

KHALIL I. ELKHODARY

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Dept. of Mechanical Engineering
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1. Academic Appointments

- *Professor*, The American University in Cairo, Egypt. July 2023 – *Current*
- *Associate Professor*, The American University in Cairo, Egypt. July 2017 – June 2023
- *Assistant Professor*, The American University in Cairo, Egypt. Sept. 2012 – June 2017
- *Post-Doctoral fellow*, Theoretical & Applied Mechanics, Northwestern University. Jan. 2011 – Aug. 2012
- *Research Assistant*, Mechanical Engineering, North Carolina State University Sept. 2006 – May 2010

2. Professional Appointments

- *Member*, Research Ethics Committee, Magdi Yacoub Heart Foundation. Jan. 2021 – *Current*
- *Consultant*, Composite Manhole Covers Failure, Al-Masreya (Egypt) Jan. 2021 – Mar. 2021
- *Consultant*, Research Management, Magdi Yacoub Heart Foundation. Feb. 2020 – Jun. 2020
- *Associate Editor*, ASME Journal of Engineering Materials and Technology Jan. 2019 – *Current*

3. Educational Background

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|-----------------------------------|-------|--|---------------|----------------|
| • American University in Cairo | Egypt | <i>Intl. & Comparative Education</i> | MA | <i>Current</i> |
| • Northwestern University | USA | <i>Theoretical & Applied Mechanics</i> | Post-Doctoral | 2012 |
| • North Carolina State University | USA | <i>Computational Micromechanics</i> | PhD | 2010 |
| • North Carolina State University | USA | <i>Applied Mathematics</i> | MS | 2010 |
| • American University in Cairo | Egypt | <i>Materials Engineering</i> | MS | 2006 |
| • American University in Cairo | Egypt | <i>Mechanical Engineering</i> | BS | 2003 |

4. Research and Creative Interests

- *Micro and Nano Mechanics*: Crystal plasticity FEM, and MD of dislocations.
- *Biomechanics & Multiphysics*: Cardiovascular system modeling, FEM, CFD, and FSI.
- *Computational Science in Nonlinear Mechanics*: ML and Graph theory in constitutive modeling and FEM.
- *Educational Neurotechnology*: VR/AR/MR/XR applications in collaborative engineering education.

5. Honors and Awards

- Services Award, MENG Department, AUC 2020
- Services Award, MENG Department, AUC 2018
- AUC Teaching Excellence Nomination. 2016
- RDI Researcher Award, Ceremony held in Cairo, Egypt 2015
- Invited Feature Article, Journal of Materials Research; Figure on Front Cover. 2011
- Research Assistantship, North Carolina State University, NC, USA. 2006-2010
- Outstanding Paper, with M.A. Zikry, et. al., Symposium HH, Materials Research Society. 2009
- Yousef Jameel Fellowship, Science & Technology Research Center, Cairo, Egypt. 2006
- Teaching Assistantship, The American University in Cairo, Egypt. 2003-2006
- Merit scholarship, The American University in Cairo, Egypt. 1999-2003

6. Research Output

Journal Papers

Nonlinear continuum mechanics (ML, Graph theory, FEM)

- 1- Z Tang, Y Wang, **KI Elkhodary**, Z Yu, S Tang, D Peng. “Data-driven modeling on anisotropic mechanical behavior of brain tissue with internal pressure” - Defence Technology, (2023).
- 2- D Liu, H Yang, **KI Elkhodary**, S Tang, X Guo “Cyclic softening in nonlocal shells—A data-driven graph-gradient plasticity approach”- Extreme Mechanics Letters, (2023).
- 3- Gang Zhang, Hai Qiu, **Khalil I. Elkhodary**, Shan Tang, Dan Peng . “Modeling tunable fracture in hydrogel shell structures for biomedical applications.” *Gels*. (2022)
- 4- Xiang, Q., Yang, H., **Elkhodary, K. I.**, Sun, Z., Tang S., Guo, X. “Derivation of the Orthotropic Nonlinear Elastic Material Law Driven by Low-Cost Data (DDONE).” *Acta Mechanica Sinica. Online* (2022).
- 5- Xiang, Q., Yang, H., **Elkhodary, K.I.**, Tang, S., Guo, X. A multiscale, data-driven approach to identifying thermo-mechanically coupled laws — bottom-up with artificial neural networks. *Computational Mechanics. Online* (2022).
- 6- Daoping Liu, Hang Yang, **Khalil I. Elkhodary**, Shan Tang, Wing Kam Liu, and Xu Guo. “Mechanistically informed data-driven modeling of cyclic plasticity via artificial neural networks.” *Computer Methods in Applied Mechanics and Engineering. Online* (2022).
- 7- Zhang, Gang, Tian Fu Guo, **Khalil I. Elkhodary**, Shan Tang, and Xu Guo. "Mixed Graph-FEM phase field modeling of fracture in plates and shells with nonlinearly elastic solids." *Computer Methods in Applied Mechanics and Engineering* 389 (2022): 114282.
- 8- Chen, Jie, Hang Yang, **Khalil I. Elkhodary**, Shan Tang, and Xu Guo. "G-MAP123: A mechanistic-based data-driven approach for 3D nonlinear elastic modeling—Via both uniaxial and equibiaxial tension experimental data." *Extreme Mechanics Letters* 50 (2022): 101545.
- 9- Qiu, Hai, Hang Yang, **Khalil I. Elkhodary**, Shan Tang, Xu Guo, and Jinhao Huang. "A data-driven approach for modeling tension–compression asymmetric material behavior: numerical simulation and experiment." *Computational Mechanics* 69, no. 1 (2022): 299-313.
- 10- B.L. Boyce, [...], **K. Elkhodary**, [...], L. Xue, “*The Second Sandia Fracture Challenge: Predictions of Ductile Failure under Quasi-Static and Moderate-Rate Dynamic Loading*,” Int. J. Frac. (2016)
- 11- S. Tang, Y. Yang, X. He Peng, W. K. Liu, X. Xu Huang, **K. I. Elkhodary**. “*A Semi-numerical Algorithm for Instability of Compressible Multilayered Structures*.” Comp. Mech. (2015)
- 12- B. Boyce, S. Kramer, H. Fang, [...], **K. I. Elkhodary**, [...], T. Wierzbicki. “*The Sandia Fracture Challenge: blind round robin predictions of ductile tearing*.” Int. J. Frac. Vol. 10, p1007. (2014)

Micro and nanocrystalline mechanics (FEM, MD, Experiments)

- 13- Islam H Abdelgalil, MA Bakr, **KI Elkhodary**, Mohamed F Aly (2023). Experimental and Computational Investigation of Mg AZ31 Grain Refinement by Shear-Enhanced Rolling. *Materials Today Communications*.
- 14- Zhangtao Sun; Fu Tian Guo; **Khalil I. Elkhodary**; Hang Yang; Nian Zhou; Shan Tang. “Localization and macroscopic instability in nanoporous metals.” *Acta Mechanica Sinica*. (2022).
- 15- Huang, C., Gao B., Zhou N., Xin R., Tang S., and **Elkhodary, K. I.** "Enabling High-fidelity Twin Pattern Prediction in Polycrystals—A Mesoscale Grain Boundary Plasticity Model." *International Journal of Plasticity* 148 (2022): 103121.

- 16- Zhou, N., **Elkhodary, K. I.**, Zhang, L., & Tang, S. "Understanding the linear relation between pop-in excursion length and critical force for spherical nanoindentation." *Phil. Mag.* (2021).
- 17- Zhou, N., **Elkhodary, K. I.**, Huang X., Tang S., and Li Y.. "Dislocation structure & dynamics govern pop-in modes of nanoindentation on single-crystal metals." *Phil. Mag.* (2020).
- 18- Huang, C., **Elkhodary, K. I.**, and Tang S.. "Resolving the diffusionless transformation process of twinning in single crystal plasticity theory." *Intr. Journal of Plasticity* (2019).
- 19- Gazder, Azdiar A., **Khalil I. Elkhodary**, Mitchell JB Nancarrow, and Ahmed A. Saleh. "Transmission Kikuchi diffraction versus electron back-scattering diffraction: A case study on an electron transparent cross-section of TWIP steel." *Micron* 103 (2017): 53-63.
- 20- **K. I. Elkhodary**, M.A. Bakr. "Single Crystal Plasticity with Bend-Twist Modes." *J. Mech. Phys. Solids*. Vol. 79, pp 44-66. (2015)
- 21- **K. Elkhodary**, MS Greene, S Tang, T. Belytschko, WK Liu. "Archetype-blending continuum (ABC) theory." *Comput. Methods Appl. Mech. Eng.* Vol. 254, pp309-333. (2013)
- 22- **K. Elkhodary**, M. Zikry. "Crack Nucleation and Propagation via Dynamic Interactions of Crystalline Phases in Al-Alloys subject to Large Deformations." *Phil. Mag.* (2012)
- 23- **K. Elkhodary**, M. Zikry. "Dynamic Crack Nucleation and Propagation in Polycrystalline Al-Aggregates Subjected to Large Inelastic Deformations." *Int. J. Frac.* (2012)
- 24- **K. Elkhodary**, M. Zikry. "A Fracture Criterion for Finitely-deforming Crystalline solids: The Dynamic Fracture of Ductile and Brittle Single Crystals." *J. Mech. Phys. Solids*. Vol. 59. (2011)
- 25- **K. Elkhodary**, W. Lee, L. Sun, D. Brenner, M. Zikry "Deformation Mechanisms of an Ω Precipitate in a High Strength Aluminum Alloy Subjected to High Strain Rates," *J. Materials Research*, Vol. 26, Issue 4, pp487-497. (2010) ([Invited Feature Article, Front Cover](#))
- 26- **K. Elkhodary**, L. Sun, D. Irving, D. Brenner, G. Ravichandran, M. Zikry "Integrated Experimental, Atomistic, and Microstructurally-Based Finite-Element Investigation of the Dynamic Compressive Behavior of 2139 Aluminum," *J. Appl. Mech.*, v 76, p. 051306-1 (2009)
- 27- **K. Elkhodary**, H. Salem, M. Zikry "Equal Channel Angular Pressing of Canned 2124-Al Compacts: Processing, Experiments, and Modeling". *Metall. and Mater. Trans. A: Physical Metallurgy and Materials Science*, v 39, n 9, p 2184-219 (2008)

Biomechanics (Inverse FEM, In-vitro, Clinical)

- 28- Ali, A. M., Hafez, A. H., **Elkhodary, K. I.**, & El-Morsi, M. (2023). A CFD-FFT approach to hemoacoustics that enables degree of stenosis prediction from stethoscopic signals. *Heliyon*.
- 29- Abulfadl, Y. S., El Ela, Y. A., Al Khaiyat, A. M., **Elkhodary, K. I.**, & Badran, M. (2023). Cyclophosphamide enfeebls myocardial isometric contraction force via RIP1/RIP3/MLKL/TRPM7-mediated necroptosis. *Biomedicine & Pharmacotherapy*, 163, 114819.
- 30- Heidari, A., **Elkhodary, K.I**, Pop C., [...], Tafti, A.H., "Patient-Specific Finite Element Analysis of Heart Failure and the Impact of Surgical Intervention in Pulmonary Hypertension Secondary to Mitral Valve Disease." *Med. Biol. Eng. Comput.* (2022).
- 31- Shalaby, N., Zemzemi, N., **Elkhodary, K. I.** "Simulating the Effect of Sodium Channel Blockage on Cardiac Electromechanics." *Proceedings of the Institution of Mechanical Engineers, Part-H: Journal of Engineering in Medicine* (2020).
- 32- D.T. O'Connor, **K.I. Elkhodary**, Y. Fouad, [...], I. Jasiuk, W.K. Liu. "Modeling Orthotropic Elasticity, Localized Plasticity & Fracture in Trabecular Bone." *Comp. Mech.* (2016)

Books & Book Chapters

- 1- Morcos, P., **K. I. Elkhodary**, and H. G. Salem. "Mechanically Alloyed Magnesium Based Nanostructured Alloy Powders for Biomedical Applications." *Magnesium Technology 2017*. Springer, Cham, p. 35-41. (2017)
- 2- T. Belytschko, W.K. Liu, B. Moran, **K. I. Elkhodary**. *Nonlinear Finite Elements for Continua and Structures*, 2nd Edition. John Wiley & Sons, LTD, Chichester, UK. Dec. 2013. ([7,400+ Citations](#))
- 3- M. A. Bessa, **K. I. Elkhodary**, W.K. Liu, T. Belytschko, B. Moran. *Solution Manual: Nonlinear Finite Elements for Continua and Structures*, 2nd Ed. John Wiley & Sons, Chichester, UK. Dec. 2013.
- 4- **K. Elkhodary**, M. S. Greene, D. O'Connor "The Archetype Blending Theory and Compact Bone Mechanics". *Multiscale Simulations and Mechanics of Biological Materials*. Eds.: Shaofan Li, Dong Qian. Publisher: John Wiley & Sons. May 2013. ([Invited Book Chapter](#))
- 5- **K. Elkhodary**, S. Tang "Inclusion Clusters in the Archetype Blending Continuum Theory". *Handbook of Micromechanics and Nanomechanics*. Eds.: Shaofan Li, Xin-Lin Gao. Publisher: Pan Stanford Press. May 2013. ([Invited Book Chapter](#))

Conference Papers

- 1- **K. I. Elkhodary**, LK Gaafar, AO Nassef. A Pedagogical Approach to an Engineering Educational Virtual Environment. *Technology Enhanced Learning Specifications, Standards and Quality*. APITEL, Alexandria Egypt. (2019).
- 2- **K. I. Elkhodary**, M. A. Bakr: Plastic Bend-Twist Modes In Dynamically Deformed Single Crystals With Embedded Secondary Phases. *Proceedings of PLASTICITY '16: The Twenty Second International Symposium on Plasticity and its Current Applications*. Kona, Hawaii, USA. (2016)
- 3- W. K. Liu, **K. Elkhodary**, S. Tang: Archetype Blending Continuum Theory. *The International Conference On Advances In Computational Mechanics, ACOME*. Ho Chi Minh City, Vietnam. (2012)
- 4- W. Lee, **K. Elkhodary**, H. Salem, M. Zikry. : Experimental and Microstructurally Based Computational Investigation of the High Strain-Rate Behavior of High Strength Aluminum Alloys. *Multiscale Polycrystal Mechanics of Complex Microstructures*. MRS /AIME, 420 Commonwealth Dr., P. O. Box 430 Warrendale PA 15086 United States.[np]. (2011)
- 5- **K. Elkhodary**, W. Lee, B. Cheeseman, D. Brenner, M. Zikry: The Effects of Precipitates and Mn-bearing Particles on High Strain-Rate Compression of High Strength Aluminum. *Multiscale Polycrystal Mechanics of Complex Microstructures*. MRS, Vol. 1225E. (2010). ([Outstanding Paper](#))
- 6- **K. Elkhodary**, W. Lee, L. Sun, B. Cheeseman, D. Brenner, M. Zikry: Deformation of Precipitate Platelets in High Strength Aluminum Alloys under High Strain-Rate Compression. *TMS Proc.*, Vol 2: Materials Characterization, Computation & Modeling & Energy, 47-52. (2010)
- 7- **K. Elkhodary**, W. Lee, B. Cheeseman, D. Brenner, M. Zikry, High Strain-Rate Behavior of High Strength Aluminum Alloys, in *Nano- and Microscale Materials—Mechanical Properties and Behavior under Extreme Environments*, eds. A. Misra, T.J. Balk, H. Huang, M.J. Caturla, C. Eberl, MRS Symp. Proc., Vol. 1137E, Warrendale, PA, EE05-31.R1. (2009)

Patents

- 1- **K. I. Elkhodary**, H.G. Salem, M. A. Bakr, M. Elbadry. *Shear Enhanced Rolling (SER). A Method to improve grain size uniformity in rolled alloy billets*. *EP. Appl. No.: 16873724.5* (2023).
- 2- **K. I. Elkhodary**, H.G. Salem, M. A. Bakr, M. Elbadry. *Shear Enhanced Rolling (SER). A Method to improve grain size uniformity in rolled alloy billets*. *CN. Appl. No.: 201680081298.0* (2019).

7. Fund Raising (1.35 Million USD)

- The American University in Cairo, Co-PI (PI Dr. Mostafa Youssef, MENG) **2022-2024**
Title: Piloting a computational framework for pharmaceutical drug effectiveness control in relation to critical process parameters (CPPs). *Funds:* \$40,000
- British Council, Co-PI (PI Dr. Sherif Aly, CSCE) **2022-2023**
Title: UK- Egypt Higher Education Climate change partnerships Grants. *Funds:* \$54,000
- Sawiris Foundation, PI **2021-2023**
Title: Fellowship for MSc in Mechanical Engineering. Sponsored by Sir Magdi Yacoub.
Funds: \$21,000
- The American University in Cairo, PI **2021-Current**
Title: Faculty Fellowship for MA in ICED. *Funds:* \$21,000
- The American University in Cairo, PI **2021-2023**
Title: Teaching and Learning Enhancement Grant, for VR in Engineering Education.
Funds: \$15,000
- Bartlett Cycle-II, Co-PI (PI Dr. El-Morsi, Co-PI Dr. Youssef) **2020-2022**
Title: Surviving Cancer to Die of Heart disease? (**Ranked #1**) *Funds:* \$83,000
- The American University in Cairo, Co-PI (PI Dr. El-Morsi, Co-PI Dr. Shalan CSCE) **2020-2022**
Title: Translating Big-data from Computational Models to Novel Clinical Metrics.
Funds: \$75,000
- The Living Heart Project Academic Member Heart Model License, PI **2020-Current**
Title: Cardiac Electromechanics Modeling and Simulation.
Support: Software, waiving equivalent of \$15,000 license fees per year.
- The American University in Cairo, PI (on behalf of MENG, ARCH) **2019-2021**
Title: Educational Virtual Environment. *Funds:* \$440,000
- The American University in Cairo, PI **2017-2019**
Title: Shear Enhanced Rolling and Projectile Stopping Panels. *Funds:* \$79,000
- Research Development and Innovation Fund, EUROPE AID, PI **2014-2016**
Title: Computational Prognosis of Drug Effects on the Heart.
- Academy of Scientific Research and Technology, PI **2013-2015**
Title: Design of concrete matrix composites with chemically functionalized polymer bars.
Funds: \$14,000
- The American University in Cairo (**Ranked Best Proposal**), PI **2016-2018**
Title: Towards a Cardiac Electromechanical Modeling Tool. *Funds:* \$107,500.
- Academy of Scientific Research and Technology, Co-PI **2016-2019**
Title: ALM repairs for air-force components. *Funds:* \$127,000
- The American University in Cairo, PI **2014-2018**
Title: Developing an HPC Infrastructure, with UTI
Support: \$50,000 worth In-kind contribution of hardware resources in data-center
- Academy of Scientific Research and Technology, Co-PI **2013-2015**
Title: Bioplastics for the Food Packaging Industry. *Funds:* \$48,000
- Bibliotheca Alexandrina, PI **2013-2015**
Title: Multiscale Materials Simulation, from Nano-science to Macro-mechanics. *Funds:* \$10,000
- The American University in Cairo, PI **2012-2014**
Title: Multiscale Materials Simulation, from Nano-science to Macro-mechanics. *Funds:* \$10,000

8. Teaching

- Continuum Mechanics of Materials (**MENG 5930**). *Three offerings.*
Introduced nonlinear mechanics with tensor algebra and tensor calculus on finitely deformed bodies, with various applications in thermo-mechanics.
- Advanced Stress Analysis in Design and Manufacturing (**MENG 5254**). *One offering.*
Introduced nonlinear constitutive models (material and geometric) for the various material classes.
- Computational Methods in Engineering (**ENGR 5202**). *Two offerings.*
Introduced parallel computing, and greatly expanded group MATLAB usage and programming, and with direct links to individualized student research.
- The Finite Element Method and Applications in Design (**MENG 4553**). *Three offerings.*
Introduced as a Galerkin method in Sobolev space, with complete MATLAB codes in 2D, and with 3D ANSYS projects on thermo-mechanical applications. Offered with VR experience.
- Failure of Mechanical Components (**MENG 4227**). *One offering.*
Greatly expanded on the failure mechanisms of polymers and ceramics; introduced X-FEM modeling.
- Mechanics of Materials (**MENG 3505**). *Twelve offerings.*
Revised content to include the direct matrix method (introductory finite elements), offered with VR experience. Revised to meet three liberal education outcomes (group work, information literacy, and critical thinking).
- Strength of Materials (**MENG 2112**). *Four offerings.*
Revised content to include a collaborative project, offered with VR experience. Revised to meet three liberal education outcomes (group work, information literacy, and critical thinking).

M.Sc. Theses Supervision (Recent)

- **Advisor**, Ms. Afnan Elhamshari, (RCSS). 2023.
Topic: Introducing a Caputo-Land Fractional Order System for Myocyte Viscoelasticity.
Now: Seeking a Ph. D. in Colorado Boulder, USA.
Journal publication: Submitted to Nonlinear Dynamics (Q1).
- **Advisor**, Mr. Ahmed Ali, (MENG). 2023.
Topic: A CFD-FFT approach to Hemoacoustics suited to Stethoscopic Auscultation.
Now: Pursuing a Ph. D. at Carleton University, Canada.
Journal publications: 2 in Heliyon (Q1, open access), one published, one under revision.
- **Advisor**, Mr. Omar Oraby, (MENG). 2023.
Topic: An in-situ digital imaging correlation method for residual stress estimation in WAAM.
Now: Accepted a Ph. D. offer in the USA.
Journal publication: To be submitted.
- **Advisor**, Mr. Youssef Naga, (MENG). 2022.
Topic: Educational Data Mining for Predicting University Students' Performance, to Enhance University Admission Criteria.
Now: Founder and leader of *Unibridge* for high school extra-curricular educational activities.
- **Co-Advisor**, Mr. Mohamed Abdel-Hay, (MENG). 2021. (Advisor Dr. El-Morsi)
Topic: Fluid-Structure Interaction of NREL 5-MW Wind Turbine.
Now: Energy engineer at **PGESCO**, Egypt.
Publication in pipeline: A Review of FSI-Based Computational Studies for Horizontal Axis Wind Turbines (HAWT)

- **Advisor**, Mr. Youssef Abdel Raouf, (MENG). 2020.
Topic: A patient-specific adaptation of the Living Human Heart Model in application to pulmonary hypertension.
Now: PhD Student at Biommeda, **Ghent University**, Belgium.
Journal Publication: Heidari, A., Elkhodary, K. I., Pop, C., Badran, M., Vali, H., **Abdel-Raouf, Y. M.**, ... & Tafti, H. A. Patient-specific finite element analysis of heart failure and the impact of surgical intervention in pulmonary hypertension secondary to mitral valve disease. *Medical & biological engineering & computing* (2022).
- **Advisor**, Mr. Mohamed Abdelkhalek, (RCSS). 2019.
Topic: Semi-automatic spatio-temporal reconstruction of the left ventricle from CMR.
Now: PhD Student, Cardiovascular Lab, **McMaster University**, Canada.
Journal Publication: **Abdelkhalek, M.**, Aguib, H., Moustafa, M., & Elkhodary, K. (2020). Enhanced 3D Myocardial Strain Estimation from Multi-View 2D CMR Imaging. *arXiv preprint arXiv:2009.12466*. **On-hold until revisions can be completed with MYF, for re-submission.**
- **Advisor**, Mr. Andrew Athanasios, (MENG). 2019.
Topic: A computational model for dilated cardiomyopathy: morphology and electromechanics.
Now: Runs his family business (unrelated).
- **Co-Advisor**, Mr. Peter Morcos, (MENG). 2018. (Advisor Dr. Salem)
Topic: Nanostructured Mg-ZK50 Sheets Fabricated for Potential Use for Biomedical Apps.
Now: PhD Student in Computational Materials Science at **Texas A&M**.
Book Chapter Publication: **Morcos, P.**, K. I. ElKhodary, and H. G. Salem. "Mechanically Alloyed Magnesium Based Nanostructured Alloy Powders for Biomedical Applications." *Magnesium Technology 2017*. Springer, Cham, p. 35-41. (2017)
- **Research Advisor**, Noha Shalaby, (NANO). RA from 2016-2018.
Topic: Computational modeling of nanodrug-induced effects on cardiac electromechanics.
Now: PhD Student at Neuroengineering and Pain Research Lab, at **University of Connecticut**.
Journal Publication: Shalaby, N., Zemezmi, N., & Elkhodary, K. (2020). Simulating the effect of sodium channel blockage on cardiac electromechanics. *Proceedings of the Institution of Mechanical Engineers, Part H: Journal of Engineering in Medicine*, 234(1), 16-27.