

BIOGRAPHICAL SKETCH

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NAME: Krummel, Thomas M.

eRA COMMONS USER NAME (credential, e.g., agency login): KRUMMEL.THOMAS.M

POSITION TITLE: Emile Holman Professor in Surgery (Pediatric Surgery) and Chair Emeritus, Department of Surgery, Stanford University, Co-Director, Stanford Byers Center for Biodesign

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, include postdoctoral training and residency training if applicable. Add/delete rows as necessary.)*

INSTITUTION AND LOCATION	DEGREE <i>(if applicable)</i>	Completion Date MM/YYYY	FIELD OF STUDY
University of Wisconsin – Parkside, Kenosha, WI	B.S.	Jun 1973	Chemistry
Medical College of Wisconsin, Milwaukee, WI	M.D.	Jun 1977	Medicine
Medical College of Virginia, Richmond, VA		Jul 1977-83	Resident/Chief Resident
Children’s Hospital of Pittsburgh, Pittsburgh, PA		Jul 1983-85	Resident in Ped Surg
University of California, San Francisco, CA		Oct-Dec 85	Fellowship in Fetal Surg

A. Personal Statement

I am currently the Emile Holman Professor and Chair Emeritus of the Department of Surgery at Stanford University; throughout my career, I have tried to be a pioneer and an innovator.

- While just a surgical resident, I formed what was then the world’s second ECMO team. The success of this team served as a major impetus to widespread adoption of this now well established technique with more than 40,000 newborn lives saved.
- As a young faculty member, our work on the study of cellular and biochemical mechanisms of scarless repair in the fetus jumpstarted this investigative field of not only of fetal scarless repair (with a window to eliminate the problems of scarring) but also formed some of the underpinnings of tissue engineering.
- Over the last 20 years, I have been a pioneer in the application of information technology to simulation based surgical training and surgical robots. I was one of the first recipients of a NIH Phased Innovation R21/R33 to develop collaborative simulation based surgical trainings. For this, I have received two Smithsonian Information Technology Innovators Awards.
- For more than 15 years, I have partnered with Dr. Paul Yock to co-direct the Byers Center for Biodesign which has trained over 160 post-doctoral fellows and over 900 engineering and medicine graduate students in the process of medical technology innovation. The program has resulted in a large number of patents, 41 start-up companies, and over 600,000 patients treated with technologies originating from the program.
- I am Chairman of the Board of Directors of Fogarty Institute for Innovation.
- I am President of the International Scientific Committee at IRCAD at the University of Strasbourg, France.

In summary, I am highly focused on understanding and facilitating the evolution of new technologies in the translation of medical technology, which has a direct relevance to this project.

B. Positions and Honors

Positions and Employment

- 1985-1989 Assistant Professor of Surgery and Pediatrics, Medical College of Virginia, Virginia
- 1989-1990 Chairman, Division of Pediatric Surgery, Medical College of Virginia, Virginia
- Associate Professor of Surgery and Pediatrics, Medical College of Virginia, Virginia

- 1990-1996 Professor of Surgery and Pediatrics Chief, Division of Pediatric Surgery, Hershey Medical Center of the Penn State, University College of Medicine, Hershey, PA
- 1994-1999 John A. and Marian T. Waldhausen Professor and Chair, Department of Surgery, Surgeon-in-Chief, University Hospitals Director, Section of Surgical Sciences, Penn State University College of Medicine Geisinger Health System, Hershey, PA
- 1998-2015 Emile Holman Professor and Chair, Department of Surgery, Stanford University School of Medicine
- 2002-2016 Susan B. Ford Surgeon-in-Chief, Lucile Packard Children's Hospital
- 2004-2015 Director, Surgical Innovation Program
- 2006-2012 Director, ACS Accredited Stanford Education Institute/Goodman Simulation Center
- 2009-2011 Program Director, General Surgery Residency Training Program

Other Experience and Professional Memberships

- 1988 Fellow, American Academy of Pediatrics (AAP)
- 1989 Fellow, American College of Surgeons
- 1993 Member, American Pediatric Surgical Association (APSA)
- 1997-2003 Director, American Board of Surgery
- 1999-2003 Director Representing ABS, American Board of Plastic Surgery
- 2003 Member, James IV Association of Surgeons
- 2003 Member, American Society for Medical Simulation
- 2003 Member, Association for Academic Surgery
- 2008-2011 International VP & US Section President, James IV Association of Surgeons
- 2009 Consultant, French Government – Mission réforme C.H.U.
- 2013-2014 President, American Pediatric Surgical Association
- 2015 Chairman, Board of Directors, Fogarty Institute for Innovation
- 2015 Board of Directors, Morgridge Institute for Research, University of Wisconsin

Honors

- 1991 The Thomas V.N. Ballantine Memorial, Excellence in Surgical Education Award
- 1999 ComputerWorld Smithsonian Award, Research in Info Technology & Innovation in Medicine
- 2004 The John Austin Collins, MD Memorial Award for Outstanding Teaching and Dedication to Resident Teaching, Department of Surgery, Stanford University School of Medicine
- 2005 Alumni Star in Medicine Award, Virginia Commonwealth University
- 2006 International Health Professional of the Year 2006, Intern Bio Centre, Cambridge, England
- 2009 Outstanding Achievement in Medicine Award, Santa Clara County Medical Association
- 2009 Consultant, French Government: Mission réforme C.H.U.
- 2012 Named Among Top 1% of Physicians, US News and World Report
- 2014 The Golden Scalpel, Stanford Surgery Residents
- 2014 Shumway Society Achievement Award
- 2015 Albion Walter Hewlett Award sponsored by the Stanford Department of Medicine
- 2015 Thomas M Krummel MD Endowed Chair established and fully funded by Stanford University School of Medicine
- 2015 Chief Resident's Award for a Career of Excellence as Chair Stanford Surgery

C. Contribution to Science

Development of Neonatal and Pediatric ECMO

*Indicates article presented at a national meeting

1. ***Krummel, TM**, Greenfield, LJ, Kirkpatrick, BV, Mueller, DG, Kerkerling, KW, Ormazable, M and Salzberg, AM: Clinical Use of an Extracorporeal Membrane Oxygenator (ECMO) in Neonatal Pulmonary Failure. J. Pediatr. Surg. 17:523 531, 1982.
2. **Krummel, TM**, Greenfield, LJ, Kirkpatrick, BV, Mueller, DG, Kerkerling, KW and Salzberg, AM: Extracorporeal Membrane Oxygenation for Neonatal Pulmonary Failure. Pediatric. Ann. 11:905 908, 1982.
3. Kirkpatrick, BV, **Krummel, TM**, Mueller, DG, Ormazable, M, Salzberg, AM and Greenfield, LJ: The Use of Extracorporeal Membrane Oxygenation for Respiratory Failure in Term Infants. Pediatrics. 62:872 876, 1984.

4. ***Krummel, TM**, Greenfield, LJ, Kirkpatrick, BV, Mueller, DG, Kerkering, KW, Ormazable, M, Napolitano, A and Salzberg, AM: Alveolar Arterial Oxygen Gradients (A aDO₂) versus the Neonatal Pulmonary Insufficiency Index (NPII) for Prediction of Mortality in ECMO Candidates. *J. Pediatr. Surg.* 19:380-385, 1984.
5. ***Krummel, TM**, Greenfield, LJ, Kirkpatrick, BV, Mueller, DG, Kerkering, KW, Ormazable, M, Myer, EC, Barnes, W and Salzberg, AM: The Early Evaluation of Survivors After Extracorporeal Membrane Oxygenation in Neonatal Pulmonary Failure. *J. Pediatr. Surg.* 19:585-590, 1984.

Contributions to Scarless Fetal Tissue Repair

1. ***Krummel, TM**, Nelson, JM, Diegelmann, RF, Lindblad, WJ, Salzberg, AM, Greenfield, LJ and Cohen, IK: Wound Healing in the Fetal and Neonatal Rabbit. *Surg. Forum* 37:595-596, 1986.
2. ***Krummel, TM**, Nelson, JM, Diegelmann, RF, Lindblad, WJ, Salzberg, AM, Greenfield, LJ and Cohen, IK: Fetal Response to Injury in the Rabbit. *J. Pediatr. Surg.* 22:640-644, 1987.
3. ***Krummel, TM**, Nelson, JM, Diegelmann, RF, Michna, BJ, Greenfield, LJ, Salzberg, AM and Cohen, IK: Fetal Response to Injury and its Modulation with Transforming Growth Factor Beta (TGF β). *Surg. Forum* 38:622-623, 1987.
4. *DePalma, RL, **Krummel, TM**, Nelson, JM, Durham, LA, Michna, BJ, Diegelmann, RF and Cohen, IK: Fetal Wound Matrix is Composed of Proteoglycan rather than Collagen. *Surg. Forum* 38:626-628, 1987.
5. ***Krummel, TM**, Michna, BA, Thomas, BL, Sporn, MB, Nelson, JM, Salzberg, AM, Cohen, IK and Diegelmann, RF: Transforming Growth Factor Beta (TGF β) Induces Fibrosis in a Fetal Wound Model. *J. Pediatr. Surg.* 23:600-604, 1988.
6. *Thomas, BL, **Krummel, TM**, Cauthorne, JW, Melany, M, Nelson, JM, Cohen, IK and Diegelmann, RF: Collagen Synthesis and Type Expression by Fetal Fibroblasts in vitro. *Surg. Forum* 39:642-644, 1988.
7. *Haynes, JH, **Krummel, TM**, Schatzki, PF, Dunn, JD, Flood, LC, Cohen, IK and Diegelmann, RF: Histology of the Open Fetal Rabbit Wound. *Surg. Forum* 40:558-560, 1989.
8. *Haynes, JH, Johnson, DA, Mast, BA, Diegelmann, RF, Salzberg, DA, Cohen, IK, and **Krummel, TM**: Platelet derived Growth Factor (PDGF) Induces a Fibrotic Response at a Fetal Wound Site. *Surg. Forum* 41:641-643, 1990.
9. Mast, BA, Flood, LC, Haynes, JH, DePalma, RL, Cohen, IK, Diegelmann, RF and **Krummel, TM**: Hyaluronic Acid is a Major Component of the Matrix of Fetal Rabbit Skin and Wounds: Implications for Healing by Regeneration. *Matrix* 11:63-68, 1991.
10. Mast, BA, Diegelmann, RF, **Krummel, TM** and Cohen, IK: Scarless Wound Healing in the Mammalian Fetus. *Surg. Gynecol. Obstet.* 174:441-451, 1992.
11. *Mast, BA, Haynes, JH, **Krummel, TM**, Diegelmann, RF and Cohen, IK: In Vivo Degradation of Fetal Wound Hyaluronic Acid Results in Increased Fibroplasia, Collagen Deposition and Neovascularization. *Plast. Reconstr. Surg.* 89:503-509, 1992.
12. *Bleacher, JC, Adolph, VR, Dillon, PW and **Krummel, TM**: Fetal Mouse Limb Explants: Regenerative Tissue Repair Occurs in an Unperfused System. *Surg. Forum* 43:626-628, 1992.
13. *Bleacher, JC, Adolph, VR, Dillon, PW and **Krummel, TM**: Isolated Fetal Mouse Limbs: Gestational Effects on Tissue Repair in an Unperfused System. *J. Pediatr. Surg.* 28:1312-1315, 1993.
14. Ehrlich, HP, **Krummel, TM**: The Regulation of Wound Healing from a Connective Tissue Perspective. *Wound Rep. Reg.* 4:203-210, 1996.
15. Bradley, JP, Levine, JP, Blewett, C, Krummel, TM, McCarthy, JG, Longaker, MT: Studies in Cranial Suture Biology: In Vitro Cranial Suture Fusion. *Cleft Palate Craniofacial J.* 33(2):150-156, 1996.
16. Chopra, V, Blewett, CJ, Ehrlich, HP and **Krummel, TM**: The Transition from Fetal to Adult Repair Occurring in Mouse Forelimbs Maintained in Organ Culture. *Wound Rep. Reg.* 5(1):47-51, 1997.

Simulation and Virtual Reality

1. Gorman, PJ, Meier, AH, **Krummel, TM**: Simulation and Virtual Reality in Surgical Education: Real or Unreal? *Arch Surg.* 134(11):1203-1208, November 1999.

2. Marshall, RL, Gorman, PJ, Verne, D, Culina-Gula, S, Murray, WB, Haluck, RS, **Krummel, TM**: Practical Training for Postgraduate Year 1 Surgery Residents. *Am J Surg*, 179(3):194-196, March 2000.
3. Gorman, PJ, Meier, AH, **Krummel, TM**: Computer Assisted Training and Learning in Surgery. *Computer-Aided Surgery*. 5(2):120-130, June 2000.
4. Acosta, E, Temkin, B, **Krummel, TM**, Heinrichs, WL. G2H-graphics-to-haptic Virtual Environment Development Tool for PC's. *Stud in Health Technology & Inform*. 70:1-3, 2000.
5. Haluck, RS and **Krummel, TM**: Computers and Virtual Reality for Surgical Education in the 21st Century. *Archives of Surgery*. 135(7):786-92, July 2000.
6. Gorman, PJ, Meier, AH, Rawn, C, **Krummel, TM**: The Future of Medical Education Is No Longer Blood and Guts, It is Bits and Bytes. *American Journal of Surgery*. 180(5): 353-356, November 2000.
7. *Welch, JN, Johnson, JA, Bax, MR, Badr, R, So, S, **Krummel, TM**, Shahidi, R. Real-time Freehand 3D Ultrasound System for Clinical Applications. In *Proceedings of SPIE Medical Imaging 2001 Conference*, San Diego, CA, February 2001.
8. Canales, MG, Macario, A, **Krummel, TM**: The Surgical Suite Meets the New Health Economy. *JACS*. 192(6):768-776, June 2001.
9. Satish, U, Siegfried, S, Marshall, RL, Gorman, PJ, Smith, JS, Powers, S, **Krummel, TM**: Strategic Management Simulations is a Novel Way to Measure Resident Competencies. *Am J. Surgery*. 181(6):557-61, June 2001.
10. Pugh, CM, Heinrichs, WL, Dev, P, Srivastava S, **Krummel, TM**: Use of a Mechanical Simulator to Assess Pelvic Examination Skills. *JAMA*, 286(9): 1021-3, September 2001.
11. Haluck, RS, Marshall, RL, **Krummel, TM**, Melkonian, MG: Are Surgery Training Programs Ready for Virtual Reality? A Survey of Program Directors in General Surgery. *JACS*. 193(6):660-665, December 2001.
12. Bloom, MB, Rawn, CL, Salzberg, AD, **Krummel, TM**: Virtual Reality Applied to Procedural Testing: The Next Era. *Annals of Surgery*. 237(3), 442-448, March 2003.
13. Lee, SK, Pardo, M, Gaba D, Sowb, Y, Dicker, R, Staus, EM, Khaw, L, Morabito, D, **Krummel, TM**, Knudson, MM: Trauma Assessment Training with a Patient Simulator: A Prospective Randomized Study. *The Journal of Trauma Injury, Infection, and Critical Care*, 55(4), 651-657, October 2003.
14. Camarillo, DB, **Krummel, TM**, Salisbury, JK. Robotic Technology in Surgery: Past, Present and Future. *Am J Surgery*, 188(4A), 1-15, October 2004.
15. Woo, R, Le, D, **Krummel, TM**, Albanese, C. Robot-Assisted Pediatric Surgery. *Am J Surg* 188(4A Suppl):27S-37S, October 2004.

Biodesign and Surgical Innovation

1. Riskin, DJ, Longaker, MT, **Krummel, TM**: Innovation in Surgery: A Historical Perspective. *Annals of Surgery* 244(5): 686-693, November 2006 (epub June 2006).
2. **Krummel, TM** and Ziegler, MM: IPEG Panel on Challenges of Medical Innovation: Introduction. *Journal of Laparoendoscopic & Advanced Surgical Techniques* 16(6):634-638, December 2006.
3. Riskin DJ, Longaker MT, **Krummel, TM**: The Ethics of Innovation in Pediatric Surgery. *Semin Pediatr Surg* 15:319-323, 2006.
4. **Krummel, TM**, Gertner M, Makower J, Milroy C, Gurtner G, Woo R, Riskin DJ, Binyamin G, Connor JA, Mery CM, Shafi BM, Yock PG: Inventing Our Future: Training the Next Generation of Surgeon-Innovators. *Semin Pediatr Surg* 15:309-318, 2006.
5. Tedesco MM, Pak JJ, Harris EJ, **Krummel, TM**, Dalman RL, Lee JT: Simulation-based Endovascular Skills Assessment: The Future of Credentialing? *Journal of Vascular Surgery* 47(5):1008-1014. May 2008 (epub April 2008).
6. Biffi, WL, Spain, DA, Reitsma, AM, Minter, RM, Upperman, J, Wilson, M, Adams, R, Goldman, EB, Angelos, P, **Krummel, TM**, Greenfield, LJ and The Society of University Surgeons Surgical Innovations Project

Team: Responsible Development and Application of Surgical Innovations: A Position Statement of the Society of University Surgeons. Journal of American College of Surgeons, Vol 206 (6):1204-1209, June 2008.

7. Nimgaonkar A, Yock, P, Brinton, T, **Krummel, TM**, Pasricha, P. Gastroenterology and Biodesign: Contributing to the Future of Our Specialty, Gastroenterology, 2013;144, pp. 258-262.

8. Brinton, TJ, Kurihara, CQ, Camarillo, DB, Pietsch, JB, Gorodsky, J, Zenios, SA, Doshi, R, Shen, C, Kumar, UN, Mairal, A, Watkins, J, Popp, RL, Wang, PJ, Makower, J, **Krummel, TM**, Yock, PG. Outcomes from a Postgraduate Biomedical Technology Innovation Training Program: The First 12 years of Stanford Biodesign. Annals of Biomedical Engineering, 2013 Sep;41(9):1803-10, Springer Link, Digital Object Identifier (DOI) 10.1007/s10439-013-0761-2. PMID: 23404074

D. Research Support

Current Research Support – Role: Co-PI

Stanford-Coulter Translational Research Grant Program

3D-Printed Springs for Intestinal Lengthening

May 16, 2017 – May 15, 2018

Completed Research Support – Role: PI

NCIIA E-Team Grant #13485-15

“Aperture Medical”

July 1, 2015 – March 31, 2016

NCIIA Grant #116061

“Caydian Stage 2”

April 1, 2014 – December 31, 2015

Coulter Grant

“Development and Testing of a Prevention Device for Ventilation-Associated Pneumonia: The Bronchoguard

April 1, 2013 – March 31, 2014

Spectrum Pilot Grant – Role: PI

“A Novel Device to Prevent Surgical Wound Infections: A Pilot Clinical Study” with Mark Welton

January 2013 – December 2013

Stanford-Coulter Translational Technology Program

A modular, minimally invasive surgical system

January 4, 2010 – December 31, 2011

NCIIA E-Team Grant #7327-09

Minimally Invasive Treatment for Hemorrhoids (“Orpheus Medical”)

April 1, 2010 - August 31, 2011

NCIIA Grant #5737-08

Low Cost Ventilator for Use in Developing Nations and Large Scale Disasters

August 1, 2008 – December 31, 2010

NCIIA Grant #6640-09

A Medical Device to Treat Gallstone Disease

September 1, 2009 – August 31, 2010

NCIIA Grant #6268-08

Restoration of Fecal Continence in Women (“Confidence Medical”)

April 1, 2009 - April 30, 2010

Stanford-Coulter Translational Technology Program

A Method to Close Enteric Port Sites Following Natural Orifice Translumenal Surgery (NOTES)

April 1, 2009 – March 31, 2010

Stanford-Coulter Translational Technology Program

A Low Cost Ventilator for Use in Developing Nations and Large Scale Disasters

April 1, 2009 – March 31, 2010