



Probability Management

2022 Annual Report
ProbabilityManagement.org

Our Sponsors and Strategic Partners

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2021 Accomplishments

Despite the pandemic, ProbabilityManagement.org had a fruitful year that included a number of developments, laying the groundwork for an even more productive 2022.

Technology

ChanceCalc

Beginning in early 2021, development continued on ChanceCalc, the revolutionary Excel add-in that accesses uncertainties stored as SIP Libraries in the cloud. ChanceCalc allows users to calculate the chance of achieving specific goals in native Excel with a single command. In May, a beta testing program was launched, followed by a fall release of ChanceCalc Beta 1.1, which included freezing the SIPmath 3.0 Standard and the incorporation of the standard by Frontline's Analytic Solver, the first commercial software package to support the new standard. Work began on developing a more robust version of ChanceCalc. Throughout the year, significant effort went into developing materials for documenting and illustrating the Standard and ChanceCalc.

Chancification

Last year, ProbabilityManagement.org introduced the concept of Chancification. Just as electrification delivers electricity generated by engineers to the general public for lighting houses and powering factories, Chancification delivers stochastic information generated by analysts to managers for estimating the chances of meeting their goals. In 2021, the nonprofit promoted Chancification in a variety of ways:

- Sam Savage delivered a webinar entitled “Wiring Your Organization for Probability” for the Houston chapter of the Society of Decision Professionals.
- Dr. Savage published the blog post “Chancification” on his Limbic Analytics blog.
- Sam Savage presented “Chancification: A Cure for the Flaw of Averages” to the Fort Worth chapter of the American Society for Quality (ASQ).
- “Chancification: Wiring Your Organization for Probability,” written by Sam Savage with sidebars by Shayne Kavanagh and Aaron Brown, was published in the June 2021 issue of ORMS Today.
- Sam Savage delivered several webinars on “Chancification: Wiring Your Organization for Probability,” hosted by ProbabilityManagement.org.
- Dr. Savage delivered an in-person talk on “Chancification: Wiring Your Organization for Probability” to Lone Star Analysis.
- Sam Savage presented “Chancification Goes Live” for Risk Awareness Week.
- Dr. Savage gave an in-person tutorial entitled “Applying Chancification to Military Readiness” at the MORS Emerging Technique Forum.
- Together with Matthew Raphaelson, Sam Savage presented “Chancification Overview” in a webinar for the Society of Decision Professionals (SDP).

GitHub

Through a group effort involving Aaron Brown and part-time contractors, ProbabilityManagement.org cleaned up and organized our GitHub site, which now contains several publicly available repositories including R and Python code.

Standard

In September, ProbabilityManagement.org announced the first general release of the SIPmath 3.0 Standard for storing virtual SIPs in the universal JSON format. This was a major milestone for the nonprofit involving a great deal of work not just to develop the standard, but also on the supporting documentation and canonical libraries. In addition, Dr. Savage worked with Frontline Systems to incorporate the standard into their latest release of Analytic Solver, which both reads and writes the 3.0 format.

Both the 2.0 and 3.0 Standards represent uncertainties as data that obey both the laws of arithmetic and the laws of probability. Whereas the SIPmath 2.0 Standard accomplishes this by storing arrays of thousands of Monte Carlo trials, SIPmath 3.0 accomplishes this with a tiny fraction of the storage.

The SIPmath 3.0 Standard uses Doug Hubbard's HDR random number generator to maintain statistical coherence,



generating identical streams of pseudo random numbers across platforms, including native Excel. These random numbers feed Tom Keelin's Metalog distributions, a flexible system for creating an extremely wide range of continuous random variates, including multi-modal.

Applications

Government

Dr. Savage pursued new opportunities for introducing chance-informed decision making within three federal agencies.

- Dr. Savage began discussions with a key member at the Defense Contract Management Agency (DCMA) on adopting the SIPmath Modeler Tools for use in their risk management program. DCMA is an independent body that performs Contract Administration Services for DoD and authorized federal agencies, foreign governments, international organizations, and others.
- In December, Dr. Savage gave an in person demonstration on SIPmath and ChanceCalc to the CIO and other key members at the Department of Energy (DoE).
- Dr. Savage was invited to demonstrate and discuss SIPmath and ChanceCalc with high profile members within the analytics teams at the Department of Defense (DoD), Office of the Secretary of Defense.

Healthcare

- Eng-Wee Ethan Yeo, Assistant Director of Technology and Standards for ProbabilityManagement.org, constructed a prototype for collaborative pandemic modeling using data from the CDC's Ensemble forecast of future hospitalizations. His first step was a simulation in Analytica to convert the CDC forecast into 2.0 SIP Libraries. The nonprofit is working to promote the use of such open libraries for the betterment of hospital resource management in general. Toward this end, Eng-Wee used the SIPmath Modeler Tools to create a dashboard for chance-informed decision making around the allocation of hospital beds between elective surgeries and COVID-19 overflow patients.
- After further refinement of the model, Sam and Eng-Wee presented this work, entitled "Actionable Certainty in Hospital Bed Management," at the July INFORMS HealthCare Conference.

Military Readiness

- Dr. Savage collaborated with Connor McLemore, Shaun Dohoney, and Philip Fahringer, all ProbabilityManagement.org chairs, to publish two articles relating to military readiness. "Military Readiness Modeling: Changing the Question from 'Ready or Not?' to 'How Ready for What?'" was published in the Military Operations Research Journal in March and "Moving Toward a Holistic, Rigorous, Analytical Readiness Framework" was published on the Center for International Maritime Security website in May
- Planning began for a course on Applications of Probability Management to be held at the Naval Postgraduate School in the spring of 2022.

Partner and Sponsor Activities

GFOA

ProbabilityManagement.org continued collaboration on varied projects with Shayne Kavanagh of the Government Finance Officers Association (GFOA), including:

- Provided education and training on risk analysis: Tacoma, WA wildfires, Charlestown, RI flooding, January/February
- Projected Revenue Estimation from Crowdsourced Information on Statistical Errors - The PRECISE Uncertainty Project. Published a blog and Dr. Savage presented the project to the Informs Business Analytics Conference in April
- Conducted online risk management class for GFOA: Risk Management and Business Continuity, October

Highmark Health

Highmark Health's sponsorship enabled PM.org to continue training, educating and certifying risk professionals within the organization. Seven Highmark employees were certified as Level 1 SIPmath Analysts. Our partner, Justin Schell, Senior Risk Management Consultant at Highmark, leads the effort within the organization.

2021 Accomplishments

Kaiser Permanente

As mentioned earlier in the Healthcare section, Dr. Savage partnered with Eng-Wee Ethan Yeo of Kaiser Permanente to construct a prototype for collaborative pandemic modeling using data from the CDC's Ensemble forecast of future hospitalizations. Sam and Eng-Wee presented this work, entitled "Actionable Certainty in Hospital Bed Management," at the July INFORMS HealthCare Conference. Kaiser Permanente continues to be a valued sponsor.

Lockheed Martin

ProbabilityManagement.org conducted an engagement with Lockheed Martin over several months to develop a web-based structure for storage and communication of stochastic information for incorporation into decision support analysis models. The engagement included:

- Meeting with key decision makers to begin discussion of Chancification
- Introducing ChanceCalc to users at Lockheed Martin
- Teaching Lockheed Martin users to use ChanceCalc via webinar training

Level 4 Ventures

In June, Dr. Savage began working with a team led by Level 4 Ventures to help the CPUC evaluate California electric and natural gas investor-owned utilities' (IOU) risk spend efficiency (RSE) modeling and assumptions. The purpose of this work is to assess whether IOUs maximize the effectiveness of safety investments while minimizing ratepayer impacts. This multi-month long engagement required extensive review, research, evaluation and expert team collaboration, culminating in a final detailed report for the CPUC. Future collaborations are planned for 2022.

Lone Star Analysis

Dr. Savage provided a two-part education series for Lone Star Analysis employees. On October 7, Sam Savage hosted a webinar on Chancification: Wiring Your Organization for Probability. On October 13, Sam Savage presented at an in person lunch and learn to further demonstrate how to chancify the organization.

Outreach

Annual Conference

Due to the ongoing uncertainty of the COVID-19 pandemic, ProbabilityManagement did not host an annual conference in 2021. However, planning began for a scaled down, hybrid event called the Chance-Informed Readiness Summit, which will take place in Monterey, CA in March 2022.

Education

- Probability Management announced that Robert Bordley will join our volunteers as the new Chair of Advanced Education. Bob is a Professor and Program Director in the Systems Engineering and Design Program at the University of Michigan Ann Arbor. A group of Bob's graduate students met with Dr. Savage and Aaron Brown to demonstrate ChanceCalc.
- Dr. Savage continued to work with a Palo Alto High School student who is interested in probability management.

Speaking Engagements

Dr. Savage and other ProbabilityManagement.org team members spoke throughout the year.

- Sam Savage presented a 2 part lecture on the Flaw of Averages for UC Davis graduate students, January/February
- Sam Savage and Brian Putt were invited to speak about SIPmath to the core modeling team at Strategic Decisions Group (SDG), March
- Presented CDC model to a panel of Stanford University Medical Doctors, March 29
- Demonstrated ChanceCalc and 3.0 Standard to Executives at Microsoft, April 2
- Presentation (virtual) to high level Department of Defense (DoD) staff with Shaun Dohoney, Connor McLemore and Phil Fahringer and Sam Savage: Military Readiness Modeling: Changing the Question from "Ready or Not?" to "How Ready for What?", April 7



- Presented the PRECISE Uncertainty Project for the annual Informs Business Analytics Conference (virtual), April 13
- Presentation to Ft Worth Chapter of American Society for Quality (ASQ) - Chancification: A Cure for the Flaw of Averages, June 3
- The 89th MORS Symposium (virtual), June 21
- Sam Savage and Shaun Dohoney presented a SIPmath Tutorial: Tutorial on Chancification using the free SIPmath Tools and ChanceCalc
- Presentation on Military Readiness: Military Readiness Modeling: An Actionable Data Framework based on the paper published in MOR Journal 2021 Vol. 26, #1, "Military Readiness Modeling: Changing the Question from 'Ready or Not?' to 'How Ready for What?'" by Connor McLemore, Shaun Dohoney, Phil Fahringer and Sam Savage
- Government Finance Officers Association (GFOA) Annual Meeting: Virtual presentation and meet the speaker: "Thinking Probabilistically" w/Shayne Kavanagh, July 16
- INFORMS HealthCare Conference 2021. Virtual presentation by Sam Savage and Eng-Wee Ethan Yeo: Actionable Uncertainty In Hospital Bed Management, July 22
- Led two sessions for Stanford University's Stanford Center for Professional Development program: The Flaw of Averages and Using SIPmath for Operational Management and Control.
- Presented at the 2021 INFORMS Annual Meeting (virtual). "Making Uncertainty Actionable in National Security," October 26
- Coordinated and co-presented three sessions with featured speakers for Risk Academy's 2021 Risk Awareness Week, October 12-15
- Department of Energy in person meeting w/CIO and other key members of the DoE to demonstrate SIPmath and ChanceCalc. Washington, DC, December 6
- Department of Defense at the Pentagon in Washington, DC. In person meeting for a SIPmath demonstration to high level officials, December 6
- MORS Emerging Technique Forum. In person tutorial: Applying Chancification to Military Readiness, December 8
- Introduction and Lunch and Learn on Chancification within Amazon, December 10

Webinars

ProbabilityManagement.org coordinated and presented several webinars on a variety of topics:

- Wiring Your Organization for Probability, presented to the Houston Chapter of the Society of Decision Professionals (SDP), February
- Sam Savage and Shayne Kavanagh (GFOA) co-hosted a webinar on chance-based forecasting for over 40 GFOA attendees, March
- Sam Savage hosted multiple webinars on Chancification: Wiring Your Organization for Probability, June
- Sam Savage and Brian Putt co-hosted a two part series on SIPmath: Simulation for the Masses for the Strategic Decisions Group (SDG), March and May
- On behalf of ProbabilityManagement.org, Justin Schell presented Speaking the Language of Uncertainty When You Are a Risk "Mad Scientist for the Society of Information Risk Analysts (SIRA), October
- Sam Savage and Matthew Raphaelson presented Chancification Overview, a webinar for the Society of Decision Professionals (SDP), December
- Sam Savage and Matthew Raphaelson presented a webinar called Chancification Overview for the Society of Decision Professionals (SDP), December 15

Website Update

ProbabilityManagement.org was updated to highlight new content:

- 3.0 SIPmath Standard, including pages on the Metalog Distribution and the HDR Random Number Generator
- ChanceCalc, including extensive documentation and tutorial files
- Chancification

2021 Accomplishments

Publications

Articles

ProbabilityManagement.org was featured in the following articles:

- Military Readiness Modeling: Changing the Question from “Ready or Not?” to “How Ready for What?” by Connor McLemore, Shaun Doheney, Sam Savage, and Philip Fahringer. This article describes an actionable data framework to improve military readiness reporting systems using stochastic scenario libraries that permit calculation of the probabilities of military readiness for specified missions at uncertain future times. *Military Operations Research Journal*, Vol. 26, No. 1, March 2021.
- Moving Toward a Holistic, Rigorous, Analytical Readiness Framework by Connor S. McLemore, Shaun Doheney, Philip Fahringer, and Dr. Sam Savage. This article proposes that the military adopt a uniform data framework to better quantify readiness predictions and better communicate risks, leading to better cost and risk tradeoff discussions among decision-makers. Center for International Maritime Security, May 24, 2021.
- Chancification: Wiring Your Organization for Probability by Sam Savage, with sidebars by Shayne Kavanagh and Aaron Brown. The article discusses how just as electrification delivers electricity generated by engineers to the general public, “chancification” can now deliver stochastic information generated by analysts to managers for estimating the chances of meeting their goals. *ORMS Today*, Vol. 28, No. 3, June 2021.

Books

Dr. Savage, with the help of with Melissa Kirmse, spent much of the year readying his new book for publication. *Chancification: How to Fix the Flaw of Averages* includes a foreword by Doug Hubbard and will be available as an e-book and in paperback starting in January 2022.

Blog Posts

Sam wrote several posts for his Limbic Analytics blog in 2021.

- The PRECISE Uncertainty Project (February)
- Chancification (May)
- Chance-Informed Decisions (May)
- Models vs. Modules (June)
- Increasing our Personal Liberty while Fighting COVID-19 (August)
- The SiPmath™ 3.0 Standard and Analytic Solver V2021.5 (September)

2022 Goals and Planned Activities



In 2022, ProbabilityManagement.org will continue its dedication to making uncertainty actionable.

Our 2022 goals and planned activities include:

Tools & Standards

- Develop an online application to generate ChanceCalc-compatible SIPmath 3.0 JSON libraries
- Launch a more robust version of ChanceCalc for sale on the ProbabilityManagement.org website
- Incorporate new Metalog developments and aspects of ChanceCalc into a powerful new version of the SIPmath Modeler Tools

Education and Training Initiatives

- Cultivate relationships with the Defense Contract Management Agency (DCMA) and the Department of Energy with the goal of bringing Chancification to governmental organizations
- Promote chance-informed decision making at the CPUC and utility companies through continued engagement with Level4
- Work with the Government Finance Officers Association (GFOA) to improve management of uncertainty in city governments
- Nurture and expand relationships with current and potential new sponsors

Outreach

- Plan and host a summit on Chance-Informed Readiness in Defense, Pandemic Modeling, and Infrastructure. This will be a hybrid event with a select group of in-person participants as well as virtual attendees, to take place in Monterey, CA in the spring
- Plan and develop a course on Applications of Probability Management at the Naval Postgraduate School, timed to coincide with the Chance-Informed Summit
- Deliver webinars on Chancification, ChanceCalc, and other topics
- Begin planning 2023 Annual Conference

Publications

- Continue to author and co-author relevant articles, blog posts, and newsletters
- Publish and promote *Chancification: How to Fix the Flaw of Averages*

Board of Directors

Sam L. Savage **Executive Director and** **Chairman of the Board**



Sam L. Savage led the development of the open SIPmath standard for storing probability distributions as auditable data. Sam is the author of *The Flaw of Averages: Why We Underestimate Risk in the Face of Uncertainty* and *Chancification: How to Fix the Flaw of Averages*, and is a Consulting Professor at Stanford University.

After receiving his Ph.D. in computational complexity from Yale University in 1973, Sam spent a year in the Mathematics Department at General Motors Research Laboratory, and then joined the Management Science faculty of the University of Chicago Graduate School of Business. Here he discovered that an Algebraic Curtain separated the bulk of his management students from management science. In 1985, Dr. Savage led the development of software called *What'sBest!*[®], which coupled Linear Programming to Lotus 1-2-3. The package won PC Magazine's Technical Excellence Award in 1986. Since then, Sam has continued working to bring analytical tools to managers in an algebra-free environment. In 1990, Sam moved to Stanford, where he teaches Management Science in the Engineering School. He has been a Visiting Professor at Northwestern University's Kellogg School of Business and the Naval Postgraduate School in Monterey, and was a Fellow of the Judge Business School at the University of Cambridge.

Dr. Savage consults and lectures extensively to business and government agencies through his consulting firm, SIPmath Group, an AnalyCorp venture, and serves as an expert witness.

Michele Hyndman **Board Member**



Michele Hyndman has over 20 years of public relations and communications experience. She has worked in broadcast television, at a public relations firm, and is the Assistant Director, Development Marketing & Communications for Stanford University's Graduate School of Business. Michele works effectively and cooperatively with people at all levels of an organization,

media and industry contacts, and vendors to achieve successful branding, media, marketing, advertising and communications plans. In 2012, she launched MMH Communications to leverage her experience and industry contacts to help other nonprofits and small businesses thrive in a highly competitive landscape. Michele is inspired by organizations that help to improve the lives of others.

Michele holds a Bachelor of Arts (BA) in Communication and Media Studies from California State University, Sacramento.

Deborah Gordon **Board Member**



Deborah C. Gordon retired in August 2019 after 22 years as the Executive Director of Stanford University's Preventive Defense Project, co-founded and directed by former Secretaries of Defense, William J. Perry and Ashton B. Carter. She currently consults to several high tech companies and has over 40 years of experience in algorithm design, signal processing, and network security. She holds several U.S. and Canadian patents for her work in medical instrumentation. She serves on the Board of Directors of Probability Management, the Council on Strategic Risks, the Arms Control Association, and Technology for Global Security. She has served both as Mayor and Council Member of Woodside, CA. Gordon holds a BS in computer science from the University of Southern California.

Financials



Statement of Operations

For the years ended December 31,

	2021	2020
	Unrestricted	Unrestricted
Income		
Corporate Contributions	115,000.00	72,700.00
Individual Contributions	110.00	1,700.00
Matching Gifts	750.00	6,000.00
Program Service Fees	0.00	8,531.37
Enterprise Tools Sales	9,175.00	11,150.00
Education	104,356.72	141,773.53
Other Income	0.74	28,533.75
Total Income	229,392.46	270,388.65
Expenses		
Program Services		
Education & Outreach	157,452.80	178,178.02
Standards	0.00	0.00
Tools	90,337.77	66,858.78
Program Service Support		
General & Administrative	11,664.31	12,413.76
IT	6,808.14	7,610.13
Facilities	146.00	118.00
Total Expenses	266,409.02	265,178.69
Change in Net Assets	(37,016.56)	5,209.96

Financials

Statement of Cash Flows

<i>For the years ended December 31,</i>	2021	2020
Cash Flows from Operating Activities		
Change in net assets	(\$37,016.56)	\$5,209.96
Adjustments to reconcile change in net assets to net cash provided by operating activities:		
Accounts Receivable	\$32,057.55	\$3,803.71
Accounts Payable	(\$17,513.20)	\$14,638.50
Prepaid Expenses	\$523.25	(\$52.25)
Unearned or Deferred Revenue	\$0.00	(\$5,745.00)
Net cash provided by Operating Activities	(\$22,228.52)	\$19,779.15
Cash Flows from Investment Activities		
Purchase of property and equipment	(\$2,086.32)	\$0.00
Net cash provided by Investing Activities	(\$2,086.32)	\$0.00
Net Change in Cash and Cash Equivalents	(\$24,314.84)	\$2,603.03
Cash and Cash Equivalents at the beginning of the period	\$88,717.41	\$68,938.28
Cash and Cash Equivalents at the end of the period	\$64,402.57	\$88,717.43

Statement of Financial Position

<i>For the years ended December 31,</i>	2021	2020
Assets		
Current Assets		
Cash and cash equivalents	64,402.57	88,717.43
Accounts receivable	(\$857.55)	31,200.00
Prepaid expenses and other assets	2,056.43	2,579.68
Total Current Assets	65,601.45	122,497.11
Property and Equipment	2,086.32	0.00
Total Assets	67,687.77	122,497.11
Liabilities and Net Assets		
Liabilities		
Accounts payable and accrued expenses	7,180.97	24,973.73
Unearned or deferred revenue	0.00	0.00
Long-term liabilities	0.00	0.00
Total Liabilities	7,180.97	24,973.73
Net Assets		
Opening Balance Equity	2,431.25	2,431.25
Unrestricted Net Assets	95,092.11	89,882.17
Net Income	(\$37,016.56)	5,209.96
Total Net Assets	60,506.80	97,523.38
Total Liabilities and Net Assets	67,687.77	122,497.11



Detailed Income and Expenses

For the years ending December 31,

	2020	
	Unrestricted	Unrestricted
Income		
Contributions		
Corporate Contributions		
Chevron	35,000.00	0.00
Foundation for Creativity in Dispute Resolution	0.00	500.00
Highmark Health	40,000.00	32,200.00
Hubbard Decision Research	0.00	0.00
Kaiser Permanente	35,000.00	35,000.00
Lockheed Martin	0.00	0.00
Lone Star	5,000.00	5,000.00
Individual Contributions	110.00	1,700.00
Matching Gifts	750.00	6,000.00
Program Income		
Program Service Fees	0.00	8,531.37
Enterprise Tools Sales	9,175.00	11,150.00
Education		
GFOA	22,000.00	0.00
Lockheed Martin	80,000.00	0.00
Other	2,356.72	0.00
Other Income		
Interest Income	0.74	2.75
Tax Refund		
CARES Grant Income	0.00	28,531.00
Total Income	229,392.46	270,388.65
Expenses		
Program Services		
Education & Outreach		
Compensation and Benefits	152,449.24	174,795.54
Travel Expenses		
Airfare	1,918.90	0.00
Lodging	1,052.93	915.95
Ground Transportation	338.47	12.78
Parking	0.00	8.95
Travel Meals and Entertainment	169.24	83.97
Total Travel Expenses	3,479.54	1,021.65
Meals and Entertainment	109.02	95.67
Marketing and Publicity		
Trade Shows	1,415.00	1,746.00
Conferences		0.00
Marketing Collateral		0.00
Marketing Materials		52.34
K-12 Education		
Email Marketing		
Public Relations		
Total Marketing and Publicity	1,415.00	1,798.34
Other Expenses		
Books, Dues, and Subscriptions		209.39
Office Supplies		257.43
Total Other Expenses		466.82
Total Education & Outreach	157,452.80	178,178.02

For the years ending December 31,

	2018	
	Unrestricted	Unrestricted
Standards	0.00	0.00
Tools		
Compensation and Benefits	90,337.77	66,858.78
Total Tools	90,337.77	66,858.78
Total Program Services	247,790.57	245,036.80
Program Service Support		
General & Administrative		
Compensation and Benefits	2,375.00	3,687.00
Office Expenses		
Office Supplies		103.11
Postage and Shipping		
Business Taxes and Fees	150.71	
Insurance		
Directors & Officers Insurance	2,389.00	1,485.75
Liability Insurance	803.25	363.02
Professional Services		
Accounting	2,650.00	2,750.00
Legal Fees	0.00	2,770.00
Banking and Financial		
Payroll Service Fees	1,845.01	777.00
Bank Fees	136.50	188.50
Checks		
Online Payment Fees	1,314.84	264.38
Total General & Administrative	11,664.31	12,413.76
IT		
Compensation and Benefits	0.00	250.00
Software and Hardware		
Software Site Licenses	4,433.53	6,497.13
Expensed Software and Hardware	733.90	
Depreciation and Amortization	90.72	
Software and Hardware - Other		
Website	1,549.99	863.00
Meals and Entertainment		
Total IT	6,808.14	7,610.13
Facilities		
Rent Expenses		
Rent - PO Box	146.00	118.00
Repairs and Maintenance		
Total Facilities	146.00	118.00
Total Program Service Support	18,618.45	20,141.89
Total Expenses	266,409.02	265,178.69
Change in Net Assets	(37,016.56)	5,209.96



Probability Management

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