

ROBERT C. HANNUM, PH.D.

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ACADEMIC DEGREES

Ph.D., Florida State University

M.S., Florida State University

B.S., University of Dayton (summa cum laude)

PRIMARY RESEARCH INTERESTS

Mathematics of Gambling & Casino Games

Applications of Mathematics in Gaming Law & Regulation

Casino Gaming Operations

PRIMARY TEACHING INTERESTS

Probability

Applied Statistics

Mathematics of Gambling & Commercial Gaming

PROFESSIONAL EMPLOYMENT

Full Professor, University of Denver, 2004-present

Associate Professor, University of Denver, 1986-2003

Visiting Assistant Professor, Temple University, 1985-1986

Assistant Professor, University of Denver, 1979-1985

Visiting Assistant Professor, Bucknell University, 1977-1979

ADMINISTRATIVE EXPERIENCE

Chair, Department of Statistics & Operations Technology, 1992-1996; 1987-1991

Acting Chair, Department of Statistics & Operations Technology, 2002

Director, Data Mining Program, University of Denver, 2004

PROFESSIONAL AFFILIATIONS

American Statistical Association

American Mathematical Society

Decision Sciences Institute

International Masters of Gaming Law

Society for Empirical Legal Studies

CURRICULUM DEVELOPMENT AND TEACHING INNOVATION

Programs and Initiatives

- *Master of Science (and affiliated programs) in Data Mining*: Sole responsibility for development and implementation of new cross-disciplinary Master of Science, M.B.A. concentration, and Professional Business Certificate data mining programs, including SAS industry certification. Personally created and designed several new courses in data mining and statistical modeling.
- *Statistical Computing Technology*: Led the integration of modern statistical software and knowledge discovery technology into the business curriculum.
- *Laptops in the Classroom*: Coordinated integration of laptop technology in the classroom for core statistics courses.

New and Innovative Courses Developed

- *Probability Theory. The Mathematics of Gambling*: A course on the theory and applications of probability with an emphasis on casino gambling.
- *Risky Business: Introduction to Gambling & Commercial Gaming*: A unique travel course to Las Vegas, where students learn about the theory of gambling and the business of casino gaming. Publicity has included feature articles in the Denver Post and the Las Vegas Sun, and pieces in more than twenty campus newspapers nationwide. Taken by more than 500 students.
- *Casino Operations*: A special topics offering on the many facets of casino operations.
- *Economic and Social Impacts of Gaming in Colorado*: A special topics course combining on-campus lectures and off-campus research work in Colorado mountain towns.
- *Gaming Law*. Developed and taught at the request of the D.U. Law School. Held in Las Vegas, with half-dozen world-class experts in gaming law, regulation, and operations addressing the class of 68 students.
- *The Art & Science of Poker*: Developed and delivered this course in 2004 covering the concepts, mathematics, theory, and culture of poker.
- *Statistics and the Law*: Special topics offering on the interface of statistics and the law.
- *Data Mining I*: This course focuses on the concepts and basic techniques of data mining, the process of discovering useful knowledge by exploring and modeling relationships in very large data sets.
- *Data Mining II*: A continuation of Data Mining I with a focus on predictive modeling.
- *Statistical Computing*: The use of modern statistical software and programming with SAS for data analysis and modeling.
- *Applied Statistical Modeling*: Categorical data analysis and generalized linear models with implementation of models using SAS and/or other statistical software.
- *Chance Honors Seminar*: A university honors seminar on risk, probability, and uncertainty.
- *MBA Online Pre-course*: Wrote and developed the statistics pre-course used for several years as required course material for University of Denver MBA students.

GRANTS, AWARDS, AND OTHER RECOGNITION

Grants

Center for Teaching & Learning

- Integrating Modern Software Technology into the Core Curriculum, 2005 (with T. Dalton).
- Incorporating Knowledge Technology into the Curriculum, 2003 (with T. Dalton).
- Software Technology, 2003 (with T. Dalton).
- Integrating Laptop Technology into the Classroom, 2000 (with T. Obremski).

College Research Grants

- Advantage Play & Commercial Casinos (2004)
- Statistical Comparison of Casino Comp Policies for Premium Players (2003)
- Statistical Issues in Gaming Regulation (2001)
- Casino Gaming in the Caribbean: Policies & Economic Impacts (2001)
- Business Research Grant (1994)
- Business Research Grant (1990)

University Internationalization Grants

- Internationalization of Gaming Curriculum & Research (2003)
- Mathematics & International Economic Impact of Gaming (2002)
- International Casino Gaming: Operations, Policies, and Impacts (2001)

Awards, Honors, Notables

- Mathematician in Residence – *MGM Grand*, Las Vegas (Nov. 26 – Dec. 24, 2007)
- Merit Awards for Research & Publication – 2005, 2004, 2003, 2002.
- Merit Awards for Teaching – 2004, 2003, 2002, 2001, 2000.
- Invited member, *International Masters of Gaming Law*, 2004 – present.
- Expert faculty list, *Gaming Studies Research Center*, UNLV, 2004 – present.
- Disability Awareness Award Recognition, 2001.
- Best paper award – cases, workshops and special sessions, *WDSI Annual Meetings*, 2002.
- Cecil Puckett Award, Outstanding Teacher, College of Business, 1988.

Press

- Source for expert analysis and opinion on various aspects of gambling mathematics and casino games. Recent quotes and background source have included articles in:
 - New Scientist – Skill in poker (Mar. 2009)
 - Pittsburg Post Gazette – Skill in poker (Feb. 2009)
 - Denver Post – Skill in poker (Feb. 2009)
 - The Economist – Skill in poker (Feb. 2009)
 - The Coloradoan – Skill in poker (Jan. 2009)
 - Newsweek – The elderly & gambling (Nov. 2008)
 - PressBox Sports Magazine – Slot machine legislation in Maryland (Nov. 2008)
 - USA Today – Slot Machines & Proliferation of Slots in U.S. (Jan. 2008)
 - Las Vegas Review-Journal – Poker/royal flush probabilities (Aug. 2007)
 - Philadelphia Inquirer – Slot machines (2007)

- U.S. News & World Report – Casino gambling & gaming industry (2005)
- Investors Business Daily – Mathematics of casino gambling (2005)
- Chicago Tribune – Casino gambling, house advantage, table games (2005)
- South Florida Sun Sentinel – Casino gambling & gaming industry (2005)
- San Diego Union-Tribune – multi-state lotteries (2005)
- Deseret News – Casino gambling, house edge, Internet gambling, etc. (2005)
- British Broadcasting Corporation – Blackjack & advantage play (2004)
- Pittsburgh Tribune – Passing of slot legislation in Pennsylvania (2004)
- Pittsburgh Post Gazette – Proposed slots in Pennsylvania (2004)
- Miami Herald – Indian gaming (2004)
- Philadelphia Inquirer – slot machine odds (2004)
- Sacramento Bee – Casino math, Indian casinos reporting hold percentages (2004)
- CBS Television Interview, WIVB Buffalo – Casino gambling (2003)
- CBS Market Watch – *Practical Casino Math* book (2003)
- Baltimore Sun – Proposed slots legislation in Maryland (2003)
- Canadian Broadcasting Corporation – Video lottery terminals (2002)
- National Public Radio – On the popular book “Bringing Down the House.” (2002)
- Other media relations & publicity:
 - CBS News Denver – Mathematics of gambling
 - ABC News Denver – *Mathematics of Gambling* class filmed & aired
 - CBS News Los Angeles – Special segment featuring the book *Practical Casino Math*
 - CBS National Radio – Powerball
 - Men’s Health Magazine – Gambling & casino gaming
 - Denver Post – Feature article on *Risky Business* course
 - Las Vegas Sun – Feature article on *Risky Business* course
 - Feature articles on *Risky Business* course in more than forty campus newspapers

SELECTED PROFESSIONAL SERVICE, NATIONAL AND REGIONAL

- Referee, Article 1, *Optimal Play: Mathematical Studies of Gambling* (2007).
- Referee, Article 2, *Optimal Play: Mathematical Studies of Gambling* (2007).
- Contributor – SAS Global Academic Initiative Newsletter (2004).
- Session Chair, *International Academy of Business & Economics Conference* (2003).
- Session Chair, *International Business & Economic Research Conference* (2002).
- Session Chair, *International Conference on Gambling & Risk-Taking* (2000).
- Session Chair, *International Conference on Gambling & Risk-Taking*. (1997).
- Chair, Workshop on Decision Sciences and the Law, *DSI Annual Meetings* (1993).
- Chair, Workshop on Decision Sciences and the Law, *DSI Annual Meetings* (1992).
- Invited session chair, *Institute of Mathematical Statistics National Meetings* (1981).
- Ad hoc Referee: *J.A.S.A.*; *Decision Sciences*; *Comm. Statistics*; *Review of Policy Research*.
- Numerous textbook reviews.
- Contributing author, Source Book for College Admissions Tests, Colorado Dept. Education.
- GMAT, GRE, SAT/ACT courses, Continuing Education Program.

SELECTED PROFESSIONAL SERVICE, COLLEGE AND UNIVERSITY

Recent

- Appointment, Promotion, & Tenure Committee, DCB (2004-2010).
- Learning Enhancement Committee (2006-2009).

Previous

Statistics Department Search Committee (2006-2007); Department Chair Search Committee (2005-2006); College Undergraduate Core Design Committee (2003-2004); College Curriculum Committee (2002-2004); Scholarship of Discovery Committee (2000-2003); Acting Department Chair (2002); Department Chair (8 years); Faculty Senate, Faculty Research Committee; Faculty Development Committee; Daniels Undergraduate Programs Committee; College Appeals Committee; Case Center Mentor; Freshman Mentor Program; Graduate Student Advisor; MBA Foundations Course Committee; MBA Analytical Skills Course Design Committee; MBA Values Course Committee; MBA Design Committee; Graduate Business School Admissions Committee; Committee on Instruction & Teaching Evaluation; Faculty Advisory Committee to Dean; Faculty/Alumni Advisory Committee for Executive MBA Program; Honors Committee.

CONSULTING AND RELATED WORK

Consulting has been primarily in the areas of casino gaming, the mathematics of gambling, game analysis, statistical modeling, regression, and sampling design and analysis.

- Selected Consulting Work:
 - Connecticut Department of Revenue (expert witness testimony)
 - Wisconsin Department of Revenue (expert witness testimony)
 - Poker Players Alliance (expert witness testimony)
 - International Game Technology (retained as expert)
 - Casinos Austria Research & Development (retained as expert)
 - MGM Grand, Las Vegas (Mathematician in Residence, Dec. 2007)
 - Gaming VC (Casino Club), Germany
 - International Tournament Poker League
 - Last Resort Consulting
 - Ameristar Casino, Mississippi
 - ShuffleMaster
 - Cut N' Shuffle
 - ProShuffle
 - Talisman Group (EZ Baccarat)
 - Terra Payments (FirePay)
 - Pari-Mutuel Poker & Billiards
 - Cyberview Technology
 - Spin & Win
 - MindPlay
 - Mirage, Las Vegas (pro bono)
 - Bellagio, Las Vegas (pro bono)
 - Iowa Racing & Gaming Commission (pro bono)
 - Casino Lugano, Switzerland (pro bono)

- Loyal Commerce Systems, Board of Advisors (pro bono)
- Data Mining Services
- Comcast Communications
- AT&T
- Ford Motor Company
- Credco
- D'Appolonia Engineers

Expert Witness

Expert Witness Testimony

- *South Carolina v. Chimento et al* (2009)
 - Defendant charged with illegal gambling; expert witness testimony centered on the roles of skill and chance in poker and whether poker is a game of skill.
 - Testified on behalf of Defendants Chimento et al.
- *Colorado v. Raley* (2009)
 - Defendant charged with illegal gambling; expert witness testimony centered on the roles of skill and chance in poker and whether poker is a game of skill.
 - Testified on behalf of Defendant Raley.
- *Peter B. Stone v. Commissioner of Revenue Services, State of Connecticut* (2006)
 - Whether or not: (1) the plaintiff is a professional gambler in the trade or business of gambling; (2) the Department of Revenue Services' income tax is discriminatory as applied to Plaintiff and other individuals categorized by the Commissioner as non professional gamblers; (3) the State impermissibly discriminates against individuals based upon the type of gambling activity engaged in; and (4) the State selectively enforces income reporting requirements against those winning larger sums of money in gambling activities. Expert witness testimony centered on the mathematics of casino games, expectation, and profit objective.
 - Testified on behalf of the Connecticut Commission of Revenue Services.
- *Thomas Calaway v. Wisconsin Department of Revenue* (2005)
 - Whether or not the petitioner was engaged in a trade or business in playing slot machines in Las Vegas and Atlantic City. Expert witness testimony centered on the mathematics of casino games, expectation, and profit objective.
 - Testified on behalf of the Wisconsin Department of Revenue.

Retained as Expert

- *Commonwealth of Kentucky v. 141 Internet Domain Names* (2008)
 - Commonwealth of Kentucky filed to seize and compel forfeiture of 141 Internet gambling site domain names; the roles of skill and chance in poker and whether poker is a game of skill.
 - Retained by PPA (Amicus Curiae, Defense).
- *Aristocrat v. IGT* (2006-2007)
 - Patent case; mathematical & statistical issues surrounding gaming devices.
 - Retained by IGT representatives.

- *ShuffleMaster v. MindPlay* (2005)
 - Patent case; statistical issues surrounding gaming devices.
 - Retained by MindPlay (Bally) representatives.
- *Casinos Austria Research & Development (CARD) v. ShuffleMaster* (2004)
 - Patent case; statistical (randomness) issues surrounding gaming devices.
 - Retained by CARD representatives.

VOLUNTEER WORK & COMMUNITY SERVICE

- Pro Bono Work: Statistical analysis of \$40,000 MGM Grand Casino War loss (2008)
- Pro Bono Work: Probability analysis and odds for Dragon Seven insurance bet in EZ Baccarat, Talisman (2008)
- Pro Bono Work: Casino Metrics – Win% vs Hold %, Banc of America Securities (2008)
- Pro Bono Work: Editing and fact checking on new casino business book (2007)
- Advisory Board Member: *Loyal Commerce, Inc.* (2006-2008)
- Guest lecture BSBA 1010 classes (2007, 2004, 2002)
- Guest lecture CORE 2639 class (2009, 2008, 2007)
- Guest speaker, Discover Daniels Weekend (2007)
- Marsico University Lecture (2004)
- Guest speaker, DU Residence Hall (2004)
- Guest speaker, UNLV School of Law (2003)
- Guest speaker, UNLV School of Law (2002)
- Guest speaker, various other college classes
- Workshops on mathematics and probability, Cherry Creek School District
- Youth soccer association coach
- Youth baseball coach
- Youth basketball coach
- Community swim team judge

SELECTED PRESENTATIONS

- “Gaming Mathematics,” *Johns Hopkins University Conference for Educators*, Las Vegas, NV, January, 2009.
- “Poker and the Law,” *Gaming Law Symposium*, Drake Law School, September 2008.
- “Table Games and Profitability: Money, Math, & Myths,” *Gaming Operations Summit*, Las Vegas, NV, April 2007.
- “Knowing When to Hold ‘Em & When to Fold ‘Em: The Mathematics of Poker,” *NSF Program on Games of Chance*, University of Utah, July 2005.
- “A Graduate Data Mining Program Using SAS,” *SAS Data Mining Conference*, Cary, NC, June 2005.
- “Teaching Data Mining Using SAS Enterprise Miner,” *SAS Data Mining Conference*, Cary, NC, July 2004.
- “Developing a Data Mining Program at the University of Denver,” *SAS Data Mining Conference*, Loma Linda, CA, June 2004.

- “A Mathematical Analysis of Casino Dead Chip Programs,” *International Academy of Business & Economics Conference*, October 2003.
- “Mathematics & Gaming Regulation,” *University of Nevada School of Law*, October 2003.
- “Statistical Standards in Gaming Regulation: Fact & Fiction,” *International Masters of Gaming Law Symposium*, September 2003.
- “Effective House Advantage and Dead Chip Programs,” *International Conference on Gambling & Risk Taking*, May 2003.
- “Flaws & Fallacies in Casino Mathematics,” *International Conference on Gambling & Risk Taking*, May 2003.
- “Casino Gaming in the Caribbean,” *International Business & Economic Research Conference*, October 2002.
- “Gaming Law & Mathematics,” *University of Nevada School of Law*, September 2002.
- “How Casinos Make Money,” *Asia-Pacific Gaming & Casinos World Conference*, Singapore, June 2002.
- “Keeping Casino Games Fair and Honest: The Role of Statistical Evidence in Gaming Regulation,” *Western Decision Sciences Institute*, April 2002.
- “The Business of Casino Gaming,” *Western Decision Sciences Institute*, April 2002 (Best paper award).
- “Casino Mathematics,” Seminar for casino executives, Aruba, March 2002.

PUBLICATIONS

Books

- [1] Hannum, R., & Cabot, A. (2005). *Practical Casino Math*, 2nd edition. Reno, NV: Institute for the Study of Gambling & Commercial Gaming, University of Nevada.
- [2] Hannum, R. (1998). *Introductory Statistics: A Self-Study Guide* (Self-published).

Papers

- [1] Hannum, R. (2010). Casino Mathematics. In *Casino Gaming Methods: Games, Probabilities, and Controls*, Williams, D., & Hashimoto, K., eds. Upper Saddle River, NJ: Prentice Hall.
- [2] Hannum, R., & Cabot A. (2009). Toward Legalization of Poker: The Skill vs. Chance Debate. *Gaming Research & Review Journal*, Vol. 13, No. 1.
- [3] Hannum, R. (2008). Product: Games and Statistics. In *Casino Management: A Strategic Approach*, Hashimoto, K., ed. Upper Saddle River, NJ: Prentice Hall.
- [4] Hannum, R. (2008). Crash and Burn: Casino Management’s Response to an Improbable Win. *Casino Enterprise Management*, Vol. 6, No. 4.
- [5] Hannum, R. (2007). The Partager Rule at Roulette: Analysis and Case of a Million Euro Win. In *Optimal Play: Mathematical Studies of Games & Gambling*, Ethier, S., & Eadington, W., eds. Reno, NV: Institute for the Study of Gambling & Commercial Gaming, University of Nevada.
- [6] Hannum, R. (2006). Skill versus Chance: A Delicate Dance. *Casino Lawyer*, Vol. 2, No. 3.
- [7] Cabot, A., & Hannum, R. (2005). Poker: Public Policy, Law, Mathematics and the Future of an American Tradition. *Cooley Law Review*, Vol. 22, No. 3.

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- [8] Cabot, A., & Hannum, R. (2005). Statistical Standards in Gaming Regulation: Fact and Fiction. *Casino Lawyer*, Vol. 1, No. 3.
- [9] Hannum, R. (2005). Objective of Profit: A Taxing Concept for Gamblers. *Casino Enterprise Management*, Vol. 3, No. 8.
- [10] Cabot, A., & Hannum, R. (2005). Advantage Play and Commercial Casinos. *Mississippi Law Journal*, Vol. 74, No. 3.
- [11] Hannum, R. (2005). Risky Business: The Use and Misuse of Statistics in Casino Gaming. *Chance*, Vol. 18, No. 2.
- [12] Hannum, R., & Kale, S. (2004). Dead Chip Programmes: Finding and Keeping the Edge. *International Gambling Studies*, Vol. 4, No. 1.
- [13] Hannum, R. (2003). Percentages Never Lie. *Global Gaming Business*, Vol. 2, No. 5.
- [14] Hannum, R. (2003). A Guide to Casino Mathematics. *Gaming Studies Research Center*, University of Nevada Las Vegas, <http://gaming.unlv.edu/research/subject/>.
- [15] Hannum, R. (2003). A Mathematical Analysis of Casino Dead Chip Programs. *Review of Business Research*, Vol. 1, No. 1.
- [16] Hannum, R., & Eadington, W. (2002). The Evolving Role of Casino Gaming in the Caribbean. *Proceedings of the International Business & Economic Research Conference*.
- [17] Cabot, A., & Hannum, R. (2002). Gaming Regulation and Mathematics: A Marriage of Necessity. *John Marshall Law Review*, Vol. 35, No. 3.
- [18] Hannum, R., & Cabot, A. (2002). Keeping Casino Games Fair & Honest: The Role of Statistical Evidence in Gaming Regulation. *Proceedings of Western Decision Sciences Institute Annual Meetings*.
- [19] Hannum, R.C. (2002). Special Session: The Business of Casino Gaming. *Proceedings of Western Decision Sciences Institute Annual Meetings*. (Best paper award).
- [20] Hannum, R. (2002). The Luck Myth. *Global Gaming Business*, Vol. 1, No. 3.
- [21] Hannum, R. (2000). Casino Card Shuffles: How Random Are They? In *Finding the Edge: Mathematical Analysis of Casino Games*, Vancura, O., Eadington, W., & Cornelius, J., eds. Reno, NV: Institute for the Study of Gambling & Commercial Gaming, University of Nevada.
- [22] Hannum, R., & Bien, D. (1996). Utility Vehicle Rollovers: A Case Study in Statistics, Public Policy, and Law. Case Study, Self-published (presented at *3rd International Conference on Forensic Statistics*).
- [23] Hannum, R., Bien, D., & Dalton, T. (1993). Decision Sciences and the Law: Quantitative Methods in Litigation (workshop). *Proceedings of the Decision Sciences Institute Annual Meetings*.
- [24] Hannum, R., & Dalton, T. (1993). Using Litigation Research: A Bayesian Decision Model. *Proceedings of the Business & Economic Statistics Section, American Statistical Association Annual Meetings*.
- [25] Hannum, R., & Dalton, T. (1993). Market Surveys: Statistical vs. Legal Reliability. *Proceedings of the 2nd International Conference on Forensic Statistics*, Harnagel, W., & Kaye, D., eds., Arizona State University Center for the Study of Law, Science, and Technology.

- [26] Hannum, R. (1992). Using Decision Analysis to Assist Settlement Negotiations. *Proceedings of the Business & Economic Statistics Section, American Statistical Association Annual Meetings.*
- [27] Hannum, R., Bien, D., & Dalton, T. (1992). Decision Sciences and the Law: Quantitative Methods and Litigation (workshop). *Proceedings of the Decision Sciences Institute Annual Meetings.*
- [28] Hannum, R., & Grove, D. (1990). Trends in the Black-White Gap in America: 1967-1987. Unpublished Manuscript.
- [29] Hannum, R., & Longbotham, C. (1988). Measuring Inequality between Income Distributions. *Quantity and Quality in Economic Research*, Vol. II, Roy C. Brown, ed., University Press of America, Lanham, MD.
- [30] Hannum, R. (1987). Bayes Nonparametric Estimation of Economic Inequality. *Proceedings of the Business & Economic Statistics Section, American Statistical Association Annual Meetings.*
- [31] Hannum, R., & Grove, D. (1986). On Measuring Intergroup Inequality. *Sociological Methods and Research*, Vol. 15, 142-159.
- [32] Hannum, R., & Hollander, M. (1983). Robustness of Ferguson's Bayes Estimator of a Distribution Function. *Annals of Statistics*, Vol. 2, 632-639.
- [33] Hannum, R., Hollander, M., & Langberg, N. (1981). Distributional Results for Random Functionals of a Dirichlet Process. *Annals of Probability*, Vol. 9, 665-670.