 1998.

4. Mehul Motani and Chris Heegard, "The Viterbi Algorithm Meets the Key Equation," 1998 IEEE Information Theory Symposium, Cambridge, MA, August, 1998.

5. Matthew Shoemake and Chris Heegard, "A New Turbo Code for 8-PSK Modulation," 1998 IEEE Information Theory Symposium, Cambridge, MA, August, 1998.

6. Ivelisse Rubio, Moss Sweedler and Chris Heegard, "Gröbner Bases for 0-Dimensional Ideals with Applications to Coding Theory," Algebraic Geometry and Coding Theory-6, Marseilles, FRANCE, June, 1997.

7. Matthew Shoemake and Chris Heegard, "Computationally Efficient Turbo Decoding with the Bi-directional Viterbi," 1997 IEEE Information Theory Symposium, Ulm, GERMANY, June-July, 1997.

8. Ivelisse Rubio, Moss Sweedler and Chris Heegard, "Gröbner Bases for Linear Recursion Relations on m-D Arrays and Applications to Decoding," 1997 IEEE Information Theory Symposium, Ulm, GERMANY, June-July, 1997.

9. Chris Heegard, "Shaping, Coding and Channel Capacity for the Gaussian Channel," 1996 IEEE Information Theory Workshop, Haifa, ISRAEL, June, 1996.

10. Chris Heegard, "Cable Modem Technology: Hopes, Dreams and Reality," Workshop on Frontiers in Distributed Information Systems, Key West, Florida, April 28 – May 1, 1996.

11. Chris Heegard, "Constellation Shaping for the Gaussian Channel," 1995 IEEE Information Theory Symposium, Whistler, B.C., CANADA, September, 1995.

12. Eric Rossin, Chris Heegard and David Rowe, "Punctured, Rotationally Invariant Trellis Coding," 1995 IEEE Information Theory Symposium, Whistler, B.C., CANADA, September, 1995.

13. Chris Heegard, "Modulation and FEC for Digital TV Transmission," 1995 IEEE Information Theory Workshop, Rydzyna, POLAND, June, 1995.

14. Chris Heegard, "Digital TV," Workshop on Emerging Opportunities for Information Technology, Key West, Florida, April 30 – May 2, 1995.

15. Talal Shamoon and Chris Heegard, "Adaptive Update Algorithms for Fixed Dictionary Lossless Data Compressors," 1994 IEEE Information Theory Symposium, Trondheim, NORWAY, June 27 – July 1, 1994.

16. Nagabhushana T. Sindhushay and Chris Heegard "Symbolic Dynamic Techniques for Trellis Group Codes," 1994 IEEE Information Theory Symposium, Trondheim, NORWAY, June 27 – July 1, 1994.

17. Keith Saints, Ivelisse Rubio and Chris Heegard, "Decoding Algebraic-Geometric Codes Using Gröbner Bases," 1994 IEEE Information Theory Symposium, Trondheim, NORWAY, June 27 – July 1, 1994.

18. Eric J. Rossin and Chris Heegard "On the Symmetries and Structure of Trellis Codes," 1994 IEEE Information Theory Symposium, Trondheim, NORWAY, June 27 – July 1, 1994.

19. Chris Heegard, Eric J. Rossin and Nagabhushana T. Sindhushay, "Trellis Group Codes for the Gaussian Channel," 1993 IEEE Information Theory Workshop on Coding, System Theory and Symbolic Dynamics Mansfield, Massachusetts, October 18–20, 1993.

20. Nagabhushana T. Sindhushay and Chris Heegard "Symbolic Dynamics Groups and Generators," 1993 IEEE Information Theory Workshop, Mt. Fuji, Japan, June, 1993.

21. Keith Saints and Chris Heegard "Cascaded Reed-Solomon Codes and Gröbner Bases," 1993 IEEE Information Theory Workshop, Mt. Fuji, Japan, June, 1993.

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24. Keith Saints and Chris Heegard, "Algebraic Structure and Decoding of Two - Dimensional Cascade Codes," 1993 IEEE Information Theory Symposium, San Antonio Texas, January, 1993.

25. Mignon Belongie and Chris Heegard, "Runlength Limited Trellis Codes for Partial Response Channels," 1993 IEEE Information Theory Symposium, San Antonio Texas, January, 1993.

26. Chris Heegard, "Isometries of Trellis Codes via Symbolic Dynamics over Groups," MSRI Symbolic Dynamics Conference Program, Berkeley, November 2–6, 1992.

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28. Chris Heegard, Mignon Belongie, Nagabhushana Sindhushay, "Coding with Variable Length Graphs," 1992 IEEE Information Theory Workshop, Salvador, Brazil, June, 1992.

29. Mignon Belongie and Chris Heegard, "Variable Length Trellis Decoding," 1991 IEEE Information Theory Symposium, Budapest, Hungary, June, 1991.

30. Chris Heegard and Mignon Belongie, "Trellis Codes and Sequence Estimation for Recording Channels," 1990 IEEE Information Theory Workshop, Eigenhoven, Netherlands, June, 1990.

31. Mignon Belongie and Chris Heegard, "Performance of Trellis Coded Run-Length Codes," 1990 IEEE Information Theory Symposium, San Diego, California, January 14–19, 1990.

32. Rajeev Krishnamoorthy and Chris Heegard, "The Effect of Coding on the Reliability of Computer Memories," 1990 IEEE Information Theory Symposium, San Diego, California, January 14–19, 1990.

33. Kenneth Kerpez, Ayis Gallopoulos and Chris Heegard, "Maximum Entropy, Charge Constrained, Run-length Codes," 1990 IEEE Information Theory Symposium, San Diego, California, January 14–19, 1990.

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36. Chris Heegard and Rajeev Krishnamoorthy, "Limits on Coding for Computer Memory," Workshop on Information Theory, Mathematisches Forschungsinstitut Oberwolfach, Oberwolfach, Germany, May, 1989.

37. Chris Heegard and Mignon Belongie, "Trellis Constrained, Run-Length Codes," IEEE Communication Theory Workshop, Hawkes Kaye, Florida, April 10–12, 1989.

38. Chris Heegard, Brian Marcus and Paul Siegel, "Variable Length State Splitting with Applications to Average Run-length Constrained (ARC) Codes," IEEE International Symposium on Information Theory, Kobe, Japan, June, 1988.

39. Chris Heegard, "Trellis Coded Run-Length Codes," 1987 Workshop on Error - Correcting Codes, Almaden Research Center, IBM, San Jose CA., September 1987.

40. Chris Heegard, "Combined Trellis and Run-Length Coding," International Symposium on Information and Coding Theory, Campinas, SP, Brazil, July 27–29, 1987.

41. Chris Heegard, "Spectral Properties of Run-Length Limited and Charge Constrained Modulation Codes," IEEE Communication Theory Workshop, Howie-In-The-Hills, Florida, April 27–29, 1987.

42. Chris Heegard, "Properties of Constrained Modulation Codes," National Radio Science meeting, Boulder Colorado, January 12–15, 1987.

43. Thomas Fuja, Chris Heegard and Mario Blaum, "Cross Parity Check Convolutional Codes for Magnetic Tape," IEEE International Symposium on Information Theory, University of Michigan, Ann Arbor, October 6–9, 1986.

44. Chris Heegard, A. Robert Calderbank and Ting-Ann Lee, "Binary Convolutional Codes with Application to Magnetic Recording," IEEE International Symposium on Information Theory, University of Michigan, Ann Arbor, October 6–9, 1986.

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46. Chris Heegard, Paul Siegal and Panagiotis Gallopoulos, "On the Spectrum of (d, k) Codes," Workshop on Information Theory, Mathematisches Forschungsinstitut Oberwolfach, Oberwolfach, Germany, May 11–17, 1986.

47. Howard L. Dyckman and Chris Heegard, "On the Capacity of Gaussian Channels with Intersymbol Interference and a Cardinality Constraint on the Input," IEEE International Symposium on Information Theory, Brighton, England, June 23–28, 1985.

48. Thomas Fuja, Chris Heegard and Rodney Goodman, "Some Linear Sum Codes for Random Access Memories," IEEE International Symposium on Information Theory, Brighton, England, June 23–28, 1985.

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50. Ting-Ann Lee and Chris Heegard, "Binary Convolutional Codes for Partial Response Channels," Fourth Caribbean Conference on Combinatorics and Computing, Puerto Rico, April 1–5, 1985.

51. Chris Heegard and Thomas Fuja, "Redundancy in the Design of Semiconductor Memories," 1984 IEEE Information Theory Workshop, Caesarea Israel, July 2–6, 1984.

52. Chris Heegard and Toby Berger, "Rate-Distortion when Side Information May Be Absent," IEEE International Symposium on Information Theory, St. Jovite, Quebec, Canada, September 25–29, 1983.

53. Chris Heegard, "Algebraic Codes for Optical Data Disks," IEEE International Symposium on Information Theory, St. Jovite, Quebec, Canada, September 25–29, 1983.

54. Chris Heegard, "Linear Block Codes for Computer Memory with Defects," IEEE International Symposium on Information Theory, Les Arcs, France, June 1982.

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