Auto-Conforming Ergonomic Chair

Product Presentation and Demo

Brought to you by

Accomodari Solutions

September 29, 2006

Introduction

- **Meet our team**
- **Why use an ergonomic chair?**
- **The problem and current solutions**
- **The ACE Chair solution**
- **Our design**
- **Conclusion**
- **Things we learned**
- **Q&A**
- **Demo**

The Accomodarsi Team

Eric Lee – CFO

Eric Leung – CTO

Jennard Dy – COO

Stephanie Fung – CEO

What is an Ergonomic Chair?

- "…exhibits good design so as to maximize productivity by reducing fatigue and discomfort."

- Supports body when seated

- Dimensions are adjustable to fit user and workspace

- Better fit than a non-adjustable chair

# Why Should I Use an Ergonomic Chair?

- **Office jobs → sitting at a desk for long periods**

- **Work-related musculoskeletal disorders cost over $45 billion to employers annually**

- **"An ounce of prevention is worth a pound of cure"**

The Problem

Ergonomic chair users continue to experience discomfort

The Problem

- **Adjusting chairs is prone to user error**

  1. **Could forget to adjust**
  2. **Difficult to find adjustments**
  3. **Complex adjustment process**
  4. **Fit could still be improved**

→ **Improper fit of ergonomic chairs**
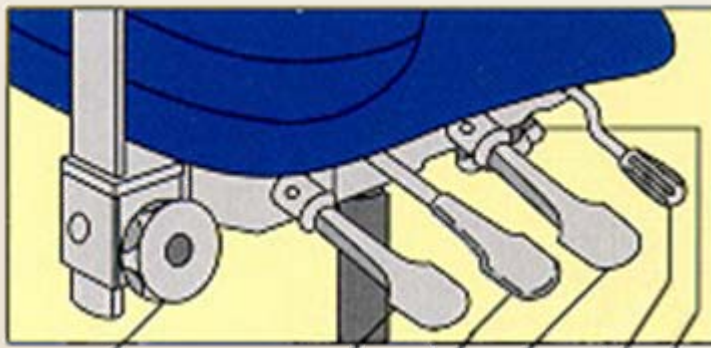
The Problem

- **Can't we just change our habits?**

I forgot to adjust it.

I just don't care.

Takes too much time and effort!

I didn't adjust it properly.

The Market

- **Multi-user desk environments**
  - **Home office**
  - **Call centres**
  - **Conference rooms**
- **$3 billion/year spent on office chairs in the US**

Current Solutions

Aeron chair
by Herman Miller
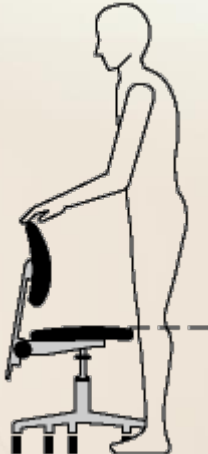
Freedom chair
by Humanscale

Leap chair
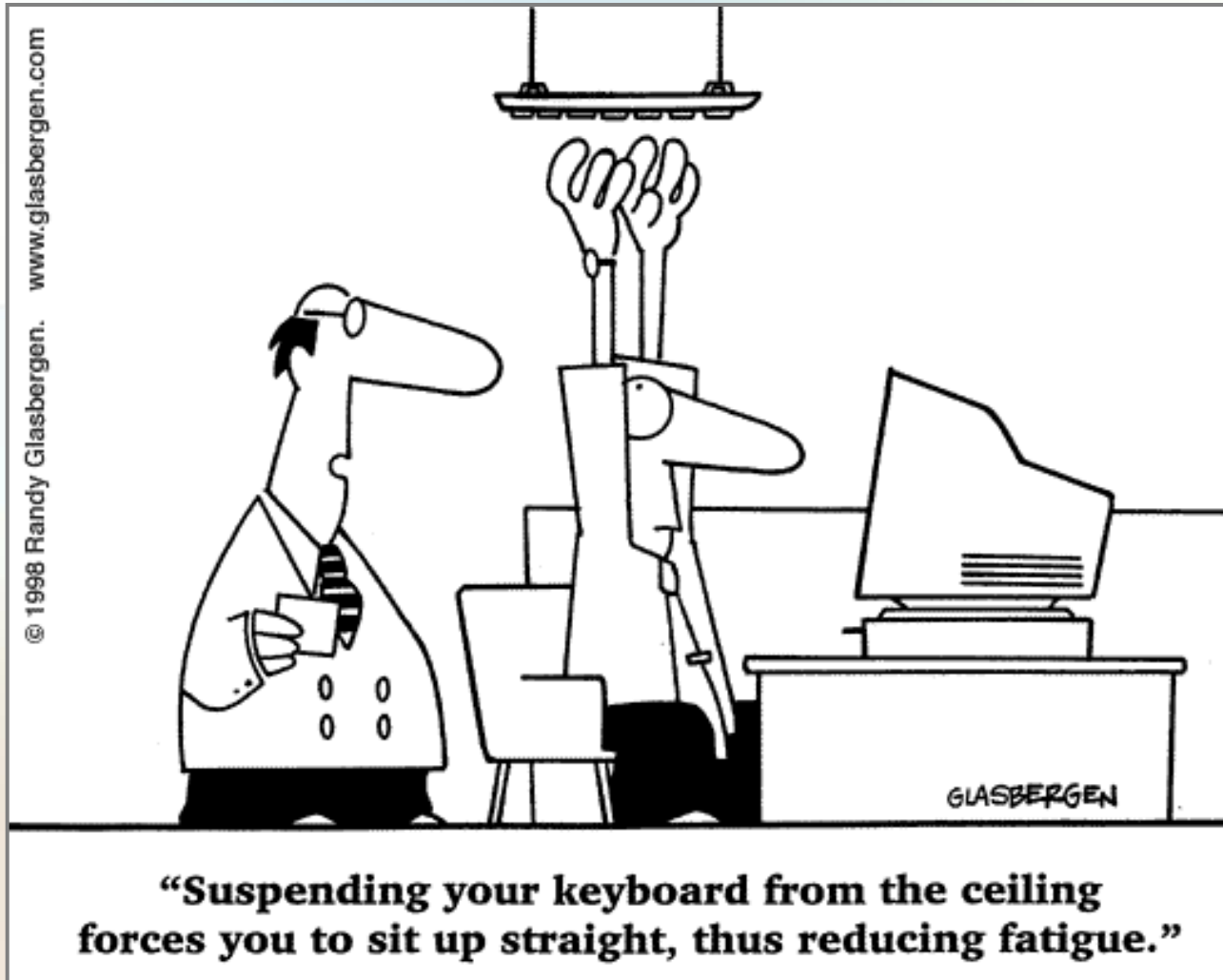by Steelcase

Current Solutions

- **Hire an ergonomist**

+

- **Train the user**

Current Solutions

The ACE Chair

- **Auto-Conforming Ergonomic Chair**
- **On demand, one-touch adjustment**
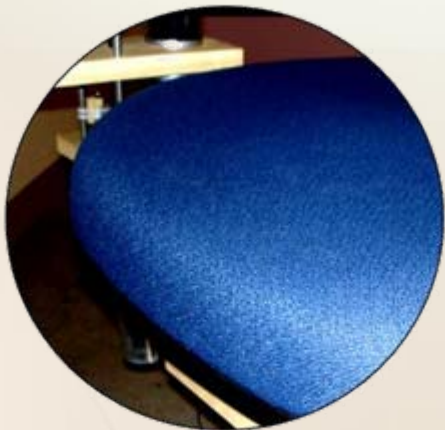- **Intelligent feedback-controlled movements**
- **Electronic user-sensing**

Prototype Features

- **3 electronic adjustments**
  - **Lumbar height**
  - **Lumbar size**
  - **Armrest height**
- **2 mechanical adjustments**
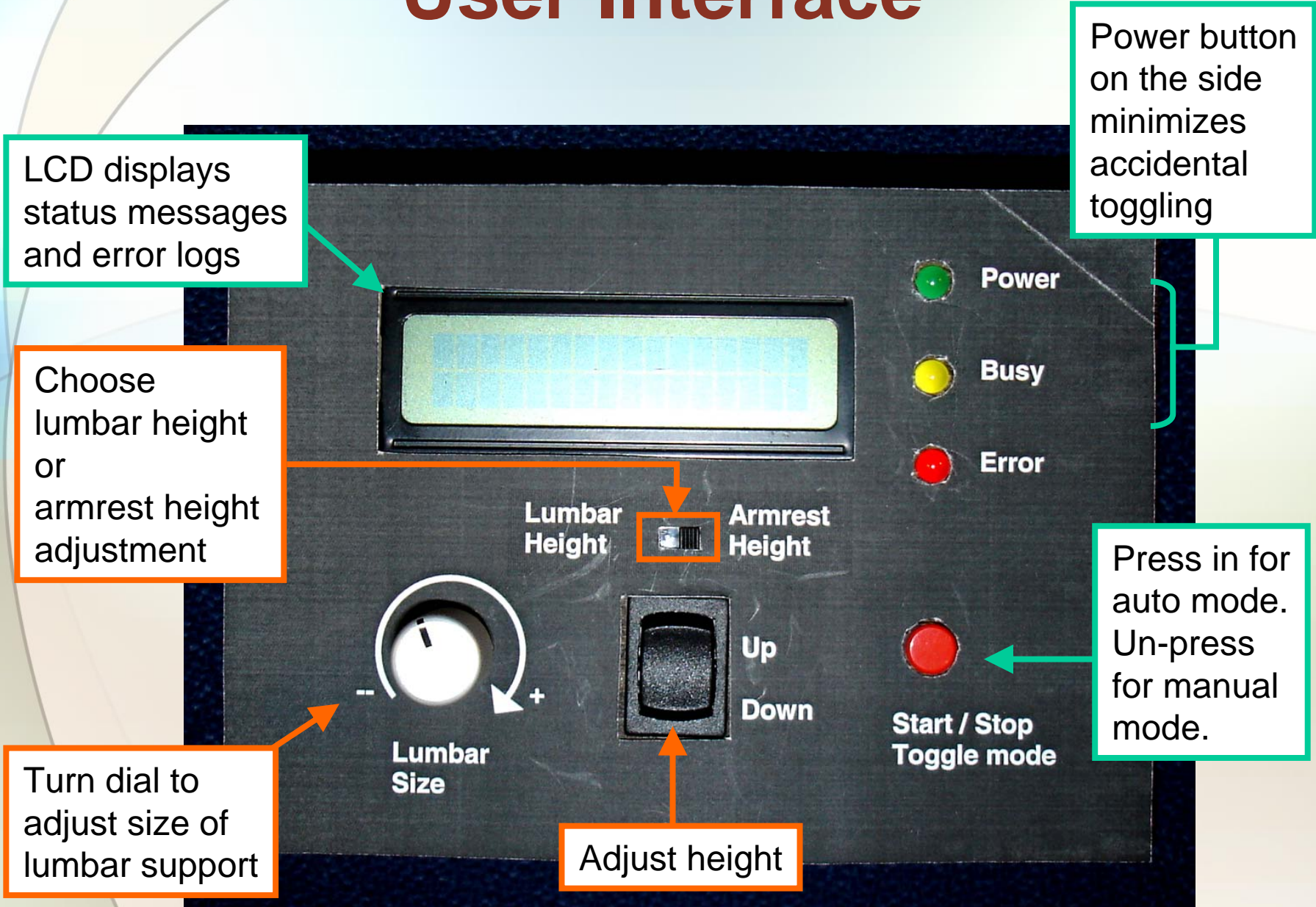 - **Seat height**
  - **Footrest**

Prototype Features

- **2 modes: Automatic and manual**
- **Contour seat with waterfall edge**
- **One-handed adjustment**
- **Simple, easy-to-use interface**
- **Safety mechanisms**
- **Firmware upgradeable**

User Interface

Power button on the side minimizes accidental toggling

LCD displays status messages and error logs

Choose lumbar height or armrest height adjustment

Turn dial to adjust size of lumbar support

Press in for auto mode. Un-press for manual mode.

Adjust height

Power

Busy

Error

Lumbar Height   Armrest Height

Up

Down

Lumbar Size

Start / Stop Toggle mode

Using the ACE Chair
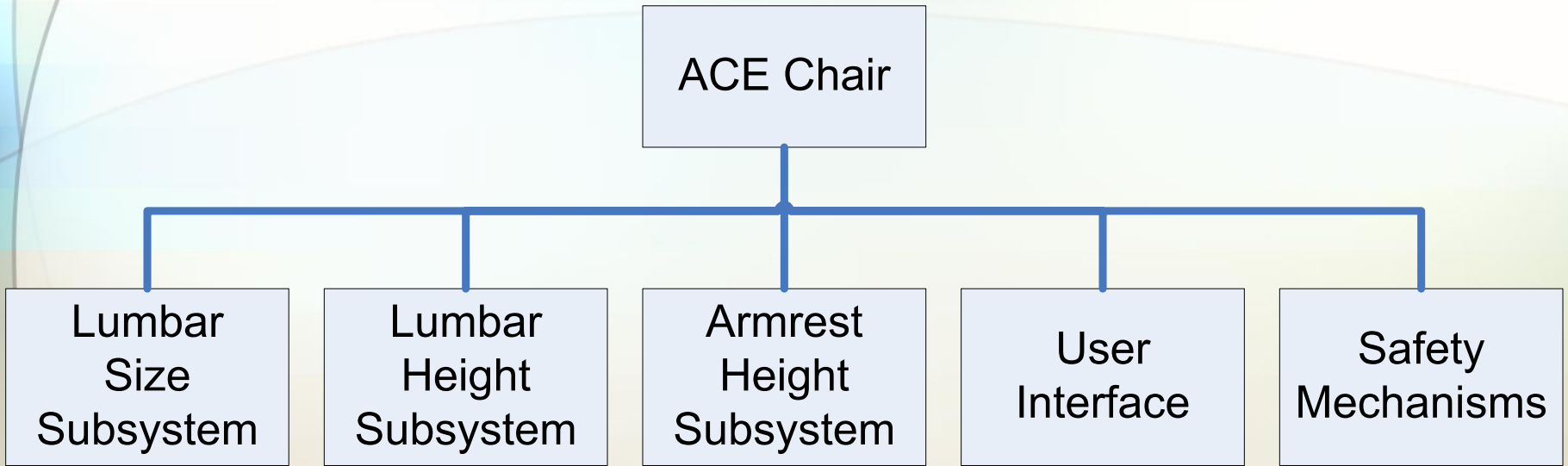
1. Sit down and power on
2. Make sure back is straight and forearms are above the armrests
3. Press Mode button to enter auto mode
4. Relax as the chair moves to home position and then auto-adjusts.
   - After homing, armrests will rise.
   - Lumbar support will rise and inflate
   - Takes about 2 minutes
5. Enjoy the comfort of the ACE Chair
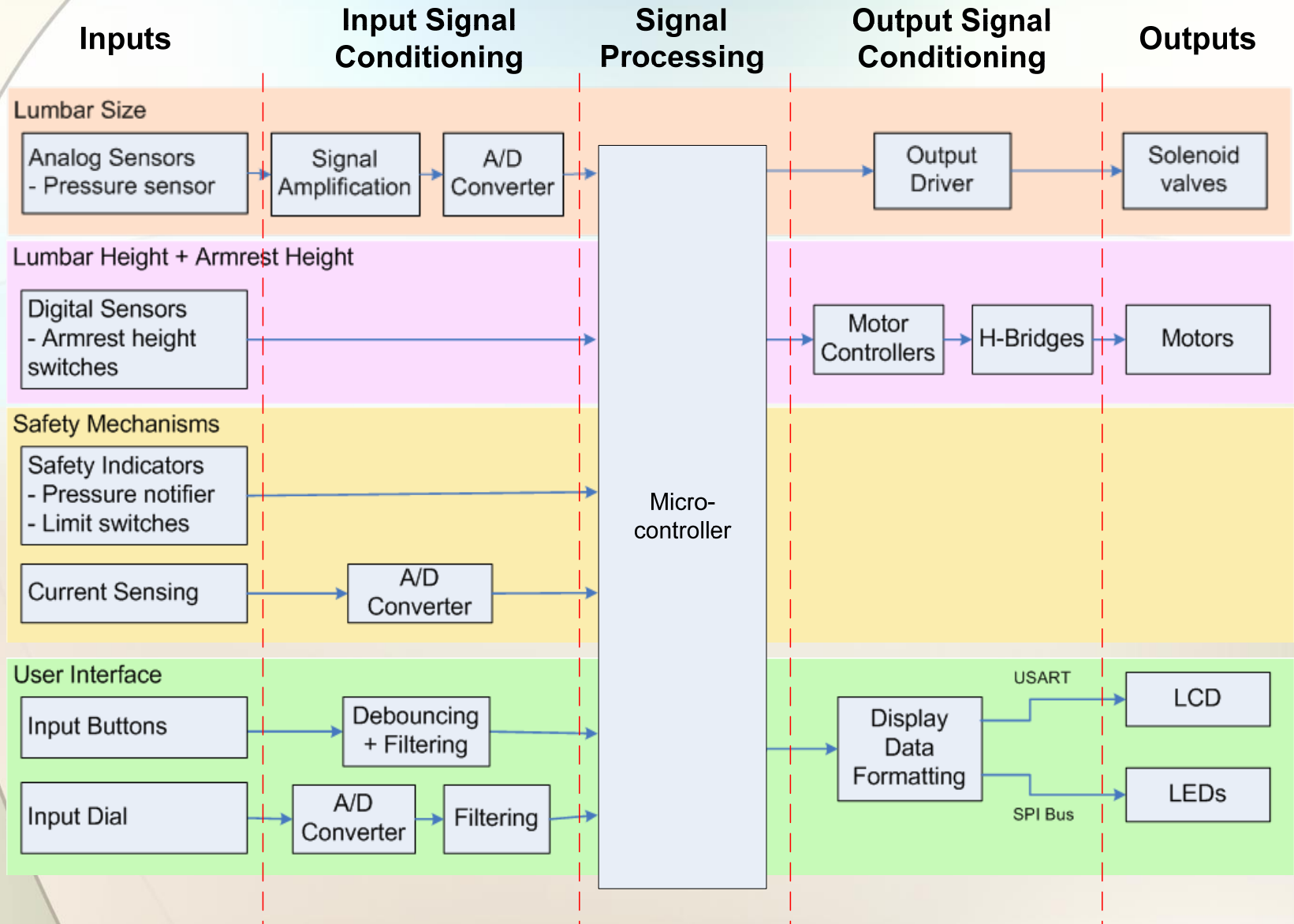
Benefits

- **One size fits all**
- **Save time**
  - **2 min auto-adjust**
- **Work in comfort**
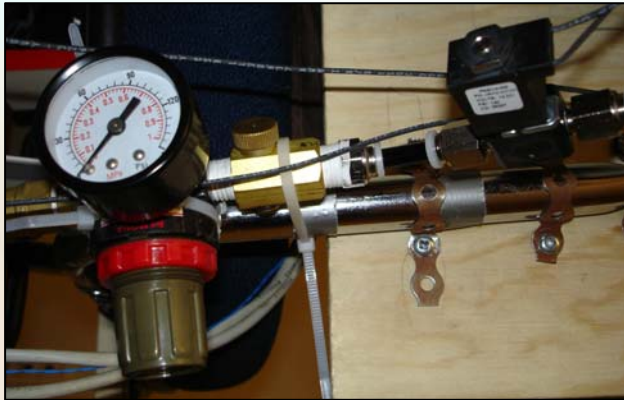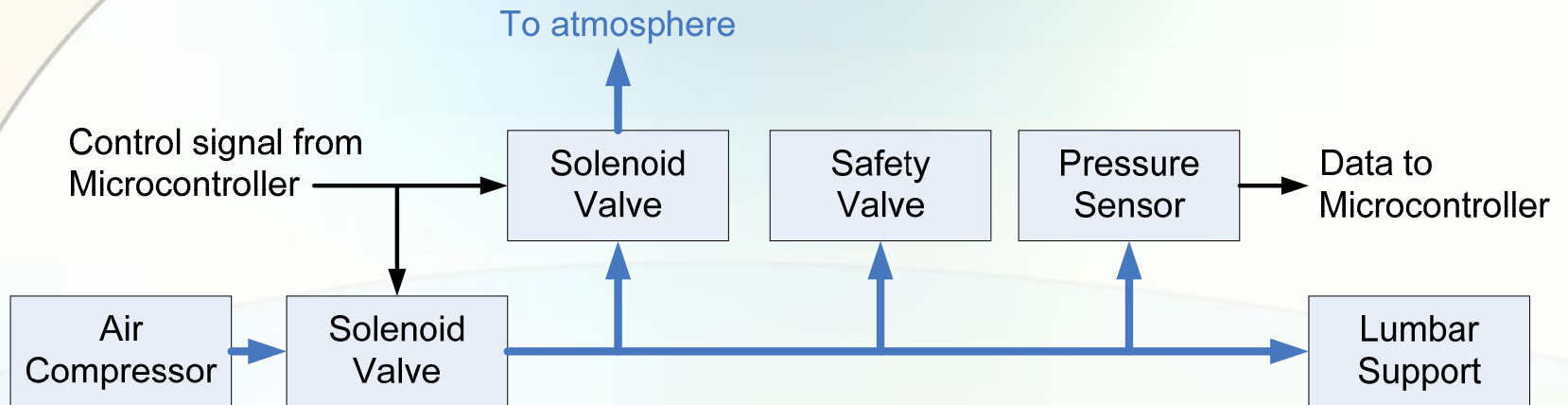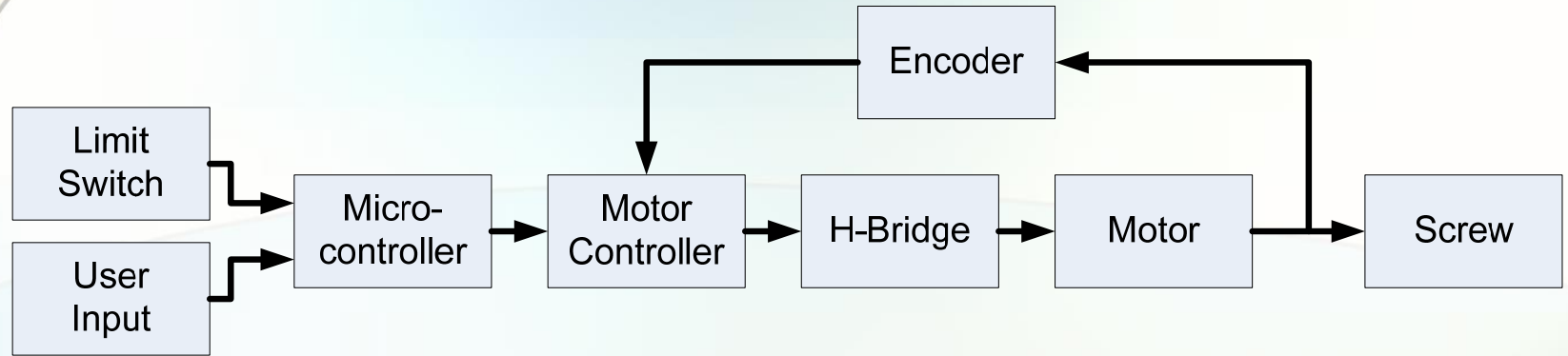- **Good for posture and health**
- **It's cool!**

System Overview

```
                    ┌──────────────┐
                    │  ACE Chair   │
                    └──────┬───────┘
       ┌────────┬──────────┼──────────┬──────────┐
 ┌─────┴────┐┌──┴────┐┌────┴───┐┌─────┴───┐┌─────┴────┐
 │ Lumbar   ││Lumbar ││Armrest ││  User   ││ Safety   │
 │ Size     ││Height ││Height  ││Interface││Mechanisms│
 │ Subsystem││Subsys.││Subsys. ││         ││          │
 └──────────┘└───────┘└────────┘└─────────┘└──────────┘
```

System Components

Lumbar Size Subsystem

To atmosphere

Control signal from Microcontroller

| Solenoid Valve | Safety Valve | Pressure Sensor | Data to Microcontroller |

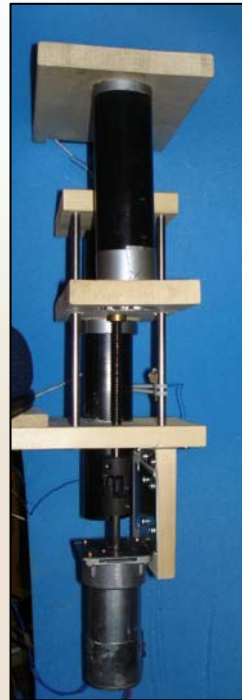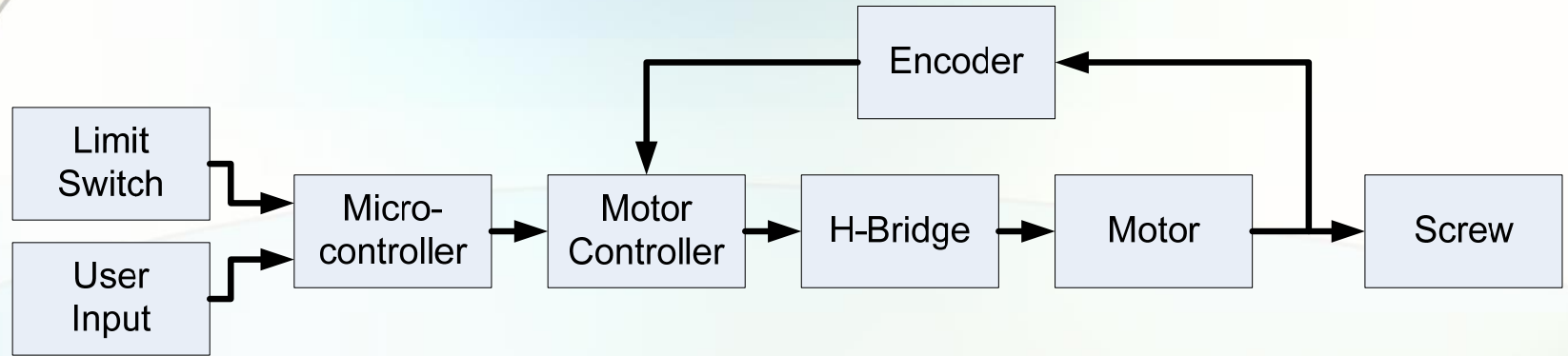| Air Compressor | Solenoid Valve | | Lumbar Support |

Armrest Height Subsystem

Front view

Side view

Lumbar Height Subsystem

Back view

Safety Mechanisms

- **Hardware**
  - **Pressure safety valve**
  - **Fuses and circuit breakers**
  - **Limit switches**
  - **Brownout reset**
- **Software**
  - **Pressure monitoring**
  - **Current sensing**
  - **Emergency shutdown**
  - **Watchdog timer**

Software

- **RTOS running 13 concurrent tasks**
- **Algorithms**
  - **Determine correct lumbar and armrest height**
  - **Determine correct lumbar size**
  - **Equalize armrest height**
  - **State machine to handle transitions between adjustments**
- **Error logging to EEPROM**

Pricing

- Projected cost per unit

Mechanical parts	**$350**
Electronics	**$250**
Air system	**$100**
Manufacturing	**$200**
Total	**$900**

- **Suggested retail price: $1800**

Product Comparison

	Existing ergonomic chairs	ACE Chair
Auto-adjusts	✗	✓
Invites user to adjust	✗	✓
Prior training required	Yes	Little to none
Time required to make adjustments	Depends on experience	Short
Price	$600 - $1400	$1800
Coolness factor	Low to medium	Very high!

Conclusion

- **Buy an ergonomic chair**
- **Need an easier way to adjust chairs**
- **Buy _our_ ergonomic chair**
- **Proof-of-concept prototype demonstrates**
  - **Short learning time**
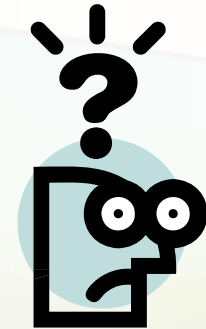 - **Quick and easy to adjust**

What We Learned

- **Ergonomics**
- **How to adjust a chair properly**

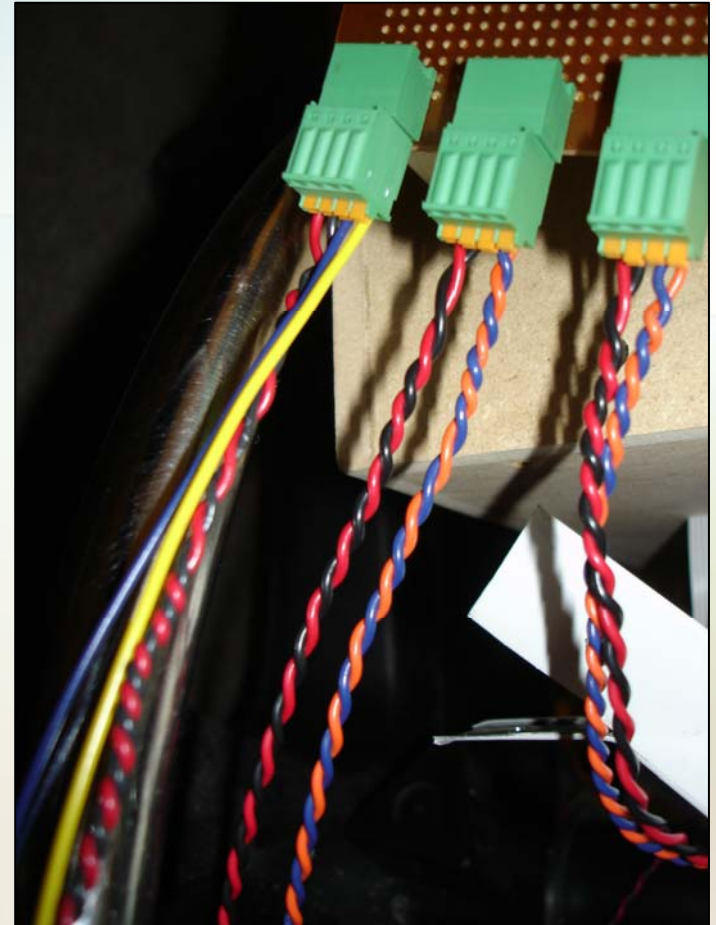Computer and Physics engineering students **+** Mechanical design **=**

- **Using machine shop tools**
- **Metal and woodworking**
- **Air systems and solenoids**

What We Learned

- **Precautions against EM noise**
- **Optocouplers**
- **Designing for safety**
- **Team software development**
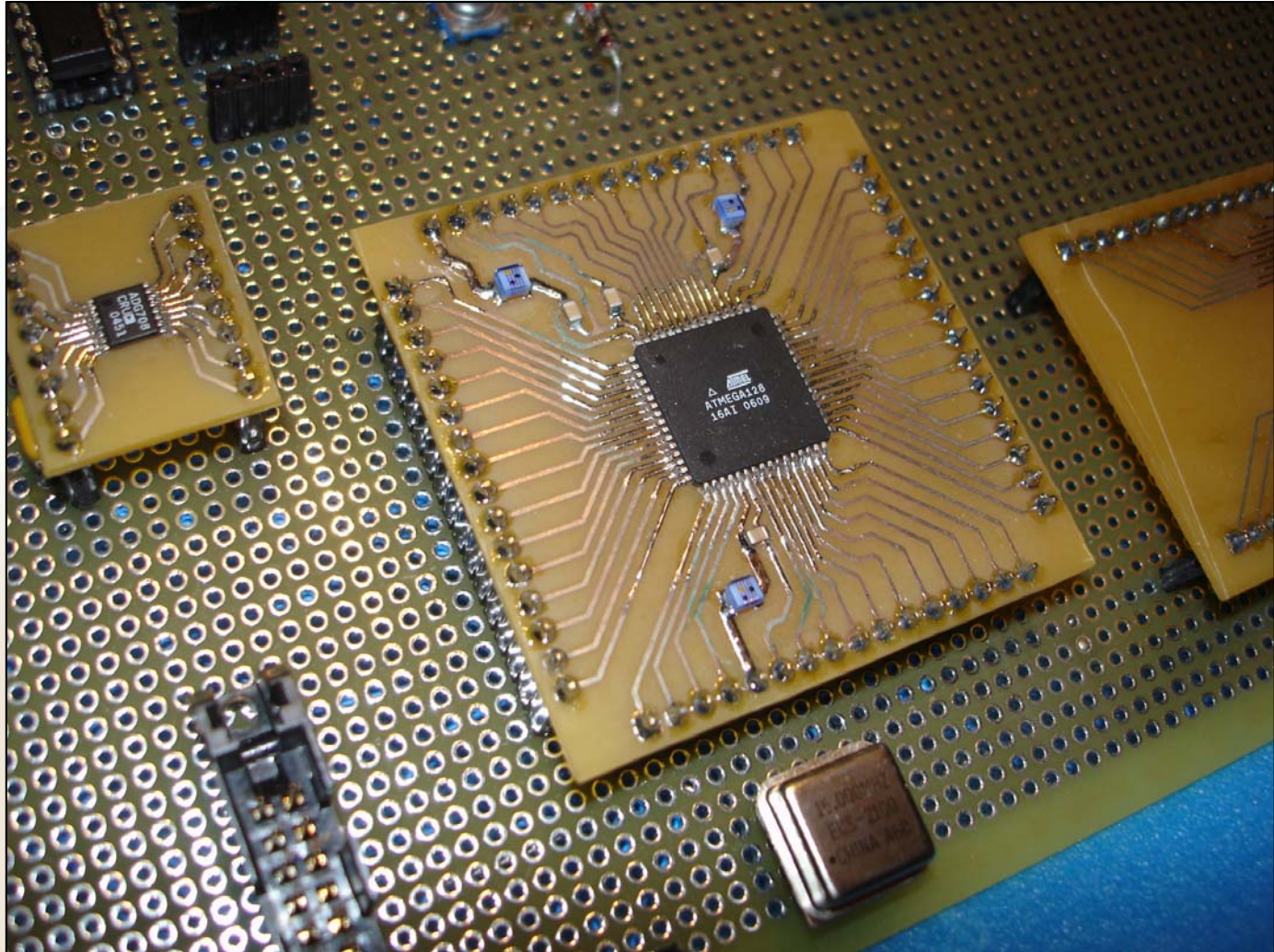- **RTOS on a microcontroller**

What We Learned
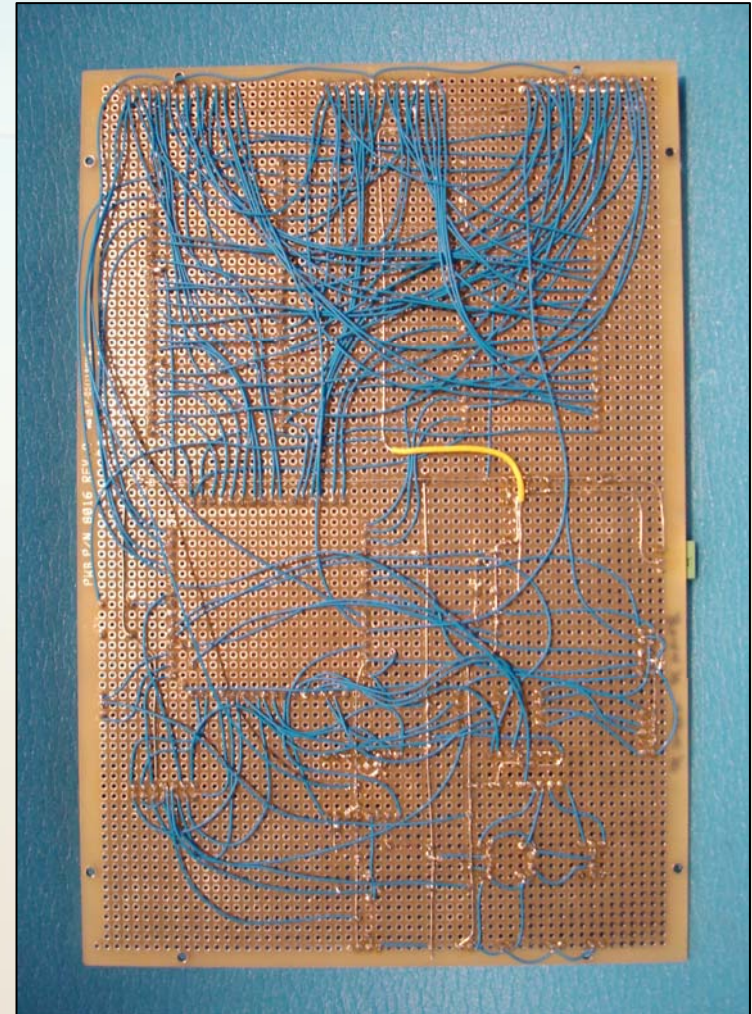
- **Sourcing parts cheaply**
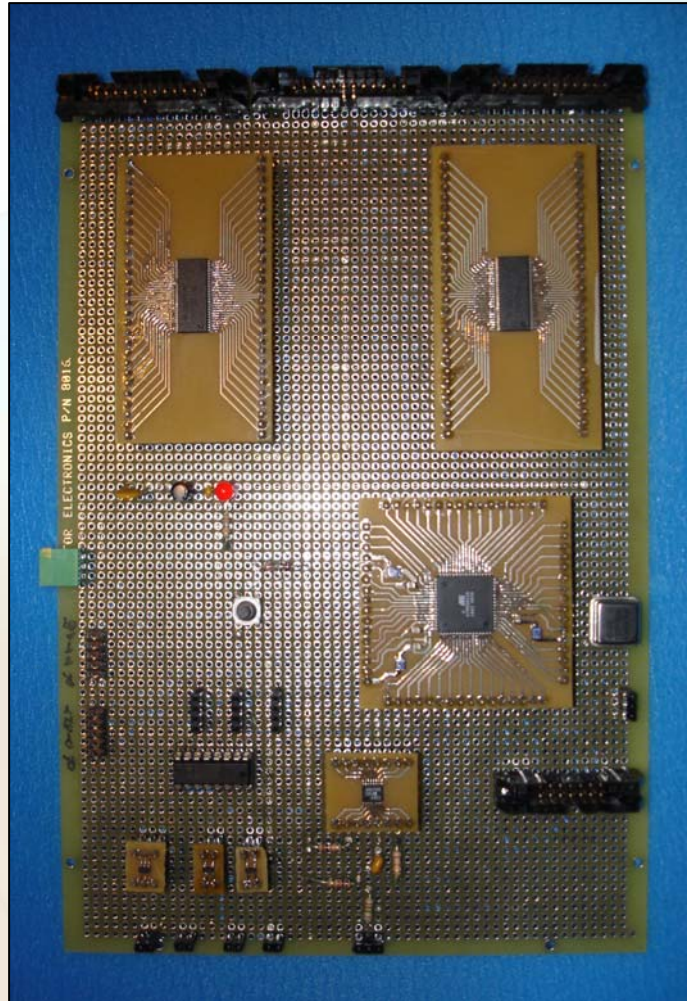
What We Learned

- **Soldering surface mount components**

What We Learned

- **Prototyping using chips with many pins**

What We Learned
…the Hard Way

- **Trying to do a project while everyone is on coop** → ☹ ☹ ☹ ☹

- **Scoping out the project**

- **Time estimation**

- **Staying on budget**

Stats

- **3120 person-hours**
- **20 000 lines of code**
- **101 sleepless nights**
- **> 70m of wire**
- **700 solder joints**
- **24 deferral forms submitted**
- **Number of times friends have asked "Is the chair done yet?" …too many.**

Acknowledgements

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- **Russell Booth** (Emily Carr Institute)
- **Mrs. Leung**
- **The elves who magically fixed things while we slept**

Acknowledgements

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  - **Anne-Kristina Arnold** (SFU Kinesiology)
  - **GF Strong Clinic**
- **Mechanical design input**
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  - **Hendrik Van Der Wal** (SFU Science Machining Centre)
- **Electronics advice**
  - **Derek Pyner and Henry Leung** (Pacific Design Engineering)
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  - **ESSEF**
  - **Wighton Fund**

Acknowledgements

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  - **Texas Instruments**
  - **Maxim Integrated Products**
  - **Freescale Semiconductor**
  - **Arrow Electronics**
  - **FreeRTOS**
  - **HCCC**

Questions?

Demonstration

- **Manual mode**

- **Auto mode**

- **Safety features**

- **Questions**