

# Bruce Schena | Electromechanical Product Design

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## Elevator Pitch

I am an engineer, inventor, and entrepreneur with 20+ years of professional experience in and around technology, machines, robots, and computers. I possess the “engineer gene” and have known that designing and building contraptions would be central to my life from a very early age. I am presently a senior member of the engineering staff at Intuitive Surgical, focused on architecting & engineering a new generation of surgical robots. I have a full machine shop in my garage and have 78 issued US Patents (most with multiple worldwide versions), with another 80+ pending.

## Professional Experience

### Feb 2006 Engineering Fellow

-Present [Intuitive Surgical](#) (NASDAQ: [ISRG](#))

One of two “Engineering Fellows” (VP-Level on Technical Ladder, the highest technical position attainable) in the company. Technical leader focused on designing next-generation robotic surgery systems. Over 40 patent filings in 6 years.

Areas of involvement include overall system architecture, exceptionally-integrated electro-mechanical designs (i.e. compact, lightweight, highest-performance attainable subject to the laws of physics), advanced servo technology (e.g. full-custom motors, full-custom sensors, ultra-dense electronics packaging including Chip-On-Board components), advanced surgical instruments, surgical endoscopes (opto-mechanical packaging, product design), managing multiple outside technical vendors for in-bound strategic technologies, failure analysis/fire-fighting, IP generation, prosecution & strategy, and many of other confidential activities.

Active mentor, creative resource, and Design Review Board member for engineering and manufacturing teams across the company.  
*Sunnyvale, California*

### 2002-Present (on hiatus) Electromechanical Consultant Silicontraption

Freelance electromechanical product design. Clients include early stage startups as well as established publicly-traded medical equipment companies. Projects include consumer products, mobile handset (cell), microcontroller-enabled architectural products, and surgical robots.  
*Menlo Park, California*

### 1995-2002 Co-Founder, Chief Technical Officer, Board Member, VP Engineering, Director of R&D, IPO Team Member, Corporate Spokesperson, Corporate Secretary, Electrical Engineer, Machinist, Modelmaker, Electrical Technician, Staff Therapist :-)

[Immersion Corporation](#) (NASDAQ: [IMMR](#))

Helped grow company from 3 full-time employees to a publicly-traded company employing 180+ people and \$20+ Million in annual sales. Individual contributor and engineering team leader on key product development efforts for both Immersion-brand and licensed strategic partners such as BMW, Logitech, and Kensington.  
*San Jose, California*

### 1993-1995 Electromechanical Consultant Pandemonium Product Development

Freelance electromechanical product design. Clients included Golfpro International, Surgical Robotics (Kleiman Medical), Nomadic Technologies, and Immersion Corporation  
*Menlo Park, California*

### 1992-1995 Teaching Assistant Stanford University, [Product Realization Lab](#)

Taught all aspects of manufacturing technology including conventional & CNC machining, foundry, welding, woodworking, and modelmaking. Often responsible for safety of 30 overstressed, sleep-deprived students in a machine shop/woodshop/foundry environment.  
*Stanford, California*

**1992 Product Design (internship & part-time)**

**[IDEO Product Development](#)**

Electromechanical design for client projects including General Motors, Canon, Arneson Pool Products, and Coinstar. Responsible engineer for original pre-production inductive charge-port mechanism for GM *Impact* electric vehicle.

*Palo Alto, California*

**1989-1991 Mechanical Engineer & Project Manager**

**Odetics Incorporated, Advanced Intelligent Machines Division**

Lead development of state-of-the art, light-weight, high-strength, dexterous robotic arm. Joint project with NASA Jet Propulsion Laboratory. Arm was featured on the cover of NASA Tech Briefs magazine and won the Grand Prize in a national engineering design competition and was featured in Design News Magazine.

*Anaheim, California*

**1987-1989 Mechanical Engineer**

**Odetics Incorporated, Advanced Intelligent Machines Division**

Engineer and project leader for all manner of robotic contraptions – robotic hands, arms, legs, beer-tank-cleaning robots during the heyday of Odetics robotics programs.

*Anaheim, California*

**1986-1987 Research Assistant**

**MIT Laboratory for Construction Automation**

[Professor Alex Slocum](#)

[Massachusetts Institute of Technology](#)

Graduate work focused on design of a robotic concrete-block-wall building robot.

*Cambridge, Massachusetts*

**1982-1986 Research Assistant**

**MIT Space Systems Lab [\(now at University of Maryland\)](#)**

Professor David Akin

[Massachusetts Institute of Technology](#)

Team member focused on robotic arms, hands, cameras, cranes, thrusters, contactors, water tanks, batteries, circuit boards, computers, CAD, and everything else imaginable. I also had the privilege to participate in the construction of a milestone Space Shuttle experiment called EASE which flew on STS-61B in 1985, two flights before Challenger.

*Cambridge, Massachusetts*

## Skills

### Technical

- Mechanical design & engineering
- Electronic design & engineering
- High, medium, & low-volume product design processes
- High, medium, & low-volume product manufacturing processes
- High, medium, & low-volume production line start-up, vendor qualification, IQC start-up
- Comprehensive knowledge of state-of-the-art sensing, actuation (motor), and power amplifier technologies
- Fluent with software, firmware, servo control, robot control, optoelectronics, and metrology
- Highly experienced in sourcing key components, materials, and vendors (domestic, Europe, Asia)
- Highly experienced in advanced R&D (products, core technologies)
- Design of medical/surgical products for FDA & UL compliance
- Design of high volume consumer products for FCC/CE compliance
- Technical project & team management
- Patent development, prosecution, & defense
- Skilled machinist (conventional & CNC), woodworker, welder, rapid prototyping, modelmaker
- Industrial design/product aesthetics
- Applications & Tools

|   |   |
|---|---|
| <b>CAD</b>                              | Solidworks ('97Beta thru 2010), AutoCAD (R2.7 through R14), Ashlar Vellum, HP ME10/30 (circa 1993), Pro-E (circa 1989), Aries ConceptStation (circa 1987), CADAM (circa 1982) |
| <b>CAM</b>                              | CamWorks, Surfcam, Virtual Gibbs, MasterCAM, native G-code  |
| <b>FEA (statics, dynamics, thermal)</b> | Solidworks Simulation, CosmosWorks, Cosmos/M, Working Model, NASTRAN, Algor   |
| <b>FEA (magnetostatics)</b>             | Magneto (2D), Amperes (3D), CosmosEMS (3D), SPEAD (voicecoils)  |
| <b>Electrical Engineering</b>           | Orcad, Electronics Workbench Pro  |
| <b>Programming Languages</b>            | Visual Basic, VBA, C, Forth, Motorola 68HC11 assembly, Basic, Fortran   |
| <b>Technical/Analytical</b>             | Matlab, MathCAD, Photoworks   |
| <b>Productivity</b>                     | All common desktop applications & utilities   |

### Strategic

- Corporate-level technology strategy (products & core technologies)
- "Inbound" technology partnerships (actuators, sensors, ASIC design, foundry services, independent inventors)
- Experienced in managing R&D-to-Product transitions
- Sponsored (Federally-funded) research strategy, proposals, & execution (e.g. SBIR, STTR, NIST ATP)
- Strategic management of extensive corporate intellectual property (IP) portfolio

### Business

- Member of Board of Directors (Public & Private)
- Chief Technical Officer (Public & Private)
- Executive-level (VP) corporate governance
- Entrepreneurship – strategy, finance, fundraising, business plan
- Experience with "Product", "IP licensing", and "Fabless Semiconductor" business models
- Initial Public Offering – S1 preparation, review, sign-off, roadshow participant
- Public relations – top-tier press interviews & relationship development – sole Corporate Spokesperson responsibility
- Analyst relations – top-tier market analyst relationship development
- Legal (inbound) – partnership agreements, pricing agreements, cooperative development agreements
- Legal (outbound) – tactical management of extensive intellectual property (IP) portfolio
- Project proposals & presentations
- Investment bank/private investor relations
- Engineering, R&D Group Management
- Corporate acquisition integration

## Education

### Stanford University

**DEGREE OF ENGINEER** (D.Eng.) 1995

Stanford, California

Focus: Joint Program in Design (Product Design)

Dissertation: ***Design of a Global Network of Interactive, Force-Feedback Sculpture***

GPA 4.0/4.0

[Joint Program in Design \(Product Design\)](#). This exclusive (12-15 students per year) world-renowned program emphasizes a broad, hands-on, multidisciplinary approach to design spanning the School of Engineering, Graduate School of Business, and Department of Fine Art. The Program aspires to train students to develop innovative products (where “product” spans the largest possible definition) that are sensitive to human needs while maintaining acute awareness of highly intertwined technical, business, and aesthetic concerns.

My focus in the Program included “smart” (microprocessor-based) product design, computer-integrated sculpture, industrial design, and business. Normally a Master’s Degree level program, I was the first (and possibly still only) person to graduate with the advanced Degree of Engineer in Product Design.

The D.Eng. degree itself is also very unique in that it lives between Masters and PhD degrees (closer to the PhD) and encourages highly customized coursework and independent investigation. Like the PhD program, the D.Eng. degree requires a written dissertation. My dissertation was entitled ***Design of a Global Network of Interactive, Force-Feedback Sculpture***; focusing simultaneously on the aesthetic and human interaction implications of remote-yet-intimate physical interaction (haptics) and the telecommunications architecture, bandwidths, and latencies required to make it work.

While at Stanford, I held Teaching Assistant positions with Professor Mark Cutkosky (undergraduate coursework development), Professor Rolf Faste (classroom TA for ME115A), and Professor David Beach (“Shop TA” in the Product Realization Lab (PRL) for 2½ years). In the last 2 years I also worked full time as an independent product design consultant in order to support my own thesis work as it fell far outside “normal boundaries” for sponsored work.

### Massachusetts Institute of Technology

**MASTER OF SCIENCE**, Mechanical Engineering, 1987

Cambridge, Massachusetts

Focus: mechanical design, precision machine design, robotics, metrology, control theory

Thesis: ***Design Methodology for Large Work Volume Robotic Manipulators: Theory and Application***

GPA: 5.0/5.0

As a student of [Professor Alex Slocum](#), I gained a deep appreciation and enhanced design skills in the areas of precision machine design (micron, sub-micron tolerances), metrology, and automation. Our lab was focused on developing new ways to apply automation techniques and technologies to building construction. Applying these “non-traditional” technologies to this challenging, dynamic environment often required us to invent and apply new solutions in areas such as large-scale metrology, mobility, lightweight/high strength actuation, advanced control, and robust mechanical design. My thesis was entitled ***Design Methodology for Large Work Volume Robotic Manipulators: Theory and Application***.

### Massachusetts Institute of Technology

**BACHELOR OF SCIENCE**, Mechanical Engineering, 1986

Cambridge, Massachusetts

Focus: mechanical design, robotics/teleoperation, control theory

Thesis: ***Design and Construction of an Interchangeable End Effector Interface for a Space Teleoperator Manipulator Arm***

GPA: 4.7/5.0, Pi Tau Sigma, Tau Beta Pi honor societies

I connected with the MIT Space Systems Lab before classes had started my freshman year. I spent 4 amazing years working under Professor David Akin (who has since moved the [SSL operation to University of Maryland](#)) building the most incredible & exciting robots and machines in all of MIT. I also had the great fortune to be taken underwing by a graduate student Eric Shain who launched me down the path of robots, teleoperation, and design of computer-controlled electromechanical devices in general. Almost daily, I was able to apply newfound engineering theory to design problems in the lab. I worked on robotic arms, hands, cameras, cranes, thrusters, contactors, water tanks, batteries, circuit boards, computers, CAD, and everything else imaginable during my tenure there. I also had the privilege to participate in the construction of a milestone Space Shuttle experiment called EASE which flew on STS-61B in 1985, two flights before Challenger.

## Publications

***Design of a Global Network of Interactive, Force-Feedback Sculpture***, D.Eng. dissertation, Stanford University, 1995

***Art & Technology: Paths, Intersections, Artifacts***, invited paper for *Virtually There – The Impact of Interactive Media on the Arts in the Twentieth Century*, Catherine Smith Gallery, Appalachian State University, Boone, NC, July 1995

***A Lightweight, High Strength, Dexterous Manipulator for Commercial Applications***, Co-authored with N. Marzwell and S. Cohan, NASA Technology 2001 Conference, San Jose, CA December 3-5, 1991

***Design and Development of a Compact, Modular, 7-Axis Manipulator Arm***, Co-authored with S. Cohan, American Nuclear Society Winter Meeting, San Francisco, CA, November 10-13, 1991

**Design of a Reconfigurable, Adaptive Shape Hand**, Third Topical Meeting on Robotics and Remote Systems, Charleston, SC, March 13-16, 1989

**Design Methodology for Large Work Volume Robotic Manipulators: Theory and Application**, Master of Science thesis, MIT, 1987

**Blockbot: A robot to Automate the Construction of Concrete-Block Walls**, Co-authored with Professor A. Slocum, Robotics, Fall 1987

**Construction Automation Research at MIT**, contributing author, Fourth International Symposium on Robotics and Artificial Intelligence in Building Construction, Haifa, Israel, June 1987

**Design and Construction of an Interchangeable End Effector Interface for a Space Teleoperator Manipulator Arm**, Bachelor of Science Thesis, MIT 1986

**Theoretical Analysis of the Parachute Bridling System Under Static Loading**, SEAS final report to the U.S. Forest Service, Foster-Miller, 1986

## Awards and Press Coverage

### Awards – Personal/Design Team

Industrial Designers Society of America (IDSA) & Business Week, Bronze Award, Medical & Scientific Products 2006, **daVinci-S Surgical System**  
The Chicago Athenaeum Museum of Architecture and Design, [Good Design 1999](#), **Logitech Wingman Joystick**  
ID Magazine [42<sup>nd</sup> Annual Design Review 1996](#), *Design Distinction Award - Immersion MicroScribe-3D*  
Design News Magazine, [Excellence in Design 1992](#), *Grand Prize - Odetics Dexterous Manipulator*  
NEA Competition – Finalist for Design Arts Grant Award, *Kinesthetic Constructions*, 1995  
Wunsch Foundation Award for Excellence in Design, Bachelors thesis work, MIT 1986

### Awards – Corporate

Silicon Valley Business Journal – *100 Fastest Growing Private Companies in Silicon Valley* 1998 (Immersion placed #19 of 100)

### Press Coverage based on 1-on-1 personal meetings with reporters & industry analysts

New York Times  
ABC World News Tonight w/Peter Jennings  
Forbes  
Technology Review (MIT)  
Bloomberg  
FamilyPC Magazine  
Seattle Post-Intelligencer  
EE Times  
TechTV (Bay Area)

Wall Street Journal  
USA Today  
Wired  
Discover Magazine  
PC Week  
ZDNet  
Oakland Tribune  
Mechanical Engineering

Associated Press  
Newsweek  
Business 2.0  
Scientific American  
CNet  
LA Times  
CanalPlus (France)  
KRON TV (Bay Area)

**Brief Visual Design Portfolio**



**daVinci-S Robotic Surgical System**



**Odetics Dexterous Manipulator**



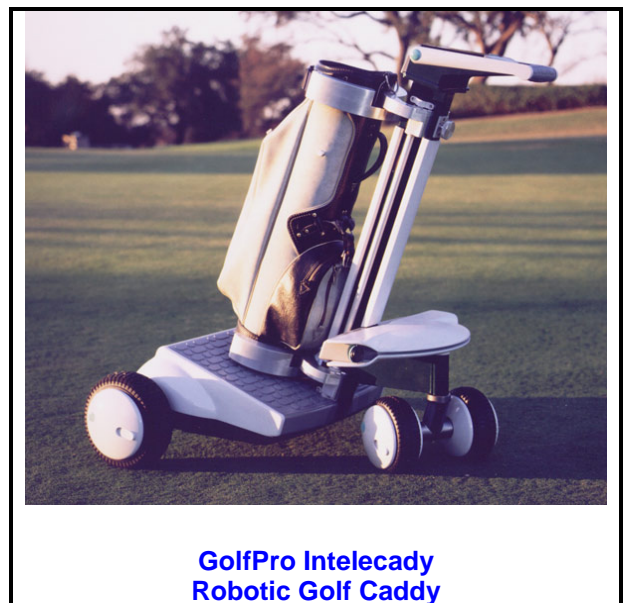
**MicroScribe 3-D Digitizing Arm**



**LightScribe Digitizing System**



**5mm Articulated Laparoscopic Instrument for Pivotal Medical Innovations**



**GolfPro Intelecady Robotic Golf Caddy**



**Logitech Wingman  
Force Feedback Mouse**



**Logitech I-Feel Mouse**

**I-FORCE FOR THE HOME:**

**LOGITECH**  
 THE LOGITECH WINGMAN FORCE™ JOYSTICK FEATURES THE MOST REALISTIC FORCE FEEDBACK AVAILABLE. THE PRODUCT REPRODUCES LOGITECH'S HAND-BUILT INDUSTRIAL DESIGN WITH IMMERSION'S ADVANCED I-FORCE 2.0 FORCE FEEDBACK TECHNOLOGY AND STATE OF THE ART HIGH-FIDELITY FORCE FEEDBACK TRANSMISSION. THIS REVOLUTIONARY PRODUCT ALSO BUILDS UPON THE FEATURES RESPONSIBLE FOR THE CONTINUOUS SUCCESS OF CURRENT MODELS IN THE PERAL CHANNEL: INCLUDING RUBBERIZED BUTTONS, A HEAVY BASE FOR GREATER STABILITY AND CONTROL, AND A BUILT-IN COILS FOR REALISTIC FEEL AND COMFORT OVER LONG PERIODS OF TIME.

THE LOGITECH-I-FORCE RELATIONSHIP REINFORCES LOGITECH'S POSITION AS THE LEADING MANUFACTURER AND INNOVATOR OF CONTROL DEVICES FOR PERSONAL GAMING. FORMED IN 1998, LOGITECH DESIGNS, MANUFACTURES, AND MARKETS PRODUCTS THAT MAKE RECREATIONAL COMPUTING CONSUMPTION MORE ENJOYING AND NATURAL.

[HTTP://WWW.LOGITECH.COM](http://www.logitech.com)




**Logitech Force Feedback Joystick for PC**

**CH PRODUCTS**  
 LAUNCHED IN 1996, THE FORCE FX IS GUARANTEED TO EXCEED YOUR SOONEST OFF WITH SIX BUILT-IN EFFECTS YOU CAN EXPERIENCE THROUGH THE STICK IN MANY DIRECTIONS OF MAGNITUDE, DURATION, AND DIRECTION. EACH VIBRATION IS DETERMINED THROUGH YOUR FAVORITE FORCE FEEDBACK SUPPORTED GAME. THE SIX INTEGRATED STYLES OF FORCE HAVE FULL PROGRAMMABLE KEY CAPABILITIES BY ALLOWING THOUSANDS OF DISTINCT SENSATIONS. THE FORCE FX FEATURES TWO SHIFTING FIRE BUTTONS, A TRIGGER AND TEAM CONTROLS FOR A TOTAL OF 14 FUNCTIONS TO PLAY WITH! IF YOU'RE CONSOLE PLAY WITH THE FORCE FX, YOU'D BETTER GET DOWN AND FASTER YOUR GREAT BELLS IT'S A BUMPY RIDE!

[HTTP://WWW.CHPRODUCTS.COM](http://www.chproducts.com)



**WINNER OF 1997 PC WEEK TECHNICAL EXCELLENCE AWARD**

**FIRST CONSUMER FORCE FEEDBACK JOYSTICK!**



**CH Products Force FX PC Joystick**

**ACT LABS**  
 ACT LABS, DEVELOPERS OF CUTTING-EDGE GAME PERIPHERALS FOR PC AND CONSOLE GAMING SYSTEMS, HAS PRODUCED A HIGH-FIDELITY FORCE FEEDBACK DRIVING WHEEL FOR THE PC PLATFORM. THE NEW FORCE RS™ WHEEL COMBINES ACT LABS' AWARD-WINNING GAME CONTROL DESIGN WITH IMMERSION'S I-FORCE 2.0 TECHNOLOGY. THE FORCE RS WILL INCLUDE ADVANCED I-FORCE DYNAMIC SENSATION TECHNOLOGY CAPABLE OF REPRODUCING THE MOST REALISTIC DRIVING SENSATIONS AVAILABLE. LOOK FOR FEATURES SUCH AS RUBBERIZED WHEEL, FT STYLE GEAR SHIFTER, AND REMOVABLE CARTRIDGE SYSTEM TO DRIVE THIS WHEEL TO THE FRONT OF THE PACK.

[HTTP://WWW.ACTLAB.COM](http://www.actlab.com)



**ACT LABS**

**Force Feedback**

**I-FORCE**

From IMMERSION

**ACT Labs Force RS  
Racing Wheel for PC**



**Gravis Exterminator  
Force Feedback Gamepad**



**Indestructible Force-Feedback Joystick  
for DisneyQuest**



**Various Industrial Design  
Explorations**

## Issued Patents (United States only)

**Note: This list is now dated – 78 issued as of November 2011**

Note: List does not include an additional 80+ pending (US), plus another 80-100 (wild guess) international versions issued & pending

|    | Patent Number | Title  |
|----|---------------|--|
| 1  | 7,113,166     | Force feedback devices using fluid braking   |
| 2  | 7,106,313     | Force feedback interface device with force functionality button  |
| 3  | 7,084,854     | Actuator for providing tactile sensations and device for directional tactile sensations                    |
| 4  | 7,061,466     | Force feedback device including single-phase, fixed-coil actuators   |
| 5  | 7,054,775     | Digitizing system and rotary table for determining 3-D geometry of an object                               |
| 6  | 7,038,657     | Power management for interface devices applying forces   |
| 7  | 6,956,558     | Rotary force feedback wheels for remote control devices  |
| 8  | 6,937,033     | Position sensor with resistive element   |
| 9  | 6,903,721     | Method and apparatus for compensating for position slip in interface devices                               |
| 10 | 6,822,635     | Haptic interface for laptop computers and other portable devices   |
| 11 | 6,762,745     | Actuator control providing linear and continuous force output  |
| 12 | 6,704,001     | Force feedback device including actuator with moving magnet  |
| 13 | 6,697,748     | Digitizing system and rotary table for determining 3-D geometry of an object                               |
| 14 | 6,697,048     | Computer interface apparatus including linkage having flex   |
| 15 | 6,693,622     | Vibrotactile haptic feedback devices   |
| 16 | 6,686,911     | Control knob with control modes and force feedback   |
| 17 | 6,486,872     | Method and apparatus for providing passive fluid force feedback  |
| 18 | 6,400,352     | Mechanical and force transmission for force feedback devices   |
| 19 | 6,348,911     | Force feedback device including safety switch and force magnitude ramping                                  |
| 20 | 6,342,880     | Force feedback system including multiple force processors  |
| 21 | 6,304,091     | Absolute position sensing by phase shift detection using a variable capacitor                              |
| 22 | 6,271,833     | Low cost force feedback peripheral with button activated feel sensations                                   |
| 23 | 6,271,828     | Force feedback interface devices providing resistance forces using a fluid                                 |
| 24 | 6,201,533     | Method and apparatus for applying force in force feedback devices using friction                           |
| 25 | 6,191,774     | Mouse interface for providing force feedback   |
| 26 | 6,166,723     | Mouse interface device providing force feedback  |
| 27 | 6,154,201     | Control knob with multiple degrees of freedom and force feedback   |
| 28 | 6,134,506     | Method and apparatus for tracking the position and orientation of a stylus and for digitizing a 3-D object |
| 29 | 6,128,006     | Force feedback mouse wheel and other control wheels  |
| 30 | 6,125,337     | Probe apparatus and method for tracking the position and orientation of a stylus and controlling a cursor  |
| 31 | 6,100,874     | Force feedback mouse interface   |
| 32 | 6,078,876     | Method and apparatus for tracking the position and orientation of a stylus and for digitizing a 3-D object |
| 33 | 6,050,718     | Method and apparatus for providing high bandwidth force feedback with improved actuator feel               |
| 34 | 6,020,875     | High fidelity mechanical transmission system and interface device  |
| 35 | 6,015,473     | Method for producing a precision 3-D measuring apparatus   |
| 36 | 5,999,168     | Haptic accelerator for force feedback computer peripherals   |
| 37 | 5,929,846     | Force feedback interface device including grounded sensor system   |
| 38 | 5,929,607     | Low cost force feedback interface with efficient power sourcing  |
| 39 | 5,907,487     | Force feedback device with safety feature  |
| 40 | 5,817,119     | Surgical instrument for endoscopic and general surgery   |
| 41 | 5,805,140     | High bandwidth force feedback interface using voice coils and flexures                                     |
| 42 | 5,792,165     | Endoscopic instrument with detachable end effector   |
| 43 | 5,724,264     | Method and apparatus for tracking the position and orientation of a stylus and for digitizing a 3-D object |
| 44 | 5,721,566     | Method and apparatus for providing damping force feedback  |
| 45 | D389,782      | Robotic golf bag carrying cart   |
| 46 | 5,691,898     | Safe and low cost computer peripherals with force feedback for consumer applications                       |
| 47 | D377,932      | Mechanical digitizing arm used to input three dimensional data into a computer                             |
| 48 | 5,582,617     | Surgical instrument for endoscopic and general surgery   |

## Garage Machine Shop (well...part of it at least)

