CURRICULUM VITAE
DAVID MUMFORD

University Professor Emeritus
Division of Applied Mathematics
Brown University

Education:

1957 B.A., Magna Cum Laude, Harvard College
1961 Ph.D., Harvard University

Employment:

1961-1962 Instructor and Research Fellow in Mathematics Harvard University
1962-1963 Assistant Professor, Harvard University
1962-1963 Member, Institute for Advanced Study, Princeton and
Visiting Professor, University of Tokyo
1963-1967 Associate Professor, Harvard University
1967-1977 Professor, Harvard University
1967-1968 Visiting Professor, Tata Institute of Fundamental Research
1970-1971 Nuffield Professor, University of Warwick
1976-1977 Visiting Professor, Institute des Hautes Etudes Scientifiques, Paris
1977-1997 Higgins Professor of Mathematics, Harvard University
1978-1979 Visiting Professor, Tata Institute of Fundamental Research
1981-1984 Chairman, Department of Mathematics, Harvard University
1985-1997 Member, Division of Applied Science, Harvard University
1991-1994 Vice-President, International Mathematical Union
1993(fall) Rothschild Professor, Isaac Newton Institute, Cambridge University
1995-1998 President, International Mathematical Union
1997- Professor Emeritus, Harvard University
1996-2007 University Professor, Division of Applied Math. Brown University
1998(fall) Visiting Professor, Institut Henri Poincare, Paris
2005(spring) Visiting Professor, Math. Sciences Research Institute, Berkeley
2007- Professor Emeritus, Brown University

Awards:

1953 Westinghouse Science Talent Search, finalist
1958-1961 Society of Fellows, Harvard University, Junior Fellow
1974 Fields Medal, International Congress of Mathematics, Vancouver
1975 Elected to the National Academy of Sciences
1978 Honorary Fellow, Tata Institute of Fundamental Research
1983 Honorary Degree of Doctor of Science, University of Warwick
1987-1992 MacArthur Foundation Fellow
1991 Elected Foreign Member, Accademia Nazionale dei Lincei, Rome

1995 Elected Honorary Member, London Mathematical Society
1997 Elected American Philosophical Society
2000 Honorary Degree of DSc., Norwegian Univ. of Science and Technology, Trondheim
2001 Honorary Degree of DSc., Rockefeller University
2004 Elected Foreign Member, Norwegian Academy of Science and Letters
2005 IEEE Longuet-Higgins Prize, CVPR 2005, (with Jayant Shah)
2006 The Shaw Prize in Mathematical Sciences, Hong Kong (shared with Wu Wentsun)
2007 Amer. Math. Society Steele Prize for Mathematical Exposition
2008 Wolf Prize in Mathematics (shared with Pierre Deligne and Phillip Griffiths)
2008 Elected Foreign Member of the Royal Society (UK)
2010 National Medal of Science

II. Research in Computer Vision: 1983-2004

Books:

1. *Filtering, Segmentation and Depth*, (with M. Nitzberg and T. Shiota), Springer Lecture Notes in Computer Science **662**, 1993.

2. *Two and Three dimensional Patterns of the Face*, (with P.Giblin, G.Gordon, P.Hallinan and A.Yuille), AKPeters, 1999.

3. *Pattern Theory: The Stochastic Analysis of Real World Signals*, (with A. Desolneux), AK Peters, 2010.

Papers:

1. The Representation of Shape (with A. Latto and J. Shah), in *Proceedings of the 1984 IEEE Workshop on Computer Vision*, pp. 183-191, 1984.

2. Boundary Detection by Minimizing Functionals I (with J. Shah), in *Image Understanding 1989*, Ablex Press, preliminary version in *1985 IEEE Conference on Computer Vision and Pattern Recognition* (CVPR), 1985.

3. The Problem of Robust Shape Descriptors, in *Proc of 1st IEEE International Conference on Computer Vision* (ICCV), 1987, pp.602-606.

4. Optimal Approximations of Piecewise Smooth Functions and Associated Variational Problems (with J. Shah), *Comm. in Pure and Appl. Math.*, 1989, **42**, pp.577-685.

5. The 2.1D Sketch (with M. Nitzberg), in *Proc. of 3rd IEEE International Conference on Computer Vision* (ICCV), 1990, pp.138-144.

6. Parametrizing Exemplars of Categories, *J. Cognitive Neuroscience*, 1991, **3**, pp. 87-88.

7. Mathematical Theories of Shape: do they model perception?, in *Proc. Conference 1570, Soc. Photo-optical & Ind. Engineers*, 1991, pp. 2-10.

8. Texture Segmentation by Minimizing Vector-Valued Energy Functionals: the coupled membrane model (with Tai Sing Lee and Alan Yuille), *Proc. European Conf. Comp. Vision, 1992*, Lecture Notes in Computer Science 588, pp. 165-173.

9. A Bayesian Treatment of the Stereo Correspondence Problem Using Half-Occluded Regions, (with P. Belhumeur), *Proc. IEEE Conf. Comp. Vision and Pattern Recognition, 1992* (CVPR), pp. 506-512.

10. Elastica and Computer Vision, in *Algebraic Geometry and its Applications*, ed. C. Bajaj, Springer-Verlag, 1993, pp. 507-518.

11. Commentary on Grenander & Miller "Representations of Knowledge in Complex Systems", *Proc.Royal Stat. Soc.*, 1994.

12. Pattern Theory: a Unifying Perspective, in *Proceedings 1st European Congress of Mathematics*, Birkhauser-Boston, 1994. Revised version in *Perception as Bayesian inference*, ed. D.Knill and W.Richards, Cambridge Univ. Press, 1996, pp. 25-62.

13. Chordal completions of planar graphs (with F.R.K. Chung), *J. of Combinatorics*, **62**, 1994, pp.96-106.

14. The Bayesian Rationale for Energy Functionals, in *Geometry-Driven Diffusion in Computer Vision*, Bart Romeny editor, Kluwer Academic, 1994, pp. 141-153.

15. The Statistical Description of Visual Signals, *ICIAM 95* ed. K.Kirshgassner, O.Mahrenholtz & R.Mennicken, Akademie Verlag, 1996.

16. Review of *Variational Methods in image segmentation*, by J-M Morel & S. Solimini, *Bull. Amer. Math. Soc.*, **33**, 1996, 211-216.

17. FRAME: Filters, Random Field and Maximum Entropy, (with S.C.Zhu and Y.Wu), *Int. J. Comp.Vis.*, **27**, 1998.

18. Minimax Entropy Principle and its Application to Texture Modeling (with S.C.Zhu and Y.N.Wu), *Neural Computation*, **9**, 1997, 1627-60.

19. Prior Learning and Gibbs Reaction-Diffusion (with Song Chun Zhu), *IEEE Trans. Patt. Anal. and Mach. Int.*, **19**, 1997, 1236-50.

20. The Statistics of Natural Images and Models (with J.Huang), *Proc. IEEE Conf. Comp. Vision and Pattern Rec.* 1999, pp.541-547, Comp Sci Press.

21. Statistics of range images (with Jinggang Huang and Ann Lee), *Proc. IEEE Conf. Comp. Vision and Pattern Rec.* 2000, pp. 324-331, Comp Sci Press.

22. Stochastic Models for Generic Images (with Basilis Gidas), *Quarterly Appl. Math.*, **59**, 2001, pp.85-111.

23. Occlusion models for natural images: A statistical study of a scale-invariant dead-leaves model, (with Ann Lee and Jinggang Huang), *Int. J. Computer Vision*, **41**, 2001, pp. 35-59.

24. Surface evolution under curvature flow (with Conglin Lu and Yan Cao), Special Issue on Partial Differential equations in Image Proc. Comp. Vision and Comp. Graphics, *Journal of Visual Communication and Image Representation*, 2001.

25. Geometric Structure Estimation of Axially Symmetric Pots from Small Fragments(with Yan Cao), in *Proc. of Int. Conf. on Signal Processing, Pattern Recognition, and Applications*, Crete, 2002.

26. Pattern Theory: The Mathematics of Perception, in *Proceedings of ICM 2002, Beijing*, **vol. 1**, 2002, pp.401-422.

27. The Nonlinear Statistics of High-contrast Patches in Natural Images (with Ann Lee and Kim Pedersen), *Int. J. Comp. Vision*, **54**, 2003, pp.83-103.

28. Riemannian Geometries on Spaces of Plane Curves (with Peter Michor), *J. of the European Math. Society*, **8**, 2006, pp.1-48.

29. Vanishing geodesic distance on spaces of submanifolds and diffeomorphisms (with Peter Michor), *Documenta Mathematica*, **10**, 2005.

30. 2D-Shape Analysis using Conformal Mapping (with Eitan Sharon), *Int. J. of Comp. Vision* **70**, 2006, pp.55-75; preliminary version in *Proc. IEEE Conf. Comp. Vision and Patt. Rec.* , 2004.

31. Stuff It! Review of *Introduction to Circle Packing: The Theory of Discrete Analytic Functions* by Kenneth Stephenson, *The American Scientist*, bf 94, 2006.

32. Empirical Statistics and Stochastic Models for Visual Signals, in *Brain and Systems: New Directions in Statistical Signal Processing*, ed. by S.Haykin, J.Principe, T.Sejnowski, and J.McWhirter, MIT Press, 2006.

33. An overview of the Riemannian metrics on spaces of curves using the Hamiltonian approach, (with Peter Michor), *Applied and Computational Harmonic Analysis*, **23**, 2007, pp. 74-113.

34. A Stochastic Grammar of Images, (with Song-Chun Zhu), *Foundations and Trends in ComputerGraphics and Vision*, **2**, 2007, pp. 259-362.

35. A metric on shape space with explicit geodesics, (with Laurent Younes, Peter Michor and Jayant Shah), *Rendiconti Lincei - Matematica e Applicazioni*, **19**, 2008, pp. 2557.

III. Research in the Biology and Psychology of Vision: 1983-2004

1. Discriminating Figure from Ground: the role of edge detection and region growing (with S. Kosslyn, L. Hillger and R. Herrnstein), *Proc. Nat. Acad. Sci.*, 1987, **84**, pp.7354-7358.

2. Teaching Pigeons an Abstract Relational Rule: Insideness (with R. Herrnstein, W. Vaughan and S. Kosslyn), *Perception and Psychophysics*, 1989, **46**, pp. 56-64.

3. On the Computational Architecture of the Neocortex, I: The role of the thalamo-cortical loop, *Biological Cybernetics*, 1991, **65**, pp.135-145; II: The role of cortico-cortical loops, *Biological Cybernetics*, **66**, pp. 241-251.

4. Neuronal Architectures for Pattern-theoretic Problems, in *Large Scale Neuronal Theories of the Brain*, MIT Press, 1994, pp. 125-152.

5. Thalamus, in *The Handbook of Brain Theory and Neural Networks*, M. Arbib editor, MIT Press, 1995.

6. Neural correlates of boundary and medial axis representations in primate striate cortex, (with T.S.Lee, K.Zipser & P.H.Schiller), ARVO abstract, 1995.

7. Issues in the mathematical modeling of cortical functioning and thought, in *The Legacy of Norbert Wiener: A Centennial Symposium*, ed. D.Jerison et al, Amer. Math. Society, 1997, pp. 235-260.

8. Visual Search and Shape from Shading Modulate Contextual Processing in Macaque Early Visual Cortices, (with T.S.Lee, R.Romero, A.Tobias & T.Moore), *Neuroscience Abstract*, 1997.

9. The Role of V1 in Shape Representation (with Tai Sing Lee, Song Chun Zhu & Victor Lamme), *Computational Neuroscience*, ed. Bower, Plenum Press, 1997.

10. The Role of Primary Visual Cortex in Higher Level Vision (with T.S.Lee, R.Romero and V.Lamme), *Vision Research*, **38**, 1998, 2429-2454.

11. Thalamus, in *MIT Encyclopedia of the Cognitive Sciences*, MIT Press, 1999.

12. Neural activity in early visual cortex reflects behavioral experience and higher-order perceptual saliency (with Tai Sing Lee, C.Yang, R.Romero), *Nature Neuroscience*, **5**, 2002, 589-597.

13. Hierarchical Bayesian Inference in the Visual Cortex, (with Tai Sing Lee), *Journal of the Optical Society of America*, **20**, 2003, 1434-1448.

14. Modeling and Decoding Motor Cortical Activity using a Switching Kalman Filter, (with W.Wu, M.Black, Y.Gao, E.Bienenstock, J.Donoghue), *IEEE Trans. on Biomed. Eng.*, **51**, pp. 933-942, 2004.

15. Movement Direction Decoding using Fast oscillation in Local Field Potential and Neural Firing, (with Wei Wu, W.Truccolo, M.Saleh and J.Donoghue), *13th Computational Neuroscience Meeting*, 2004.

16. Minds must unite: Its time for experimentalists to stop ignoring computational modelers (with David Donoho and Bruno Olshausen), 'Opinion' section, *The Scientist*, June 6, 2005.

PhD Students in Computational Neurobiology:

1993 Tai Sing Lee, *Surface inference by minimizing energy functionals: a computational framework forthe visual cortex*

2004 Wei Wu, *Statistical Models of Neural Coding in Motor Cortex.*

IV. Research in Algebraic Geometry: 1959-1982

Books:

1. *Lectures on Curves on Surfaces*, (with G. Bergman), Princeton University Press, 1964.

2. *Geometric Invariant Theory*, Springer-Verlag, 1965; 2nd enlarged edition, (with J. Fogarty), 1982; 3rd enlarged edition, (with F. Kirwan and J. Fogarty), 1994.

3. *The Red Book of Varieties and Schemes*, mimeographed notes from the Harvard Mathematics Department 1967, reprinted in Lecture Notes in Mathematics 1348, Springer-Verlag 1988.

4. *Abelian Varieties*, Oxford University Press, 1st edition 1970, 2nd edition 1974.

5. 6 Appendices to *Algebraic Surfaces*, by O. Zariski, 2nd edition, Springer-Verlag, 1971.

6. *Toroidal Embeddings I* (with G. Kempf, F. Knudsen and B. Saint-Donat), Lecture Notes in Mathematics 339, Springer-Verlag 1973.

7. *Curves and their Jacobians*, University of Michigan Press, 1975.

8. *Smooth Compactification of Locally Symmetric Varieties* (with A. Ash, M. Rapoport, Y. Tai), Lie Groups: History Frontiers and Applications, Vol. 4, Math. Sci. Press 1975.

9. *Algebraic Geometry I: Complex Projective Varieties*, Springer-Verlag, New York, 1976.

10. *Tata Lectures on Theta* (with C. Musili, M. Nori, P. Norman, E. Previato and M. Stillman), Birkhauser-Boston, Part I, 1982, Part II, 1983, Part III, 1991.

11. *Selected Papers on the Classification of Varieties and Moduli Spaces*, Springer-Verlag, 2004.

Papers:

1.Topology of Normal Singularities and a Criterion for Simplicity, *Publ. de l'Institut des Hautes Etudes Scientifiques*, 1961, pp. 5-22.

2.Pathologies of Modular Geometry, *Amer. J. of Math.*, 1961, pp. 339-342.

3.An Elementary theorem in Geometric Invariant Theory, *Bull. Amer. Math. Soc.*, 1961, pp. 483-487.

4.Further Pathologies in Algebraic Geometry, *Amer. J. of Math.*, 1962, pp. 642-648.

5.The Canonical Ring of an Algebraic Surface, an appendix to a paper by Oscar Zariski, *Ann. of Math.*, **76**, 1962, pp. 612-615.

6.Topics in the Theory of Moduli, (in Japanese), *Sugaku*, 1963.

7.Projective Invariants of Projective Structures, *International Congress of Mathematicians, Stockholm1962*, 1963, pp. 526-530.

8.Two Fundamental Theorem on Deformations of Polarized Varieties (with T. Matsusaka), *Amer.J. of Math.*, 1964, pp. 668-684.

9.A Remark on Mordell's Conjecture, *Amer. J. of Math.*, 1965, pp. 1007-1016.

10.Picard Groups of Moduli Problems, in *Arithmetic Algebraic Geometry*, (Proc. of a Conference in Purdue, 1963), Harper and Row, 1965.

 11.On the Equations Defining Abelian Varieties I, II, III, *Inventiones Mathematicae*, 1966, **1**, pp. 287-384; 1967, **3**, pp. 75-135 and pp. 215-244.

12.Families of Abelian Varieties, in *Proc. of Symposium in Pure Math.*, **9**, Amer. Math. Soc., 1966. Pathologies III, *Amer. J. of Math.*, 1967, **89**, pp. 94-104.

13.Abelian Quotients of the Teichmuller Modular Group, *Journal d'Analyse*, 1967, **28**, pp. 227-244.

14.Deformations and Liftings of Finite Commutative Group Schemes (with F. Oort), *Inventiones Mathematicae*, 1968, **5**, pp. 317-334.

15. Periods of Moduli Spaces of Bundles on Curves (with P. Newstead), *Amer. J. of Math.*, 1968, **90**, pp. 1200-1208.

16. Enriques' Classification of Surfaces in Char. p, I, in *Global Analysis (papers in honor of K. Kodaira)*, Spencer and Iyanaga editors, U. of Tokyo Press, 1969, pp. 325-339.

17. Bi-extensions of Formal Groups, in *Algebraic Geometry*, Oxford University Press, 1969, pp. 307-322.

18. A Note on Shimura's paper "Discontinuous Groups and Abelian Varieties", *Math. Annalen*, 1969, **181**, pp. 345-351.

19. Rational Equivalences of 0-cycles on Surfaces, *J. of Math. of Kyoto Univ.*, 1969, **9**, pp. 195-204.

20. The Irreducibility of the Space of Curves of Given Genus (with P. Deligne), *Publ. Math. de l'I.H.E.S.*, 1969, **36**, pp. 75-109.

21. Varieties Defined by Quadratic Equations, in *Questions on Algebraic Varieties*, C.I.M.E., 1969, publ. by Editioni Cremonese, 1970.

22. Theta Characteristics of an Algebraic Curve, *Annales de l'Ecole Norm. Sup.*, 1971, pp. 181-192.

23. A Remark on Mahler's Compactness Theorem, *Proc. Amer. Math. Soc.*, 1971., **28**, pp. 289-194.

24. The Structure of the Moduli Spaces of Curves and Abelian Varieties, *Actes du Congress Int. du Math.*, Nice, 1970; publ. by Gauthier-Villars, 1971.

25. An Analytic Construction of Degenerating Curves Over Complete Local Rings, *Composito Math.*, 1972, **24**, pp. 129-174

26. An Analytic Construction of Degenerating Abelian Varieties over Complete Rings, *Composito Math.*, 1972, **24**, pp. 239-272.

27. Some Elementary Examples of Unirational Varieties which are not Rational (with M. Artin), *J.London Math. Soc.*, 1972, **25**, pp. 75-95.

28. Introduction to the Theory of Moduli (with K. Suominen), in *Algebraic Geometry, Oslo 1970*, F. Oort editor, Wolters-Noordhoff, 1972, pp. 171-222.

29. Introduction to *Oscar Zariski: Collected Works*, vol. I, MIT Press, 1972 and vol. II, MIT Press, 1973.

30. A Rank 2 Vector Bundle on **P4** with 15,000 Symmetries (with G. Horrocks), *Topology*, 1973, **12**, pp. 63-81.

31. An Example of a Unirational 3-fold which is not Rational, *Accad. Naz. dei Lincei*, 1973.

32. A Remark on the Paper of M. Schlessinger, in *Complex Analysis, 1972*, Rice University Studies, **59**, 1973, pp. 113-117.

34. Prym Varieties I, in *Contributions to Analysis*, Academic Press, 1974, pp. 325-350.

35. A New Approach to Compactifying Locally Symmetric Varieties, in *Discrete Subgroups of Lie Groups*, (Proc. of International Colloquium Bombay, 1973), Oxford University Press, 1975, pp. 211-224.

36. Matsusaka's Big Theorem (with D. Lieberman), in *Algebraic Geometry, Arcata 1974*, AMS Proc. of Symposia in Pure Math., **29**, 1975, pp. 513-530.

37. The Self-Intersection Formula and the "Formule-Clef" (with A.T. Lascu and D.B. Scott), *Math.Proc. Camb. Phil. Soc.*, 1975, **78**, pp. 117-123.

38. Pathologies IV, Amer. J. of Math., 1975, **97**, pp. 847-849.

39. Hilbert's 14th Problem - The Finite Generation of Subgroups such as Rings of Invariants, in *Proc.of a Conference on Hilbert's Problems*, (Dekalb, 1974), Amer. Math. Society, 1976.

40. The projectivity of the moduli space of stable curves, I: Preliminaries on "det" and "Div", *Math.Scand.*, **1**, 1976, pp.19-55.

41. Enriques Classification of Surfaces in Char. p, III (with E. Bombieri), *Invent. Math.*, 1976, **35**, pp. 197-232.

42. Enriques Classification of Surfaces in Char. p, II (with E. Bombieri, in *Complex Analysis and Algebraic Geometry*, Baily and Shioda editors, Cambridge Univ. Press, 1977, pp. 23-42.

43. Stability of Projective Varieties, Monographie No. 24 de *L'Enseignement Math.*, **23**, 1977, pp. 39-110.

44. Hirzebruch's Proportionality Theorem in the non-compact case, *Invent. Math.*, 1977, **42**., pp. 239-272.

45. An Algebro-Geometric Construction of Commuting Operators and of Solutions to the Toda Lattice Equation, Korteweg de Vries Equation and Related Non-Linear Equations, in *Proc. of the Int. Symp. on Alg. Geom.*, (Kyoto, 1977), Kinokuniya, Tokyo 1978, pp.115-153.

46. Some Footnotes to the Work of C.P. Ramanujam, in *C.P. Ramanujam– A Tribute*, Studies in Math. No 8, Tata Institute of Fundamental Research, 1978, pp.247-262.

47. The Work of C.P.Ramanujam in Algebraic Geometry, in *C.P. Ramanujam– A Tribute*, Studies in Math. No 8, Tata Institute of Fundamental Research, 1978, pp.8-10.

48. An Instinct for the Key Idea (with John Tate), *Science*, 1978, **202**, pp. 737-739.

49. An Algebraic Surface with K ample, (K2) = 9, pg = q = 0, *Amer. J. of Math.*, 1979, **101**, pp. 233-244.

50. The Spectrum of Difference Operators and Algebraic Curves (with Pierre Van Moerbeke), *Acta Math.*, 1979, **143**, pp. 93-154.

51. On the Kodaira Dimension of the Moduli Space of Curves (with Joe Harris and an appendix by William Fulton), *Inv. Math.*, 1982, pp.23-88.

52. On the Kodaira Dimension of the Siegel Modular Variety, in *Algebraic Geometry - Open Problems*, (Ravello, 1982), *Lecture Notes in Mathematics 997*, Springer-Verlag 1983, pp.348-375.

53. Towards an Enumerative Geometry of Moduli Space of Curves, in *Arithmetic and Geometry*, edited by M. Artin, J. Tate, Birkhauser-Boston, 1983, pp.271-326.

54. A Stratification of the Null Cone via the Moment Map (with Linda Ness), *Amer. J. of Math.*, **106**, 1984, pp.1281-1329.

55. Oscar Zariski: 1899-1986, *Notices of the Amer. Math. Society*, **33**, 1986, pp.891-894.

56. Oscar Zariski and his Work, AMS-MAA joint meeting, 1988, VHS cassette, Amer. Math. Society, 1988.

57. Foreword for non-mathematicians, in *The Unreal Life of Oscar Zariski*, by Carol Parikh, Academic Press, 1990.

58. What can be Computed in Algebraic Geometry? (with Dave Bayer), in *Computational Algebraic Geometry and Commutative Algebra*, ed. D.Eisenbud & L.Robbiano, Camb Univ. Press, 1993, pp. 1-48.

V. Other Work

1. Contributor to *Multi-variable Calculus*, The Calculus Consortium based at Harvard, Wiley, 1995.

2. Calculus Reform – For the Millions, *Notices Amer. Math. Soc.*, May 1997, pp. 559-563.

3. Trends in the Profession of Mathematics, *Mitteilungen der Deutsche Mathemtiker Verein REF*, 1998.

4. The Dawning of the Age of Stochasticity, in *Mathematics: Frontiers and Perspectives*, edited by V.Arnold, M.Atiyah, P.Lax and B.Mazur, AMS, 2000.

5. *Indra's Pearls* (with C.Series and D.Wright), a semi-popular book on fractals arising from complex geometry, Cambridge University Press, 2002.

6. Mathematics in the Near East, some personal observations, *Notices of the AMS*, May 2005.

7. Mathematics Belongs in a Liberal Education, *The Arts and Humanities in Higher Education*, **5**, 2006, pp.21-32.

8. Henri's Crystal Ball (with Phil Davis), *Notices of the AMS*, **55**, 2008, pp. 458-466.