

Curriculum Vitae: Steen Rasmussen, March 2019

Personal Data Born July 7, 1955 in Elsinore, Denmark
Alien of extraordinary abilities (US green card holder) 1996-2009

Affiliations Professor & Center Director
Center for Fundamental Living Technology (FLinT)
Department of Physics, Chemistry and Pharmacy
University of Southern Denmark (SDU), Campusvej 55, DK-5230, Denmark
+45 6011 2507 / steen@sdu.dk / <http://flint.sdu.dk>

External Research Professor
Santa Fe Institute
1399 Hyde Park Rd.
Santa Fe NM 87501
USA / steen@santafe.edu / <http://www.santafe.edu>

Formal Education

1985 Ph.D. in Physics, Technical University of Denmark (DTU)
1982 M.Sc. in Physics & Physical Chemistry, Technical University of Denmark (DTU)
1978-1981 Philosophy studies at University of Copenhagen, Denmark

Positions & institutions

2017 - present CTO and co-founder of BINC Technologies, New York, USA
2009 – present Founder, Initiative for Science, Society and Policy (ISSP), Denmark
2007 - present Professor & Center Director for Fundamental Living Technology (FLinT), Department of Chemistry, Physics & Pharmacy, SDU

2004 – present External Research Professor, Santa Fe Institute (SFI), New Mexico, USA
2004 - 2005 Guest Professor, Molecular Biochemistry and Genetics (Panum), University of Copenhagen, Denmark

2004 – present Co-founder, European Center for Living Technology (ECLT), Venice, Italy.
2002 – 2007 Scientific Team Leader, Self-organizing Systems, Los Alamos National Laboratories (LANL), USA

1992 – 2002 Staff Scientist, LANL, USA
1988 – 2004 Part Time Researcher in residence, Santa Fe Institute (SFI), USA
1988 – 1991 Postdoc, Center for Nonlinear Studies, LANL, USA
1985 – 1988 Postdoc, Physics Laboratory III, Technical University of Denmark

Awards & Honors

2018 Lifetime Achievement Award, International Society for Artificial Life (ISAL)
2009 Top-5 Scientific Break-Through in Denmark, *Rasmussen, Maurer & Monnard*
2005 Top-5 World Technology Network Reward, Biotechnology Category
2004 Los Alamos Achievement of Excellence: Simulation of Critical Infrastructures
2004 Los Alamos Achievement of Excellence: Protocell Design
2000 Los Alamos Cerro Grande Wildfire Award: Web-based disaster mitigation,
1988 P. Gorm-Petersens Mindelegat, in the presence of Her Majesty the Queen, Margrethe II of Denmark

Publications Author/co-author of 126 peer-reviewed scientific journal papers; written and edited 15 scientific books, proceedings and special journal issues; 200+ invited talks; 140+ media interviews; 30+ consulting & internal reports; Erdős number: 2.

Major Research Funding

Prof. Rasmussen has since 2003 brought in about \$39M (255M DKK) in competitive research grants (as PI: \$17M and as Co-PI: \$22M) to his home institutions and his international research consortia. Selected grants:
2013 – 2017 Local PI, SYNENERGENE (FP7-SiS.2012.1.2.2-1-318671) – *Mobilisation and mutual learning action plans* (3.961M Euro)
2012 – 2015 Local PI, MICREAGENTS (FP7-ICT-8-9.6-FET Proactive: Unconventional Computing-318671) *Microscale Chemically Reactive Electronic Agents* (3.400M Euro)
2012 – 2015 Local PI, TRUCE (FP7-ICT-2011-8-CSA-318235) *Training and Research in Unconventional Computing in Europe* (500K Euro)

2010 – 2013	COBRA (FP7-ICT-2009-6-270371) - <i>Coordination of Biological and Chemical Research Activities</i> (485K Euro)
2010 – 2013	PI, MATCHIT (FP7-ICT-2009-4-249032) <i>Matrix for Chemical IT</i> (2.770M Euro)
2008 - 2011	Local PI and Coordination Committee, ECCell (FP7-ICT-2007-8-222422) – <i>Electronical Chemical Cell</i> (2.000M Euro)
2009	PI, Danish Center for Scientific Computing: <i>DCSC-grant for High Performance Computing Research Infrastructure Hardware</i> (135K Euro)
2008	PI, Danish Center for Scientific Computing: <i>DCSC-grant for High Performance Computing Research Infrastructure Hardware</i> (335K Euro)
2009 – 2018	PI, University of Southern Denmark: <i>Initiative for Science, Society and Policy</i> (675K Euro for startup) Since 2012 sponsored by two Danish Universities, currently ~ 80K Euro/year (480K Euro).
2009	PI, University of Southern Denmark: <i>The vice-chancellors seed-money</i> (40K Euro)
2007 – 2013	Director, The Danish National Research Foundation & University of Southern Denmark <i>Center for Fundamental Living Technology (FLinT)</i> (5.380K Euro)
2004 – 2007	PI, Los Alamos, <i>Protocell Assembly, LDRD-DR</i> , (\$5M ~ 4.440K Euro)
2004 – 2008	Local PI & Coordination Committee PACE (FP6-ICT) – <i>Programmable Artificial Cell Evolution</i> (6.700M Euro + additional 900K Euro from Switzerland)
2004 – 2005	PI, US Air Force, <i>Cell-Like Entities</i> (\$25K ~ 22.2K Euro)
2003 – 2005	Co-PI, Water on Mars, LDRD-DR, Los Alamos (\$2.4M ~ 2.133M Euro)

Brief Professional History

After his postdoc at the Technical University of Denmark he joint Los Alamos National Laboratory and Santa Fe Institute, August 1988, and spent 20 years in New Mexico, USA (Alien of Extraordinary Abilities). Late 2017 he returned to Denmark as a professor and center director at University of Southern Denmark.

He was one of the founders of the Artificial Life field in the late 1980s, which he has engaged with ever since. At Los Alamos he contributed to the Human Genome Project, Transportation Simulation, Urban Security, Disaster Mitigation, and Distributed Satellite Communication. In the mid 1990s he co-directed the Urban Security Initiative at Los Alamos, developing an integrated simulation framework for urban systems as well as web-based disaster mitigation tools. These were implemented in Cerro Grande Wildfire where 20.000 people were evacuated. He was also part of the original Los Alamos team on Critical Infrastructure Protection, now implemented by the US Department of Homeland Security. In the early 90s he co-developed the Transportation Simulation System (TRANSIMS), which was implemented by the US Department of Transportation.

He became the Scientific Team Leader of the Self-Organizing Systems (SOS) team in 2002. He was leading the Los Alamos Protocell Assembly (LDRD-DR) project and the Astrobiology program (origins of life) at Los Alamos, developing experimental and computational protocells as well as Cell-Like Entities with USAF as a co-sponsor. Further, he was the Co-Director of the EC sponsored Programmable Artificial Cell Evolution (PACE) project and a Guest Professor at University of Copenhagen (2004-5), where he co-founded the European Center for Living technology (ECLT) Venice, Italy 2004.

Late 2007 he returned to Denmark as founder and Director of the Center for Fundamental Living Technology (FLinT) at SDU. In 2009 he founded the Initiative for Science Society and Policy (ISSP). SFI, ISSP and the ECLT allow Prof. Rasmussen to pursue his interdisciplinary scientific interests in the physics behind living and intelligent processes as well as how technologies based on living and intelligent processes both change our societies and what it means to be human.

Recent Scientific Track Record

The main scientific effort of Prof. Rasmussen over the last 19 years has been to explore, understand and construct transitions from nonliving to living materials. Creating artificial living and intelligent materials requires an interdisciplinary scientific effort, which is why he has assembled, sponsored, and lead research teams in the US, across Europe and in Denmark. He is currently in the process of exploring commercial funding to pursue these efforts. In recent years he has also assembled international scientific teams to explore the impact, challenges and opportunities driven by the bag between our physical technologies (internet, big data, AI, AL, etc.) and our social technologies (governance, law, education, social norms, etc.). He has extensive experience in architecting new scientific programs and assembling research teams to pursue these.

Selected recent publications

Professor Rasmussen has published 126 peer reviewed scientific papers (incl. *Science*, *Nature* & *PNAS*):

- 1) M. Battaglini & S. Rasmussen (2019) Transparency, automated decision-making processes and personal profiling, *J. Data Protection & Privacy* 2, 4, 1–18
- 2) S. Rasmussen & P. Sibani (2019) Two modes of evolution: optimization and expansion, *Artificial Life* 25, 1, 9-21
- 3) B. Straatmann et al. (7 co-authors) & S. Rasmussen (2018) A consumption-based, regional input-output analysis of greenhouse gas emissions and the carbon regional, *Int. J. Env. Tech. and Man.*, 21, 1/2, 1-36
- 4) H. Fellermann, B Corominas-Murtra, P. Hansen, J. Ipsen, R. Solé, S. Rasmussen (2018) Non-Equilibrium Thermodynamics of Self-Replicating Protocells, *Sci. Rep.* ISSN 2045-2322
- 5) M. Monti & S. Rasmussen, RAIN: A Bio-Inspired Communication and Data Storage Infrastructure (2017), *Artificial Life*, 23, ISSN 1064-5462
- 6) S. Rasmussen, A. Constantinescu & C. Svaneborg (2016) Generating minimal living systems from nonliving materials and increasing their evolutionary abilities, *Phil. Trans. R. Soc. B* 20150440
- 7) K. Ikari, Y. Sakuma, T. Jimbo, A. Kodama, M. Imai, P. Monnard & S. Rasmussen, Dynamics of fatty acid vesicles in response to pH stimuli, *Soft Matter* (2015) 10.1039 / C5SM01248A
- 8) S. Tanaka, H. Fellermann & S. Rasmussen, Structure and selection in an autocatalytic binary polymer model, *Eur. Phys. Let.* 107 (2014) 0.1209/0295-5075/107/ 28004 (editors choice)
- 9) M Porcar, A Danchin, V de Lorenzo, VA Dos Santos, N Krasnogor, S Rasmussen, A Moya (2011) The ten grand challenges of synthetic life, *Systems and synthetic biology* 5 (1-2), 1-9
- 10) M. Bedau, G. Church, S. Rasmussen, A. Caplan, S. Benner, M. Fussenegger, J. Collins, D. Deamer (2010) Life after the synthetic cell *Nature*, 465,7297, 422-424
- 11) S. Rasmussen, M. Bedau, L. Chen, D. Krakauer, N. Packard & P. Stadler, eds., *Protocells: Transitions from nonliving to living matter*, Cambridge: MIT Press, 2009. (First comprehensive book on state of the art in protocell research)
- 12) P Ehrenfreund, S Rasmussen, J Cleaves, L Chen (2008) Experimentally tracing the key steps in the origin of life: The aromatic world, *Astrobiology* 6 (3), 490-520
- 13) MS DeClue, PA Monnard, JA Bailey, SE Maurer, GE Collis, HJ Ziock, Nucleobase mediated, photocatalytic vesicle formation from an ester precursor, *JACS* 131 (3), 931-933
- 14) T Rocheleau, S Rasmussen, PE Nielsen, MN Jacobi, H Ziock (2007) Emergence of protocellular growth laws, *Philosophical Transactions of the Royal Society B: Biological Sciences* 362

Recent invited keynote presentations (selected)

Steen Rasmussen has given 200+ invited presentations at international meetings and seminars and more than 100 during the last 10 years. Five representative keynote lectures are listed below:

- 1) *Artificial Life in our Lifetime*, TWIN Global, Chicago, USA, September 25-27, 2018
- 2) *From Active Materials to Minimal Living Processes*, Active Matter Summer School, Georgetown University, Washington D.C., USA, June 12, 2017
- 3) *The "4th Industrial Revolution" in fact a More Radical "BINC Revolution?"*, American Chamber of Commerce (AmCham), Beijing, China, December 14, 2016
- 4) *What Might the Assembly of Minimal Protocells Reveal About the Origin of Life?*, Gordon Research Conference on the Origin of Life, Galveston, Texas, USA. January 9, 2012
- 5) *Bottom Up Assembly of Minimal Life*, 13th Annual Conference Companion on Genetic and Evolutionary Computation (GECCO 11). Dublin, Ireland. July 14, 2011

Organization of international conferences and workshops (selected)

- 1) *The growing gap between our physical and social technologies*, Santa Fe Institute, USA, July 30-Aug. 10, 2018, Chair
- 2) *An emergent technological and societal transition*, Leiden, The Netherlands Oct. 5-9, 2015, Chair
- 3) *Science beyond fiction*, Future Emergent Technology (FET-11), Budapest, Hungary, May 4-6, 2011
- 4) *Artificial Life 12*, Odense, Denmark, August 19-23, 2010, Chair
- 5) *Bridging nonliving and living matter*, Los Alamos National Laboratory and Santa Fe Institute, September 9-11, 2003, Chair

Recent edited and authored books, proceedings and special issue peer-reviewed journals

- 1) Open-Ended Evolution and Open-Endedness (theme issues) Packard N., Bedau M., Channon A., Ikegami T., Rasmussen S., Stanley K., & Taylor T., *Artificial Life*, 25, issues 1 & 2 (2019)
- 2) Stepney S., Rasmussen S. & Amos M., eds. Computational matter, *Springer Nature Press*, 2018
- 3) Andersen L. & Rasmussen S., What practical policy ought to focus on, *ISSP Press*, 2015 (Danish)
- 4) Living technology: 5 Questions, eds. Bedau, M.; Hansen, P.G.; Parke, E. & Rasmussen, S., *Automatic Press / VIP*. p 236, 2010

- 5) Proceedings of the 12th Int. conf. on synthesis and simulation of artificial life, Eds. Fellermann, H. et al., (8 co-organizers) & Rasmussen, S. *MIT Press*, 2010
- 6) Protocells: Transitions from nonliving to living matter, S. Rasmussen, M. Bedau, L. Chen, D. Krakauer, N. Packard & P. Stadler, eds., Cambridge: MIT Press, 2008. (First comprehensive book on state of the art in protocell research)
- 7) Towards the Artificial Cell (theme issue). Solé, R. V.; Bedau, M. A. & Rasmussen, S., *Philosophical Transactions of the Royal Society of London. Biological Sciences*; vol. 362, 1486; 1725-1925 (2007)

Science Boards (selected)

- 2014 – present National Data Ethics Think-Do-Tank, Denmark (Advisory Board)
- 2009 – present Initiative for Science, Society and Policy (ISSP) Denmark (Founder & Head)
- 2008 – present Project Zero, Denmark, Non-profit NGO (Head)
- 2004 – present European Center for Living Technology (ECLT), Venice, Italy (Co-Founder).

Recent International and National Science Policy and Management as well as Business Consulting

Prof. Rasmussen has consulted on science and technology issues for the European Commission, the Danish Parliament, the German Bundestag and the US Congress:

(a) Science Road mappings for the US DOE, NASA, NIH, 2001-2008. (b) Whitepaper development for European Commission (EC), Future Emergent Technology (FET) 2007-2011. (c) Elected Danish National expert panel for EC's *Nanoscience, Materials and Processes*, 2009-2013 and (d) *Information and communication technology* 2013-today. (e) Elected expert for the Danish National Technology Council (Teknologirådet) for *Synthetic Biology*, 2010-2011 and (f) for *Artificial Intelligence*, 2019. (g) External expert for the Danish Center for Bio-security & Bio-preparedness (CBB) on synthetic biology, 2012-2013. (h) Invited council to the Chair of the Armed Forces Committee on Science and Engineering at the National Laboratories in the US Congress, Washington D.C. 2012. (i) Elected high level Advisor for the EC FET program office, Brussels, 2013-2014. (j) Invited expert on *Synthetic biology, consumer protection and food safety*, German Bundestag, 2014. (k) Elected Advisory Board for Danish National *Data Ethics* Think-Do-Tank, 2014-today. (l) Consulting for bank Lombard Odier, Switzerland, May 2018. (m) Elected expert by Danish Government on *Data Ethics and Technology Disruption*, 2018.

Selected Public Outreach

Prof. Rasmussen has for many years been actively engaged in the public discourse regarding science and society and in particular how technology changes what it means to be human. This is why he founded the *Initiative for Science, Society and Policy* (ISSP) in 2009. ISSP is currently co-funded by four Danish universities, has a Director, five Science Thrust Leaders and a Science Board. In addition Prof. Rasmussen has more than 140+ media interviews, many in high profile outlets as exemplified below:

- 1) Conversations about the future, Korsholm & Rasmussen, (17 video interviews) *youtube.com*, 2018-19
- 2) There are 100 definitions of life and they are all wrong, *BBC Earth*, The Big Questions, January 2, 2017
- 3) We are in danger of loosing control of our technology and our lives, *EurekaAlert.org*, December 10, 2014. This interview was picked up by multiple 82 international news outlets across the world
- 4) The living technologies and the life lived, *Kunst og Videnskab*, Documentary, *youtube.com*, 2012
- 5) Can a Simple Model Explain the Advent of Cells? *Science Now*, January 7, 2011
- 6) Naked Science: Finding the Origin of Life. *National Geographic Channel* (Europe), Sept. 19, 2010
- 7) Sizing up the synthetic cell, *Nature News*, May 20, 2010
- 8) Konkurrenz für Gott. *Der Spiegel* (cover story), Germany, January 4, 2010
- 9) Public lecture, *Am. Ass. Adv. of Sci. (AAAS)*, Washington D.C., Dec. 1, 2005
- 10) Life from dust, *NOVA*, *USA Public Broadcasting Services (television)*, Oct. 18, 2005
- 11) Researchers seek to create a living cell, *Wall Street Journal* (cover story), April 2, 2004

Examples of early career contributions to excellent researchers

(a) Martin Jacobi, my Postdocs at Los Alamos, now full Prof. in Physics and Dean at Chalmers Uni. Technology, Sweden. (b) Pierre-Alain Monnard, my first junior staff hire at Los Alamos, now Associate Prof., Chemistry, SDU. (c) Carsten Svaneborg, my postdoc at FLinT now Associate Prof. Physics, SDU.

Examples of leadership in industrial innovation

(a) Co-founder and CTO of BINC Technologies LLC, development and implementation of emerging living and intelligent technologies. (b) CEO of Technology Tomorrow, technology consulting and education, (c) Head of Science Board at ProjectZero, Non-profit company directing regional sustainability initiatives in Sønderborg, Denmark. (d) Science Board member at AquaZ, a joint Danish-US start-up company developing biomimetic water purifying systems.