

## Dr. Peter M. Hines

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### CONTACT INFORMATION

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### PROFILE

**A established academic with international reputation and experience, working on the interface of pure mathematics and theoretical computer science.** Specialising in category theory and its applications in a range of fields including pure mathematics, logic and theoretical computer science, quantum computing, cryptography, and linguistics.

Further academic experience and publications in cognitive science, information theory, psychology, and communication channels.

Recently returned to academia after a partial break dealing with childcare responsibilities.

Experience teaching a range of subjects related to both mathematics and computing. Significant success with grant applications in a collaborative setting. International reputation and track record of research in chosen areas.

Qualified under Conseil National des Universités (CNU) system for French academic positions in Pure Mathematics, Computer Science, Applications of Mathematics (Sections 25, 26, 27).

A British national, with native language English & second language French. Also eligible for, and currently applying for, French nationality.

### OCCUPATIONAL HISTORY

- (Oct. 2015 to present)** *University of York*  
Combining **childcare responsibilities** with a range of **teaching, research,** and **commercial** roles:  
**Associate** in York Center for Cross-Disciplinary Systems Analysis, University of York. Also member of Semigroups (Mathematics) and CyberSecurity (Computer Science) groups.  
**Casual lecturer** Lecturing on several postgraduate-level courses.  
**Consultant** Consultancy for external organisations, on projects related to modeling information flow in secure communication.
- (2012 to Oct. 2015)** *University of York*  
**Researcher Co-Investigator** in categorical linguistics and models of meaning.
- (2010-2012)** *Univ. York, Univ. Oxford, U.S. Gov.*  
A range of **teaching** and **research** roles:  
- **2012 I.P. Lecturer** at US Naval Research Laboratory, Washington D.C., U.S.A.  
- Member of CAP quantum and logic **research network** (Oxford).  
- A variety of **single-course lecturing rôles** on graduate courses (York), including supervising fourth-year projects.
- (2005-2010)** *University of York*  
**Researcher** in quantum computation and foundations.
- (2002-2005)** *Oxford University*  
**Research Associate** in the foundations of reversible and quantum computation.
- (2000-2002)**  
**Self-employed programmer** on a range of highly mathematical computing projects for commercial clients, including  
- An aluminium refinery optimisation algorithm and program, for Rio-Tinto Zinc.

	<ul style="list-style-type: none"> <li>- A logic-based access control system and online learning environment, for a management consultancy group.</li> </ul>	
	<b>(1999-2000)</b>	<i>University of Wales, Bangor</i>
	<b>Research Assistant</b> on an information theory project based in cognitive science.	
	<ul style="list-style-type: none"> <li>- Mathematical models of unsupervised human classification,</li> <li>- Algorithms for classifying data with non-metric distance functions,</li> <li>- Computer programs (Matlab, C++) implementing these models and algorithms.</li> </ul>	
	<b>(1997-1999)</b>	<i>University of Wales, Bangor</i>
	<b>Tutor</b> responsible for designing and teaching undergraduate and graduate courses in a variety of mathematical and computational subjects.	
EDUCATION	<b>PhD</b> Pure Mathematics	<i>University of Wales, Bangor</i>
	<b>Thesis title:</b> The algebra of self-similarity and its applications	
	<ul style="list-style-type: none"> <li>- Linear logic, Category theory, Inverse semigroup theory, Self-Similarity, Universal Algebra, Order theory, Automata theory.</li> </ul>	
	<b>MSc.</b> Pure Mathematics	<i>University of Wales, Bangor</i>
	<b>Thesis title:</b> Racks and related structures in low-dimensional topology	
	<ul style="list-style-type: none"> <li>- Knot theory, Algebraic Topology, Invariants, Self-distributive Algebras</li> </ul>	
	<b>BSc.</b> Pure & Applied Mathematics	<i>University of York</i>
TEACHING EXPERIENCE	<b>Lecturing, course and exam writing</b>	<i>University of York</i>
	<ul style="list-style-type: none"> <li>- Quantum Computation, L<sup>A</sup>T<sub>E</sub>X, Formal Logic, Propositional and Predicate Calculus, Discrete Mathematics for Computer Science.</li> </ul>	
	<b>Demonstrating</b>	<i>Oxford University</i>
	<ul style="list-style-type: none"> <li>- Artificial Intelligence, Category theory, Formal Logic, Game Semantics, Maple</li> </ul>	
	<b>Lecturing and demonstrating</b>	<i>University of Wales, Bangor</i>
	<ul style="list-style-type: none"> <li>- Automata theory, Combinatorics, Statistics, Discrete mathematics, Introductory Computing, Mathematics for Computer Scientists, Parallel Computation, Programming (MatLab, LISP, Java, C, C++, 68000 assembler), Web-authoring.</li> </ul>	
SUCCESSFUL GRANT APPLICATIONS	<b>A Unified Model of Compositional and Distributional Semantics</b>	<b>EPSRC</b>
	Named Research CoInvestigator	
	<ul style="list-style-type: none"> <li>- An investigation of the relationship between linguistics, grammar and meaning, based on category-theoretic semantics.</li> <li>- A joint project between the universities of Cambridge, Edinburgh, Oxford, Sussex and York.</li> </ul>	
	<a href="http://gow.epsrc.ac.uk/NGBOViewGrant.aspx?GrantRef=EP/I037512/1">http://gow.epsrc.ac.uk/NGBOViewGrant.aspx?GrantRef=EP/I037512/1</a>	
	<b>Quantum Computation: Foundations, Security, Cryptography and Group Theory</b>	<b>EPSRC</b>
	Named Research Associate	
	<ul style="list-style-type: none"> <li>- A multi-site project on the interaction of quantum computation and information with other areas of mathematics and computing.</li> <li>- A collaboration between the universities of Herriot-Watt, Newcastle and York.</li> </ul>	
	<a href="http://gow.epsrc.ac.uk/NGBOViewGrant.aspx?GrantRef=EP/F005881/1">http://gow.epsrc.ac.uk/NGBOViewGrant.aspx?GrantRef=EP/F005881/1</a>	

**Foundational Structures for Quantum  
Information and Computation**

**EU FP6**

Named Research Associate

- A collaboration between a large number of EU sites, on the foundations of quantum computation and information.

[http://cordis.europa.eu/project/rcn/80451\\_en.html](http://cordis.europa.eu/project/rcn/80451_en.html)

**Foundations of Quantum and  
Reversible Computation**

**LMS / MathFit**

Named Research Assistant

- A project, based at Oxford University, on the relationship between reversible and quantum computation.

**OTHER ACADEMIC  
RESPONSIBILITIES**

**Reviewer** for *A.M.S. Mathematical Reviews*

**Seminar Organiser** for *University of York Artificial Intelligence Seminar Series*

**Viva Panel Member** for *Postgraduate Quantum Computing and Quantum Information courses*

**Selection Committee Member** for *Research Associate Position in QM computation*

**Grant Reviewer** for *E.P.S.R.C.*

**Program Committee Member** for several international conferences.

**Referee** for a large number of journals and conferences, including: *Compositional Approaches in Physics, NLP and Social Sciences, Computability in Europe, International Colloquium on Automata Languages and Programming, International Journal of Quantum Information, International Journal of Unconventional Computation, LMS Journal of Computation and Mathematics, Journal of Pure and Applied Algebra, Logic in Computer Science, Mathematical Foundations of Programming Semantics, Mathematical Structures in Computer Science, Non-Standard Computation, PRS (A), Reversible Computation, Theoretical Computer Science.*

**VISITING  
LECTURESHIPS**

***I.P. Lecturer (2012)*** U.S. Naval Research Laboratory, Washington D.C.

- *A series of talks on topics of interest to US Naval Research*

## Appendix A: Publications

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- PEER-REVIEWED PUBLICATIONS
- + **Peter Hines, M. V. Lawson**, An Application of Polycyclic Monoids to Rings *Semigroup Forum* (56) (1996) pp. 146-149
  - + **Peter Hines**, *The Algebra of Self-Similarity and its Applications* PhD Thesis, University of Wales, Bangor (1997)
  - + **Peter Hines**, The Categorical Theory of Self-Similarity, *Theory and Applications of Categories* 6(3) (1999) pp.33-46
  - + **Peter Hines**, A Short Note on Coherence and Self-Similarity, *Journal of Pure and Applied Algebra* (175) (2002) pp. 135-139
  - + **Peter Hines**, A Categorical Framework for Finite State Machines *Mathematical Structures in Computer Science* (13) (2003) pp. 451-480
  - + **Peter Hines**, Physical Systems as Constructive Logics, in *Unconventional Computation*, C. Calude et. al (ed.s), Springer LNCS (2006) pp.101-112
  - + **Peter Hines, E. Pothos, N. Chater**, A Non-Parametric Approach to Simplicity Clustering, *Applied Artificial Intelligence* 21(8) (2007) pp. 729-752
  - + **Peter Hines**, Machine Semantics, *Theoretical Computer Science* 409(1) (2008) pp. 1-23
  - + **Peter Hines**, Machine Semantics: From Causality to Computational Models, *International Journal of Unconventional Computation* 4(3) (2008) pp. 249-272
  - + **E. Pothos, A. Perlman, D. Edwards, T. Gureckis, P. Hines, N. Chater** Modelling Category Intuitiveness, *Cognitive Science Journal* (2008) pp. 415-420
  - + **Peter Hines, S. Braunstein** The Structure of Partial Isometries, in, *Semantic Techniques in Quantum Computation*, Cambridge University Press (2010) pp.361-389
  - + **Peter Hines** Quantum circuit oracles for Abstract Machine computations, *Theoretical Computer Science* 411 (2010) pp. 1501-1520
  - + **E. Pothos, N. Chater, P. Hines** The simplicity model of unsupervised categorization, in *Formal Models of Categorization*, A. Mills & E. Pothos (ed.s) (2010) Cambridge University Press
  - + **Peter Hines** Can a quantum computer run the von Neumann architecture? in *B. Coecke (ed.) New Structures for Physics, Lect. Notes Phys. 813*, Springer Berlin (2011) pp.941-978
  - + **V. Kendon, A. Sebald, S. Stepney, M. Bechmann, P. Hines, R. Wagner** Heterotic Computing, *Unconventional Computation 2011, Turku, Finland. Springer L.N.C.S. 6714* (2011) pp. 113-124
  - + **E. Pothos, A. Perlman, T. Bailey, K. Kurtz, D. Edwards, P. Hines, J. McDonnell** Measuring category intuitiveness in unconstrained categorization tasks *Cognition* 121(1) (2011) pp.83-100
  - + **Peter Hines, P. Scott** Categorical traces from single-photon linear optics, in *S. Abramsky, M. Mislove (ed.s), AMS Proceedings of Symposia in Applied Mathematics (vol. 71)* (2012) pp. 89-124
  - + **S. Stepney, V. Kendon, P. Hines, A. Sebald** A framework for Heterotic Computing *8th workshop on quantum physics and logic (QPL 2011), Nijmegen, Netherlands, ETPCS (95)* (2012) pp. 263-273

- + **Peter Hines** A categorical analogue of the monoid semiring construction, *Mathematical Structures in Computer Science 23(1)*, (2013) pp. 55-94
- + **Peter Hines** Types and forgetfulness in categorical linguistics and quantum mechanics, in *C. Heunen, M. Sadrzadeh, E. Grefenstette (ed.s), Quantum Physics and Linguistics: a compositional diagrammatic discourse*, Oxford University Press (2013) pp. 1-34
- + **Peter Hines** Quantum speed-up and categorical distributivity, in *B. Coecke, L. Ong, and P. Panangaden (Eds.) Computation, Logic, Games, and Quantum Foundations*, LNCS 7860, pp. 122-138 (2013)
- + **Peter Hines** Modular Arithmetic Identities from Untyped Categorical Coherence, in *G. Dueck, D. Miller (ed.s) Reversible Computation*, Springer LNCS 7984 (2013) pp. 84-95
- + **Peter Hines** Classical Structures based on Unitaries, in *B. Coecke, P. Panangaden (ed.s) Categories & Types in Logic, Language, and Physics*, Springer LNCS 8222 (2014) pp. 188-210
- + **Peter Hines** Coherence and strictification for self-similarity. *Journal of Homotopy & Related Structures* (2016)
- + **Peter Hines** Information flow in pregroup models of natural language. *EPTCS* (2018)

PUBLICATIONS  
UNDER REVIEW

- + **Peter Hines** Categorical coherence in cryptography: algebra, and number theory. *Submitted* (2018)
- + **Peter Hines** Picturing communication: graphical & categorical models of information flow *Submitted* (2019)
- + **Peter Hines** Girard's  $!( )$  as a reversible fixed-point operator *Submitted* (2018)

WORKS IN  
PROGRESS

- + **Peter Hines** Notes on the category theory of Cantor Space *Monograph*
- + **Peter Hines** Categorical models of timed communication channels
- + **Peter Hines** Grigorchuk's group as monoidal category theory.
- + **Peter Hines** Automata-theoretic models of Lambek pregroups

REFERENCED  
MANUSCRIPTS

(*The following unpublished manuscripts have been referenced by other authors. The majority of material they contain has since appeared in my published work.*)

- + **Peter Hines** A one-object inverse compact closed category used in the Geometry of Interaction (1996)
- + **Peter Hines** A hierarchy of finite state machines and their algebraic models (2000)
- + **Peter Hines** Unitary computations of factorials (2004)
- + **P. Hines, P. Scott** Conditional quantum iteration from categorical traces (2006)
- + **P. Hines** A constructive decision procedure for commutativity of canonical diagrams (2012)

## Appendix B: Invited and Accepted Talks

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*A selection of national and international invited or accepted talks.*

- **York, U.K.**
  - Card Shuffles & Cantor Space: an inverse semigroup perspective *North British Semigroup & Applications Network* (2019)
  - Distinguishing Features of Natural Languages *York Cross-Disciplinary Systems Seminar* (2019)
  - Categorical & Diagrammatic Methods in Cryptography & Communication *York CyberSecurity Group Seminar* (2019)
- **Nice, France** Information flow in pregroup models of natural language *C.A.P.N.S.* (2018)
- **Birmingham, U.K.** Theoretical Computer Science in Quantum Circuit Design *Computer Science Departmental Seminar*, (2017)
- **Leeds, U.K.** Diagrammatic Reasoning in Cryptography and Cryptanalysis *Peripatis seminar on Sheaves and Logic*, (2017)
- **Ottawa, Canada** Inverse monoids and Categories of monotone partial injections *Fields Institute workshop*, (2016)
- **Queen Mary London, U.K.** How complex is Category theory – Cryptanalytic applications of MacLane’s coherence theorem *Computer Science Theory Seminar*, (2015)  
[http://theory.eecs.qmul.ac.uk/oldpages/QM-EECS-TCS/Seminars\\_files/abstract/13052015.html](http://theory.eecs.qmul.ac.uk/oldpages/QM-EECS-TCS/Seminars_files/abstract/13052015.html)
- **York, U.K.** How complex is category theory? – From Foundations to Cryptography. *Computer Science Departmental Seminar*, (2014)  
<https://www.cs.york.ac.uk/research/research-seminars/abstracts2014-15/#hines-12-11-14>
- **Cambridge, U.K.** On the complexity of deciding commutativity of canonical diagrams *Category Theory 2014*, (2014)
- **Oxford, U.K.** Quantum speedup & categorical distributivity *AbramskyFest* (2013)  
[http://link.springer.com/chapter/10.1007/978-3-642-38164-5\\_9](http://link.springer.com/chapter/10.1007/978-3-642-38164-5_9)
- **Oxford, U.K.** Reconsidering MacLane: Coherence for associativity in untyped and infinitary settings *OASIS seminar - Joint Mathematics / C.S. invited talk* (2013)  
<https://www.cs.ox.ac.uk/seminars/847.html>
- **Sussex, U.K.** Logic, Meaning, and Grammar *Dept. Computer Science, invited talk* (2013)  
<http://www.sussex.ac.uk/calps/resources/nlpseminars/archive>
- **Oxford, U.K.** Quantum Circuits for Coherent Conditional Iteration *Quantum Information Sciences Workshop* (2012)  
([www.cs.ox.ac.uk/qisw2012](http://www.cs.ox.ac.uk/qisw2012))  
[http://www.youtube.com/watch?v=K\\_-9YEMwqlA](http://www.youtube.com/watch?v=K_-9YEMwqlA)
- **Leibniz-Zentrum für Informatik, Germany** Coherence in Hilbert’s hotel *Dagstuhl Seminar: Informatic Phenomena*, (2012)  
<http://www.dagstuhl.de/de/programm/kalender/semhp/?semnr=12352>
- **Washington D.C., USA** Informatic Phenomena Lecture Series *U.S. Naval Research Laboratories* (2012)

- **York, U.K** Information theory: from cognitive science to communication channels *Computer Science Departmental Seminar* (2011)  
<https://www.cs.york.ac.uk/seminars/Past/11Autumn/Hines.php>
- **Newcastle, U.K** The category theory of Shor's algorithm *Mathematics Departmental Seminar* (2011)  
<http://www.ncl.ac.uk/math/research/seminars/pure.htm?theme=Quantum>
- **Oxford, U.K.** Types in models of meaning (and elsewhere) *The categorical flow of information in quantum physics and linguistics* (2010)  
[https://golem.ph.utexas.edu/category/2010/09/categories\\_and\\_information\\_in.html](https://golem.ph.utexas.edu/category/2010/09/categories_and_information_in.html)  
<https://www.youtube.com/watch?v=ygBva651wGQ>
- **Leibniz-Zentrum für Informatik, Germany** Quantum oracles for space-bounded Turing machines *Dagstuhl Seminar: Semantics of Information* (2010)  
<http://drops.dagstuhl.de/opus/volltexte/2010/2759/pdf/10232.report.2759.pdf>
- **Oxford, U.K.** Is (categorical) coherence important in quantum computation and information? *QICS Summer School* (2010)  
<http://www.cs.ox.ac.uk/people/bob.coecke/local-info-doc.pdf>
- **Oxford, U.K.** A tale of two programming styles: Comparing quantum and classical approaches to the same problem *QNET Workshop* (2009)  
<https://wiki.comlab.ox.ac.uk/qnet/schedule#hines>
- **New Orleans, U.S.A.** Using information theory to find hidden structure in datasets *Analysis of Informatic Phenomena* (2009)  
[http://dauns.math.tulane.edu/~mwm/wip/Titles\\_and\\_Abstracts.html](http://dauns.math.tulane.edu/~mwm/wip/Titles_and_Abstracts.html)
- **Obergurgl, Austria** Category theory and quantum logic *Foundational Structures for Quantum Information and Computation* (2008)  
<http://www.uibk.ac.at/th-physik/qics-obergurgl2008/>
- **New Orleans, U.S.A.** Towards a quantum machine semantics: *Mathematical Foundations of Program Semantics, special session on Physics, Computation, and Information* (2007)  
<http://www.illc.uva.nl/LogicList/newsitem.php?id=1569>
- **Wroklaw, Poland** The inverse and the trace - iteration in models of reversible computing *Logic In Computer Science, Workshop on Traces and Feedback* (2007)
- **Leibniz-Zentrum für Informatik, Germany** The order theory of iteration *Computational Structures for Modelling Time, Space, and Causality* (2006)  
<http://www.dagstuhl.de/06341>
- **York, U.K.** Planar two-way automata - from inverse semigroups to the quantum Jones polynomial *FountainFest: Semigroups, Categories & Automata, in honour of J. Fountain* (2006)  
<http://maths.york.ac.uk/www/LectureSchedule>
- **Marseille, France** Compact closed monoids - definitions and constructions *Geocal Semantics Workshop on Geometry of Interaction* (2006)  
<http://aix1.uottawa.ca/~scpsg/GeoCal06.GoI/GoI.workshop.titles.html>
- **Bellairs, Barbados** Random thoughts on abstract machines *Categorical Quan-*

- tum Information, Bellairs Research Institute, McGill University* (2006)
- **Paris, France** Reversibility and coherence between computational paths *Institut Henri-Poincare, Mathematical Structures in Quantum Informatics* (2005)  
<http://www.cs.ox.ac.uk/people/bob.coecke/QdayII.html>
  - **London, U.K.** Quantum data and code in computer architectures *QUOXIC seminar, Imperial College* (2004)
  - **Ottawa, Canada** The zoology of quantum computers - classical and quantum control structures & data *Fields Institute Summer School* (2003)  
<http://www.mathstat.dal.ca/~selinger/lfc/fields2003/quantum.html>
  - **Oxford, U.K.** Kleene's theorem, star-free languages, and the Geometry of Interaction *Oxford Informatic Seminars* (2000)