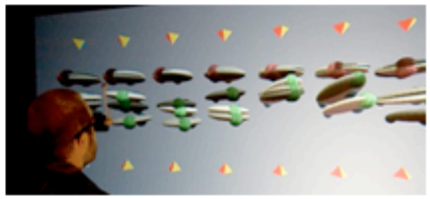
Dan Keefe
McKnight Land-Grant Assistant Professor
Department of Computer Science and Engineering
University of Minnesota

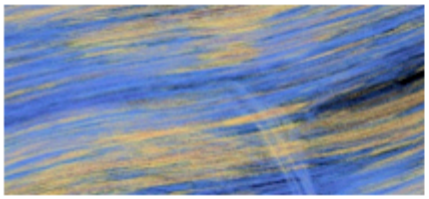
IV/LAB

UNIVERSITY OF MINNESOTA'S **INTERACTIVE VISUALIZATION LAB**

Research Projects



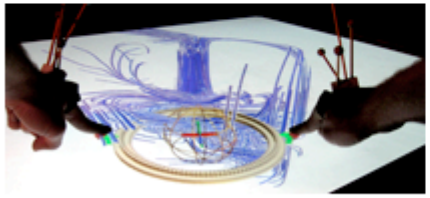
NSF CAREER: Visualizing Scientific Motions



National Academies / Keck Foundation: Intelligent Interactive Imaging (3I)

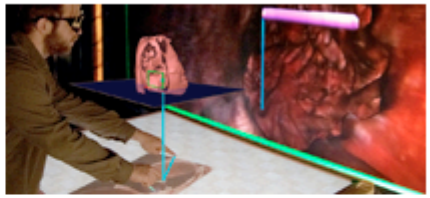
Art and Design in Visualization

3D Modeling, CavePainting, and Drawing on Air



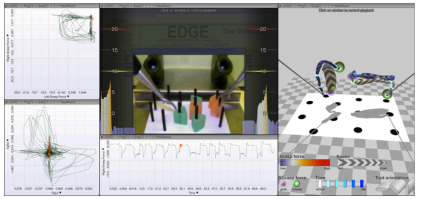
3D User Interfaces (Multi-Touch, Haptics, Virtual Reality)

Next Generation Immersive Visualization Environments



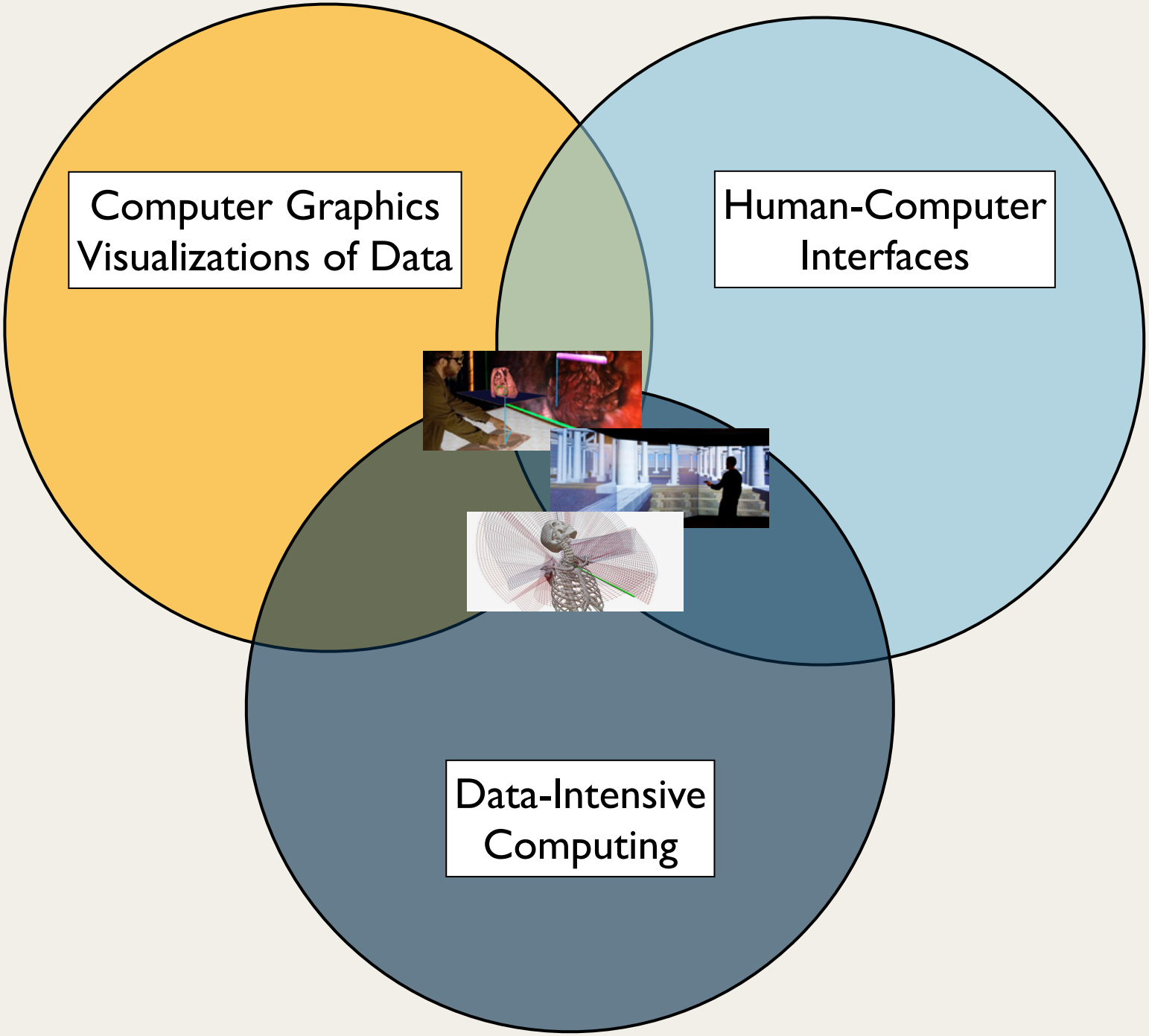
Virtual Prototyping of Medical Devices

Virtual Classics



Data-Driven Surgical Training

Our Computer Science Research



What brings me here?

My own art practice - I need at least one foot in this door.

Interest/experience in collaborative research.

my art practice:
form through movement,
the expressiveness of the
hand in virtual space

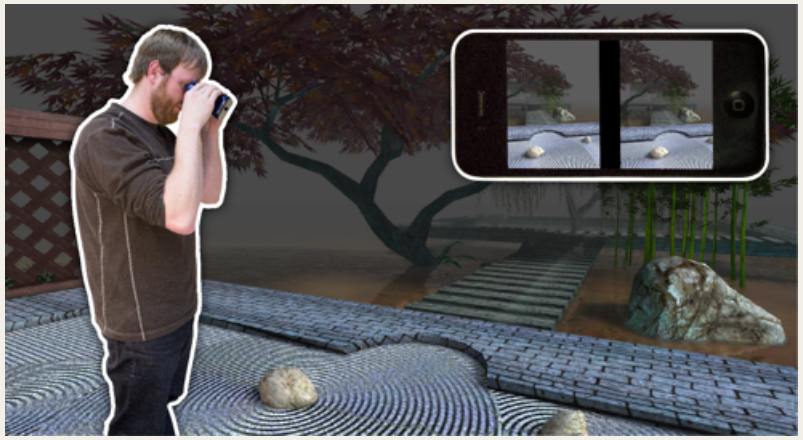
CavePainting & Making la Guitarrista Gitana
I3D 2001, SIGGRAPH Art Gallery 2002, ...

Hiding Spaces with Cynthia Beth Rubin
SIGGRAPH 2002, ISEA 2002.

Collaborations in Courses and Research



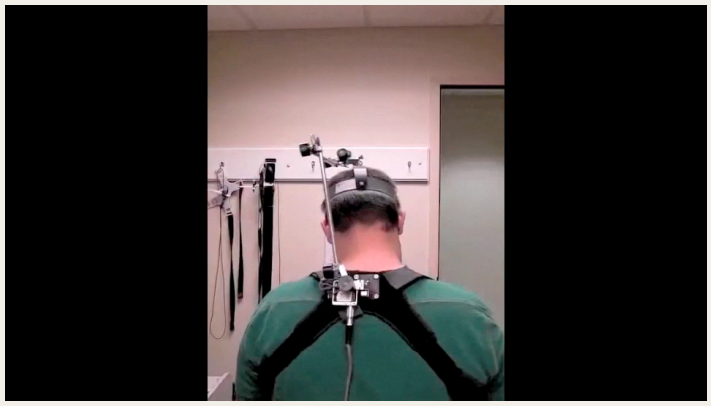
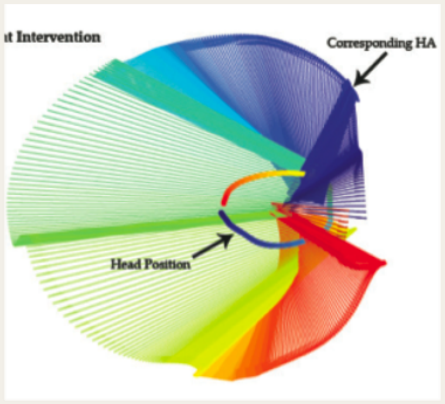
"Advanced Virtual Environments" course:



Collaborations in Courses and Research

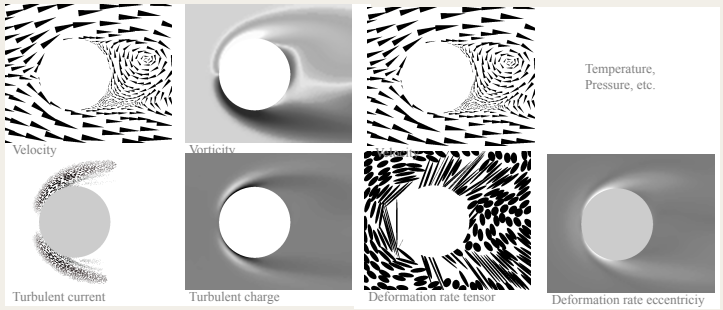


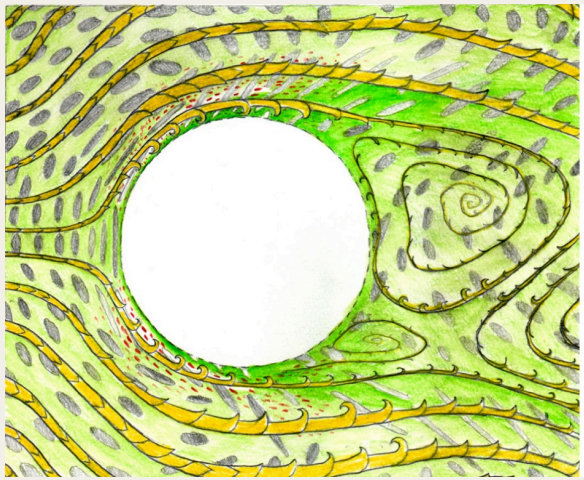
Research on medical data visualization (more on this later):

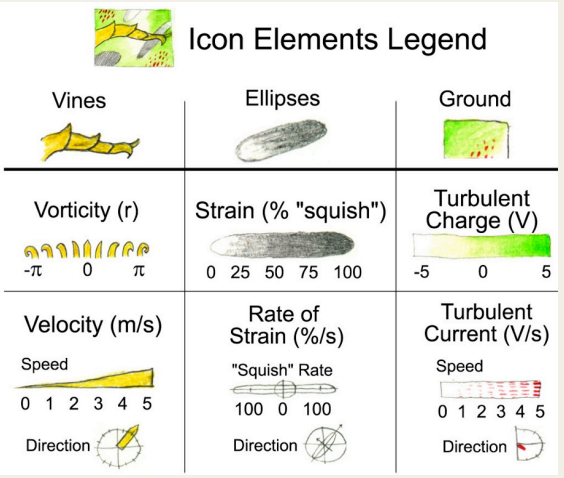



Collaborations in Courses and Research

Example multi-variate data visualization assignment:



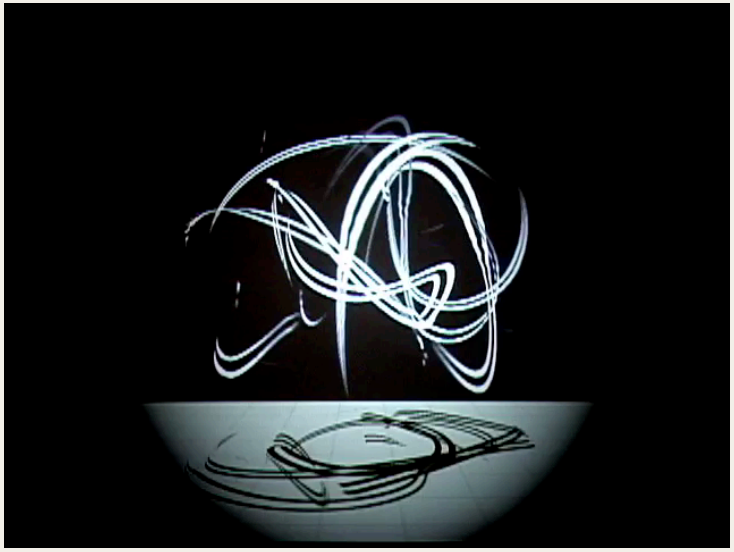




Collaborations in Courses and Research

Former illustration student, Harrison Love:

"The collaboration between science and art is exactly what my art is about."
"Much of the abstract work that I have been creating since my last few years at RISD is, in part, inspired by the work that we did in the Lab at Brown."



Harrison's work utilizing my 3D computer interfaces

Harrison's current work

What is art+science collaboration? Some examples:

Koan Baysa

Ellen Levy

Koan Baysa

Ellen Levy

5 Minute Descriptions of Current Research

Ann Fink

The Sandy Project & Rachel Bernstein

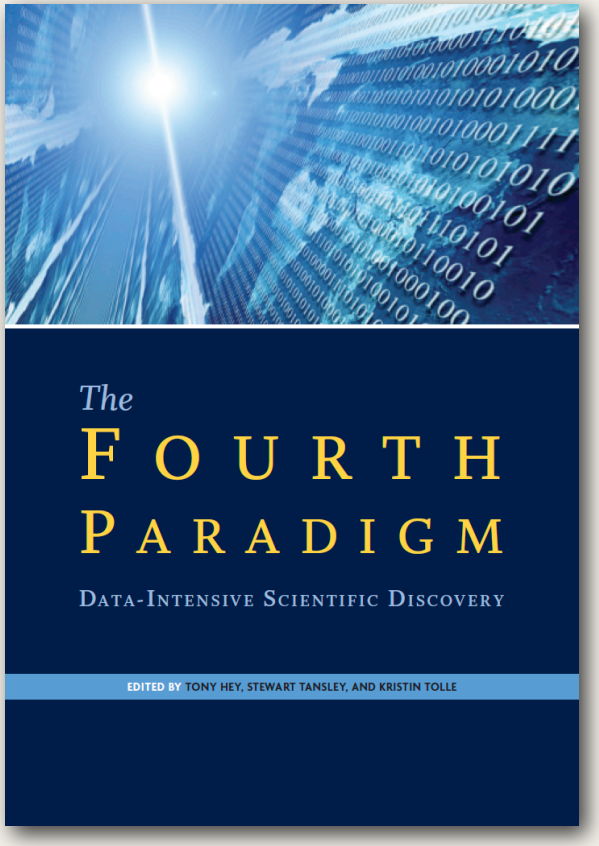
Dan Keefe

Ann Fink
New York University

Rachel Bernstein
New York University

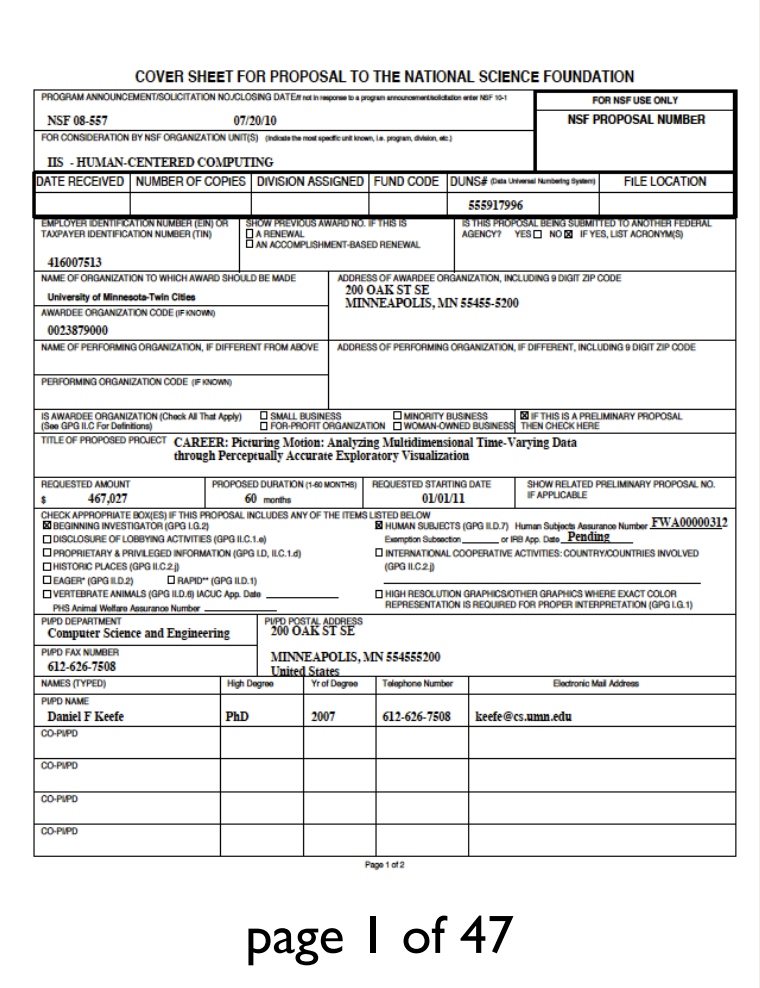
Dan Keefe
McKnight Land-Grant Assistant Professor
Department of Computer Science and Engineering
University of Minnesota

Data-Intensive Science and Engineering: A New Paradigm



- Rather than looking through telescopes, we are now looking through large-scale, complex simulations and instruments.
- Knowledge is stored in a computer in the form of massive, multidimensional datasets.
- Scientists/engineers analyze using data management, statistics, and visualization.
- Disciplines must adjust; new tools are needed to manage, organize, share, query, visualize, document, validate, and preserve data.

NSF Research Grant Example



COVER SHEET FOR PROPOSAL TO THE NATIONAL SCIENCE FOUNDATION

PROGRAM ANNOUNCEMENT/SOLICITATION NO./CLOSING DATE (If not in response to a program announcement/solicitation enter NSF 10-1) — FOR NSF USE ONLY

NSF 08-557 07/20/10 — NSF PROPOSAL NUMBER

FOR CONSIDERATION BY NSF ORGANIZATION UNIT(S) (Indicate the most specific unit known, i.e. program, division, etc.)

IIS - HUMAN-CENTERED COMPUTING

DATE RECEIVED	NUMBER OF COPIES	DIVISION ASSIGNED	FUND CODE	DUNS# (Data Universal Numbering System)	FILE LOCATION
				555917996	

EMPLOYER IDENTIFICATION NUMBER (EIN) OR TAXPAYER IDENTIFICATION NUMBER (TIN): 416007513

SHOW PREVIOUS AWARD NO. IF THIS IS ☐ A RENEWAL ☐ AN ACCOMPLISHMENT-BASED RENEWAL

IS THIS PROPOSAL BEING SUBMITTED TO ANOTHER FEDERAL AGENCY? YES ☐ NO ☒ IF YES, LIST ACRONYM(S)

NAME OF ORGANIZATION TO WHICH AWARD SHOULD BE MADE: University of Minnesota-Twin Cities

AWARDEE ORGANIZATION CODE (IF KNOWN): 0023879000

ADDRESS OF AWARDEE ORGANIZATION, INCLUDING 9 DIGIT ZIP CODE: 200 OAK ST SE MINNEAPOLIS, MN 55455-5200

NAME OF PERFORMING ORGANIZATION, IF DIFFERENT FROM ABOVE:

PERFORMING ORGANIZATION CODE (IF KNOWN):

ADDRESS OF PERFORMING ORGANIZATION, IF DIFFERENT, INCLUDING 9 DIGIT ZIP CODE:

IS AWARDEE ORGANIZATION (Check All That Apply) (See GPG II.C For Definitions) ☐ SMALL BUSINESS ☐ FOR-PROFIT ORGANIZATION ☐ MINORITY BUSINESS ☐ WOMAN-OWNED BUSINESS ☒ IF THIS IS A PRELIMINARY PROPOSAL THEN CHECK HERE

TITLE OF PROPOSED PROJECT: CAREER: Picturing Motion: Analyzing Multidimensional Time-Varying Data through Perceptually Accurate Exploratory Visualization

REQUESTED AMOUNT	PROPOSED DURATION (1-60 MONTHS)	REQUESTED STARTING DATE	SHOW RELATED PRELIMINARY PROPOSAL NO. IF APPLICABLE
$ 467,027	60 months	01/01/11	

CHECK APPROPRIATE BOX(ES) IF THIS PROPOSAL INCLUDES ANY OF THE ITEMS LISTED BELOW

☒ BEGINNING INVESTIGATOR (GPG I.G.2)
☐ DISCLOSURE OF LOBBYING ACTIVITIES (GPG II.C.1.e)
☐ PROPRIETARY & PRIVILEGED INFORMATION (GPG I.D, II.C.1.d)
☐ HISTORIC PLACES (GPG II.C.2.j)
☐ EAGER* (GPG II.D.2) ☐ RAPID** (GPG II.D.1)
☐ VERTEBRATE ANIMALS (GPG II.D.6) IACUC App. Date _____ PHS Animal Welfare Assurance Number _____
☒ HUMAN SUBJECTS (GPG II.D.7) Human Subjects Assurance Number FWA00000312 Exemption Subsection _____ or IRB App. Date Pending
☐ INTERNATIONAL COOPERATIVE ACTIVITIES: COUNTRY/COUNTRIES INVOLVED (GPG II.C.2.j)
☐ HIGH RESOLUTION GRAPHICS/OTHER GRAPHICS WHERE EXACT COLOR REPRESENTATION IS REQUIRED FOR PROPER INTERPRETATION (GPG I.G.1)

PI/PD DEPARTMENT: Computer Science and Engineering
PI/PD POSTAL ADDRESS: 200 OAK ST SE MINNEAPOLIS, MN 554555200 United States
PI/PD FAX NUMBER: 612-626-7508

NAMES (TYPED)	High Degree	Yr of Degree	Telephone Number	Electronic Mail Address
PI/PD NAME: Daniel F Keefe	PhD	2007	612-626-7508	keefe@cs.umn.edu
CO-PI/PD				
CO-PI/PD				
CO-PI/PD				
CO-PI/PD				

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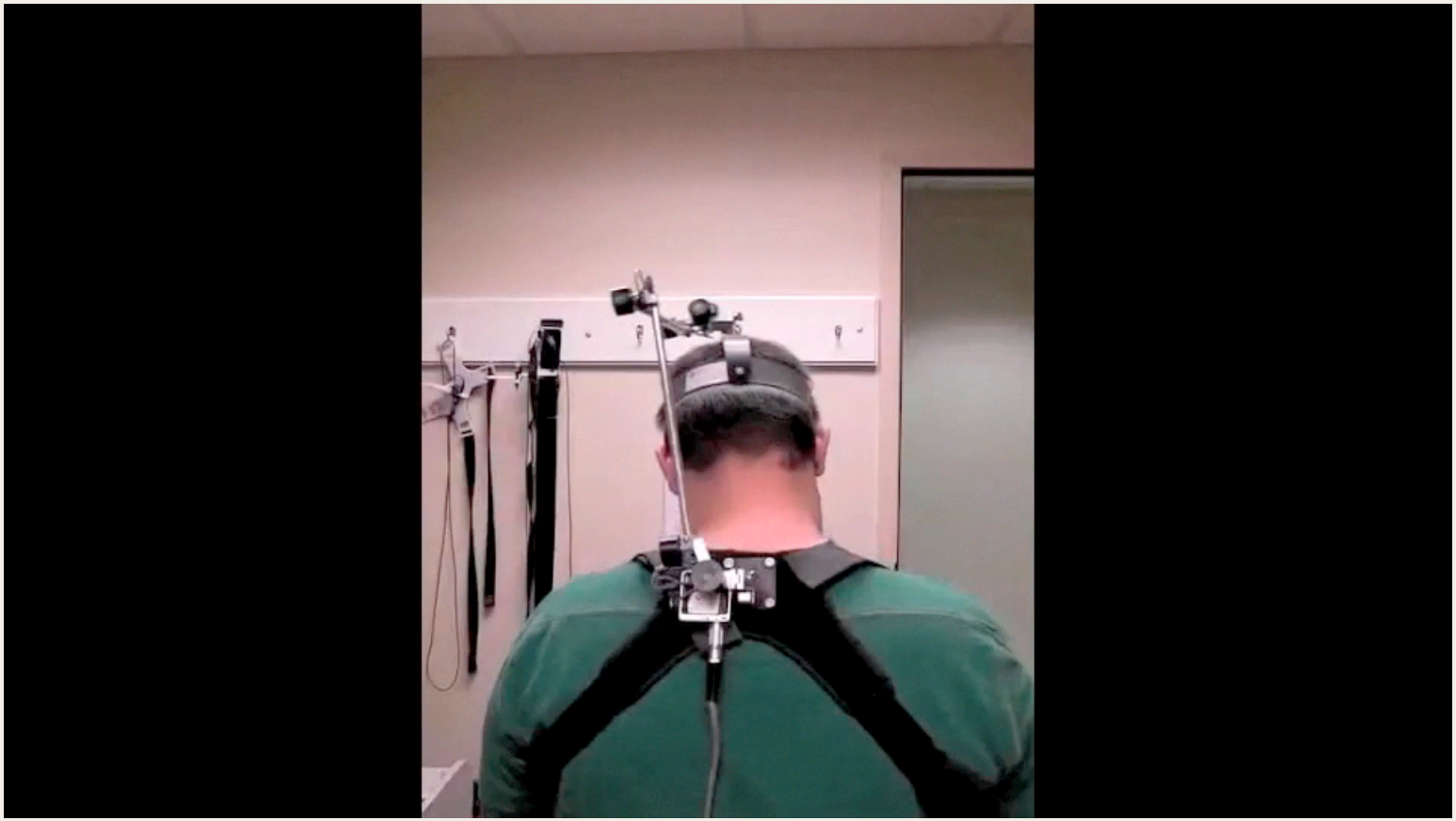
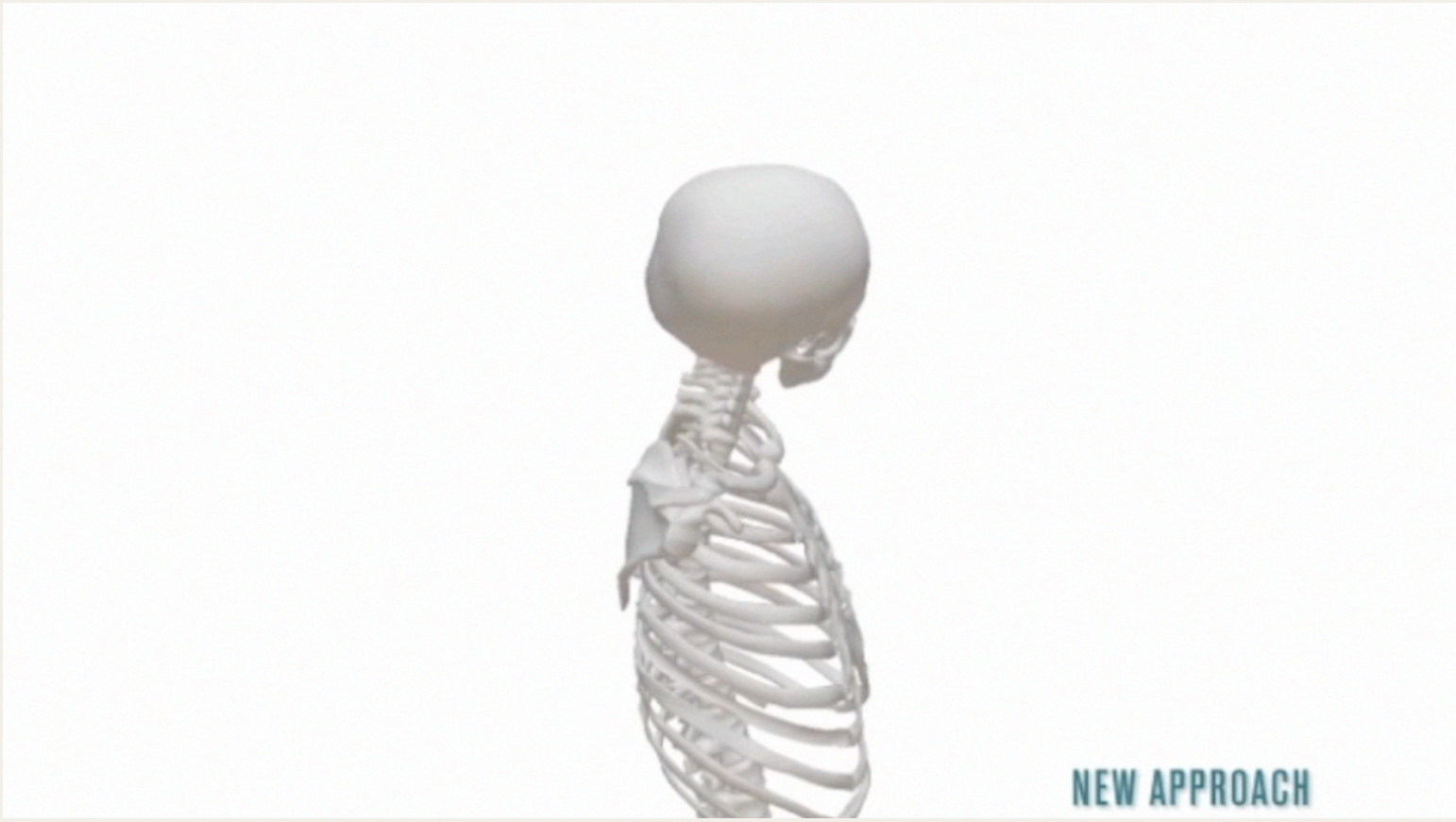
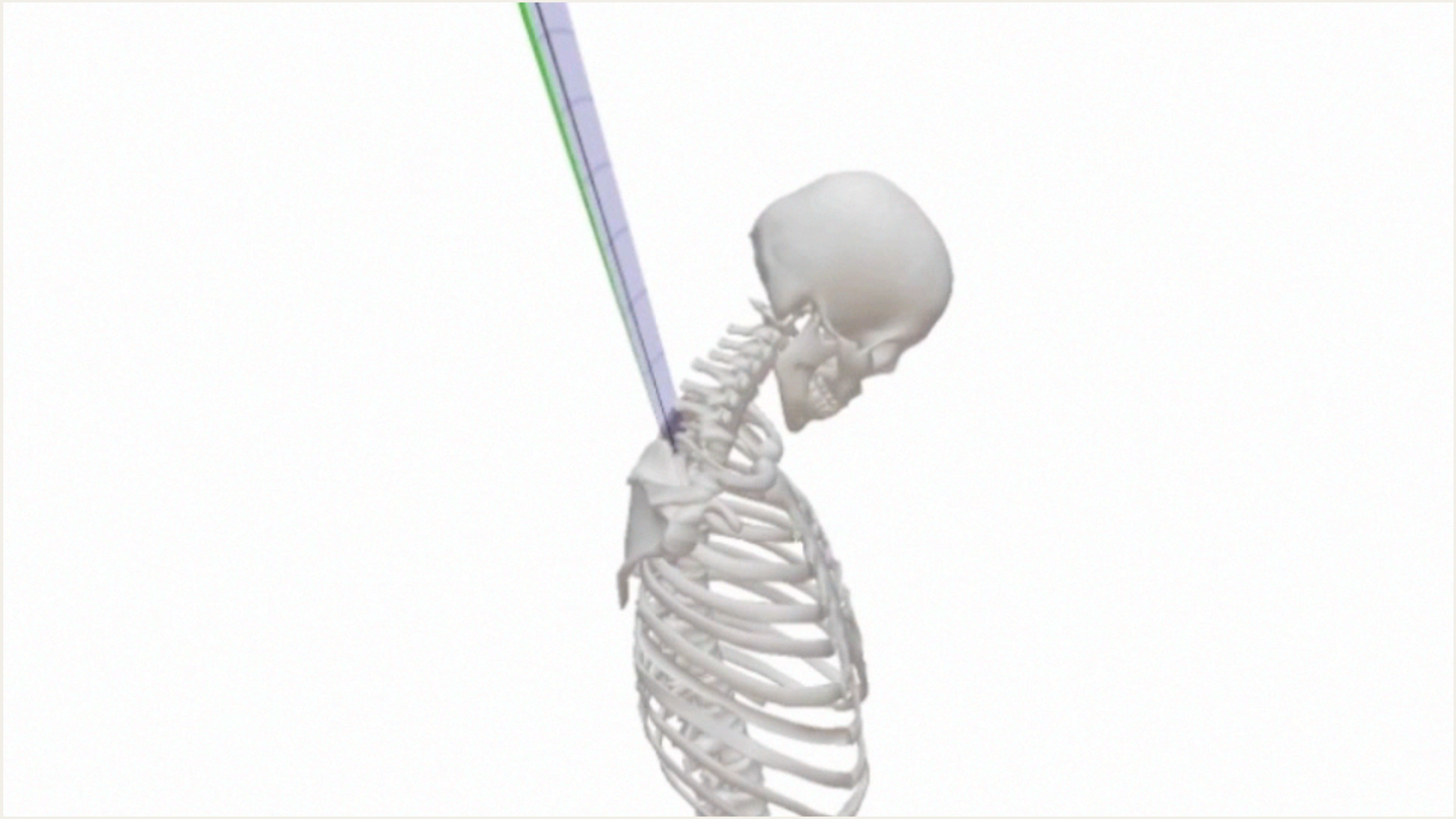
- "Picturing Motion: Analyzing Multidimensional Time-Varying Data through Perceptually Accurate Exploratory Visualization"
- 47 pages, 5 letters of support from collaborators, maybe 5-20% success rate depending on agency, for this example two submissions to be successful
- Almost $500,000 … but that only covers:
  - 1 grad student per year
  - 1/3 of summer research salary
- I have 4 or 5 Ph.D. students in my lab, so need 3 or 4 good grants at all times to keep it running.
- When art connects with the cutting edge science the collaboration can enhance a proposal like this by making it unique and exciting. An art component might also be valued by science funding agencies due to the potential for the work to have broader impact on science and increase participation in science.




NEW APPROACH



How do we scale this up to analyze hundreds or thousands of motions as a group?

- The problem:
  - It's too much data to look at it all at once.
  - Yet, it is so complex that statistical techniques are not sufficient.

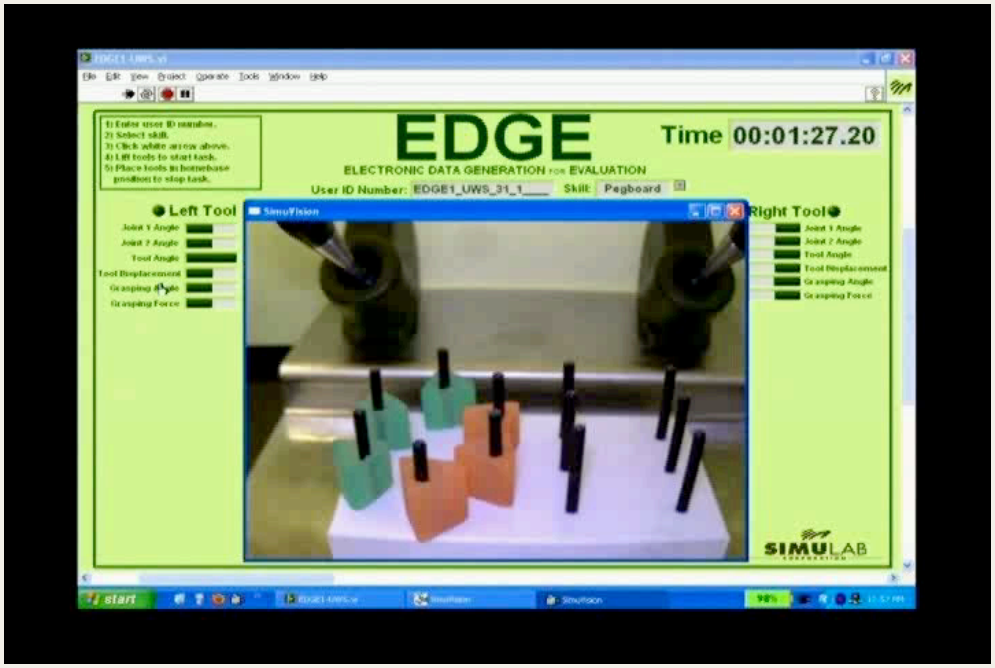
- Our approach:
  - Combine human visual processing with computing.
  - Some automatic data processing to at least determine the subsets of the data that are most "interesting".
  - Develop novel interactive computer graphics visualization strategies to depict these subsets.

This is a really hard problem and it shows up everywhere because "making comparisons" is fundamental to science.

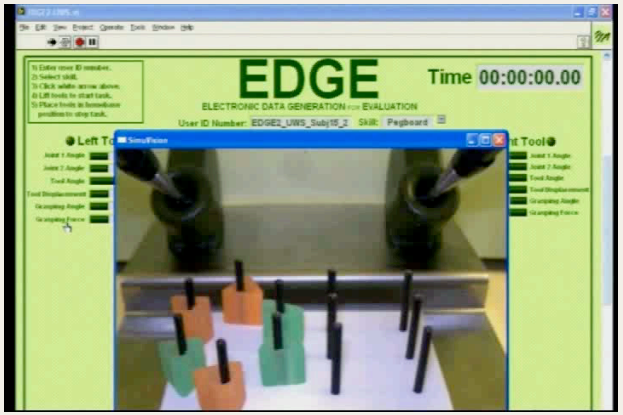
http://en.wikipedia.org/wiki/Laparoscopic_surgery

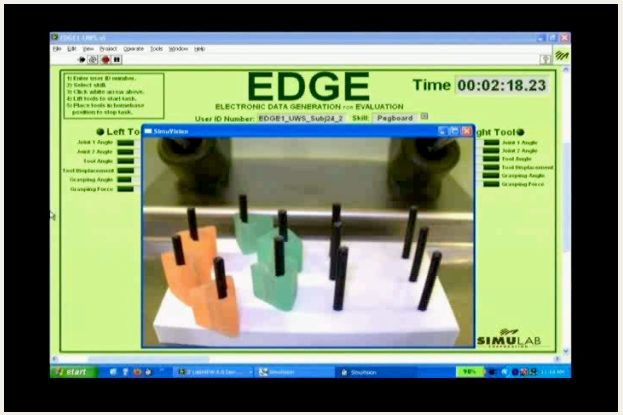
A simulator logs vast amounts of data from training exercises.

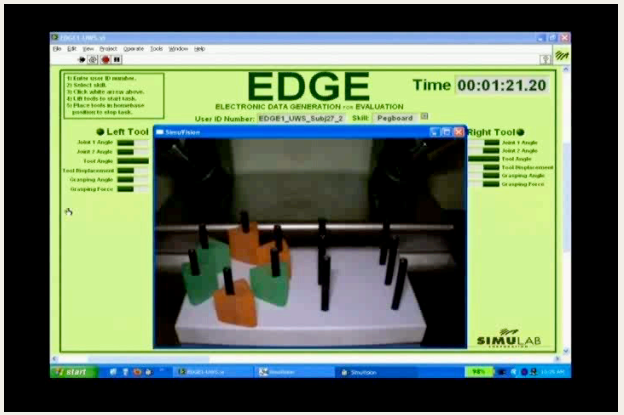
U. of Wash. / Simulab

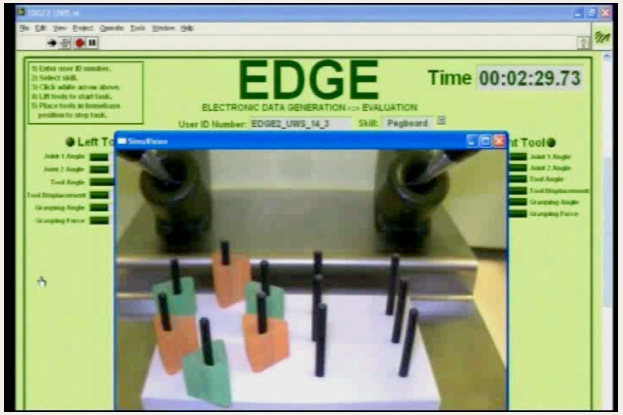


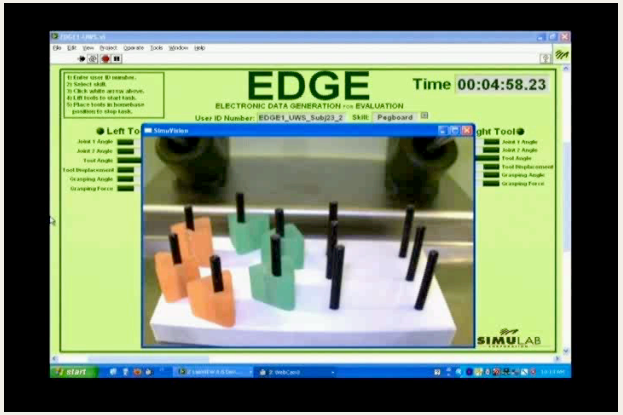
Video taken during a training task.

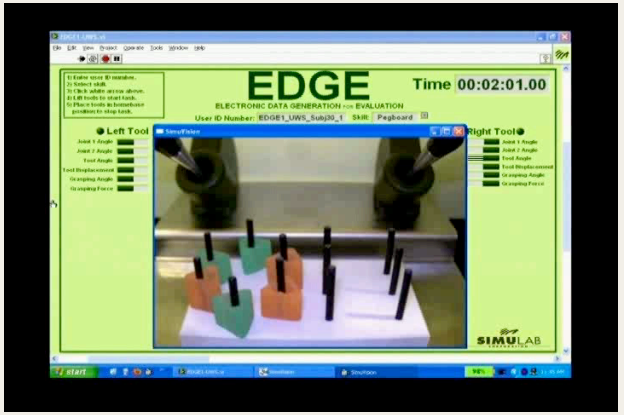


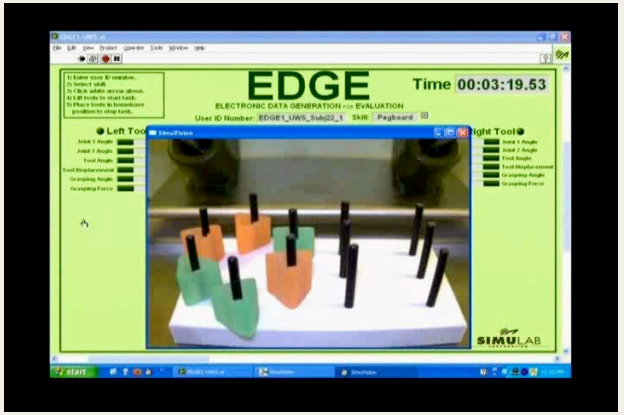


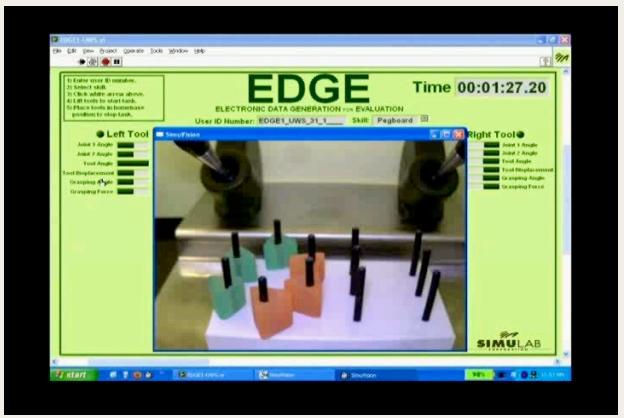












1 task, 104 trials, 428,924 frames = 3.97 hours of video, 12+ variables per frame

Thanks to

Students at the University of Minnesota and Minneapolis College of Art and Design: Dane Coffey, Joseph Downing, Bret Jackson, Fedor Korsakov, David Schroeder, Heesung Sohn, Lauren Thorson, John Bremseth, Nina Rivera, Mia Manzo, Antonio Morales, Charles Price, and Kay Rossbach.

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