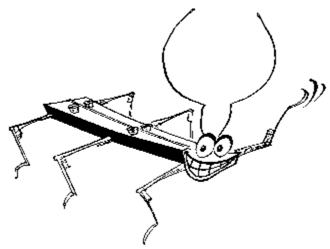
Stiquito
An Inexpensive Robot



James M. Conrad
Ericsson, Inc. - RTP, NC
North Carolina State University

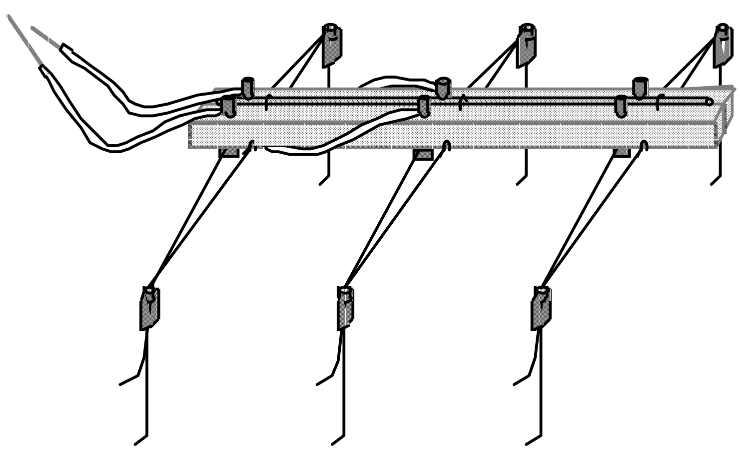
Outline of Talk

- Introduction
- A Walking Robot: Stiquito - What Is It?
- Locomotion
- Uses of Stiquito
- Books on Stiquito
- Using Stiquito For Engineering Education
- Conclusions

James M. Conrad - Background

- BS Computer Science - University of Illinois
- Software/Hardware Test - IBM, RTP, NC
- MS, Ph.D. in Computer Engineering - North Carolina State University, Raleigh, NC
- Assistant Professor, Computer Systems Engineering - University of Arkansas, Fayetteville, AR
- Embedded Systems Engineer - BPM Technology, Greenville, SC
- Embedded Systems Engineer - Ericsson, RTP, NC
- Adjunct Assistant Professor - North Carolina State

Stiquito - What is it?



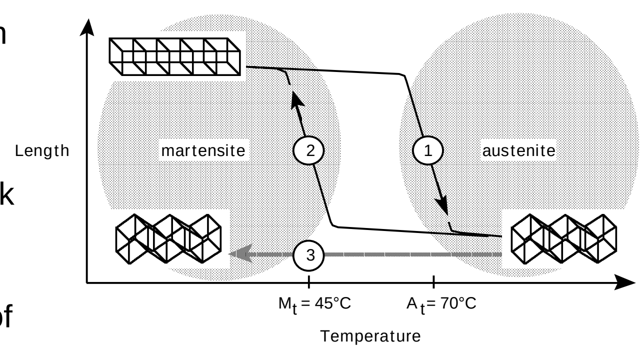
Stiquito: An Inexpensive Robot

Stiquito - What Is It?

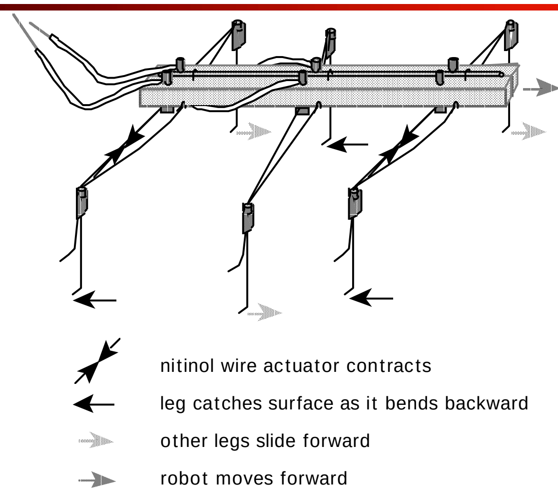
- Invented by Jonathan Mills, CS Department, Indiana University, in 1992.
- Hexapod (six legs)
- Small - can sit on a credit card (75mm x 70mm x 25mm, 10g)
- Inexpensive ($5.00 in mass quantities), easy-to-build
- Can carry about 50g of weight
- Travels using a "Nitinol" muscle (also comprises 1/2 of the cost of the kit)

Nitinol - What Is It?

- Alloy of nickel and titanium
- Contracts when heated
- When cooled, must be "stretched" back to its original size
- Lasts millions of cycles



Stiquito - How Does It Work?



Are There Other Walking Robots?

Stiquito was the first robot published by Mills. Also:

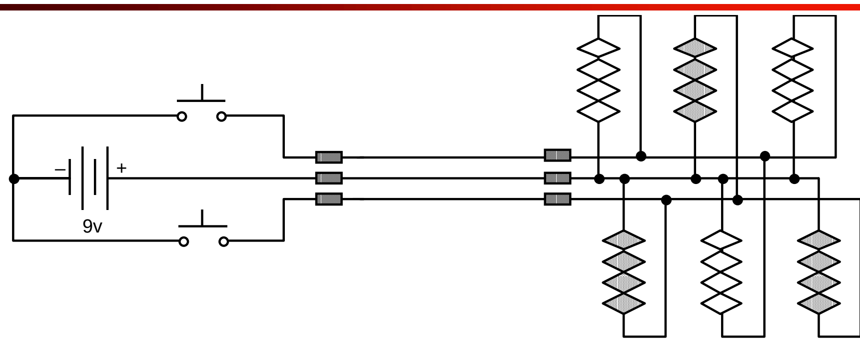
- Tensipede: 10-legged, easy to build
- Stiquito II: Larger, can carry more, legs have two ranges of motion (legs can lift)

Others:

- Boris, by Gilbertson of MondoTronics
- Scorpio, by Estell of Bluffton College
- Others, by Tilden of Los Alamos

Of course, there are HUGE walking robots everywhere!

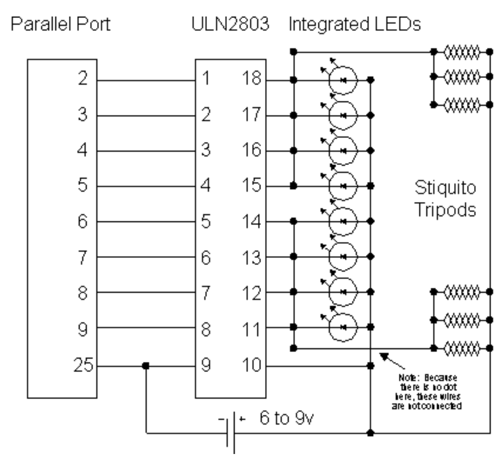
Controlling Stiquito Manually



- Simple operation, no components, two switches, requires tether

Controlling Stiquito - PC Parallel Port

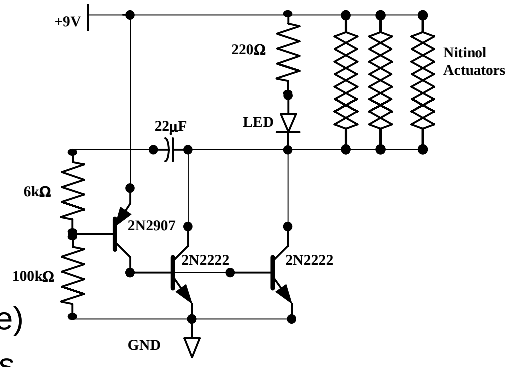
- Attach Stiquito to a PC's Parallel port via a tether
- Provide a separate power source from the PC
- Program via C, BASIC, or Assembler
- Simple circuit, easier to change program



Stiquito: An Inexpensive Robot

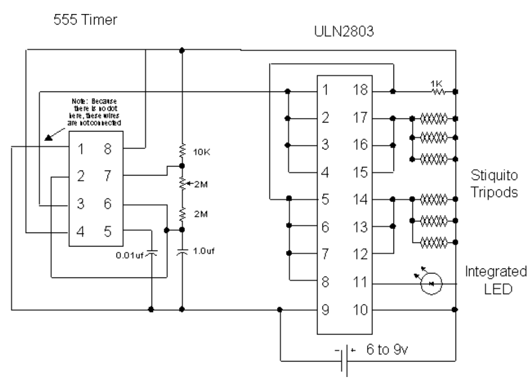
Controlling Stiquito - A Simple Analog Circuit

- Comprised of:
  - » 6 resistors
  - » 6 transistors
  - » 2 capacitors
  - » 2 LEDs
- Only walks straight (well, most of the time)
- Battery and circuit sits on top - no tether



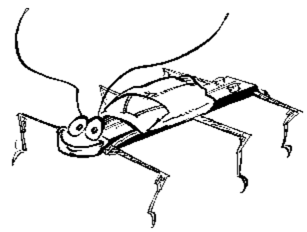
Controlling Stiquito - Another Simple Analog Circuit

- Comprised of:
  - » 4 resistors/Pots
  - » 8 “transistors”
  - » 2 capacitors
  - » 1 LED
  - » 555 timer
- Battery and circuit sits on top - no tether



Controlling Stiquito -Complex Microcontroller

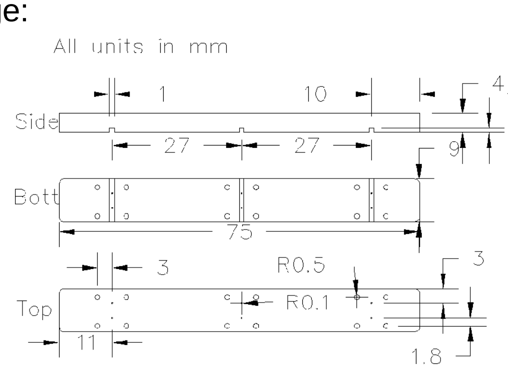
- Uses a microcontroller
  - » PIC
  - » MC68HC11
  - » 80C32
  - » FPGA
- Programming & hardware design
- Difficult & advanced



Kit Contents*

- Basic Stiquito Package:
  body,
  Nitinol,
  aluminum tubing,
  music wire,
  electrical wire,
  manual controller,
  9V terminal,
  sandpaper.

* Batteries not included.

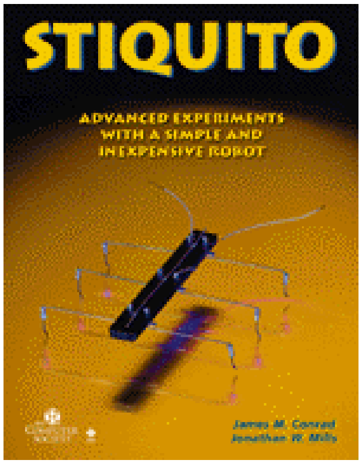


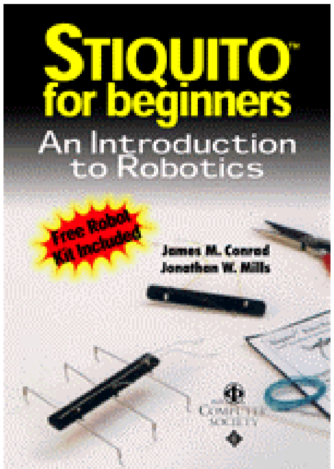
Other Kit Contents*

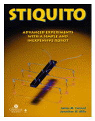
- Analog Controller Package: 555 timer, ULN2803A Driver, resistors, capacitors, LEDs, PCB.
- PC Controller Package: 25-pin D-shell connector, ULN2803A Driver, PCB.
- “Education” Package: LEDs, indicator light, resistors, wire, extra Nitinol, electronics

* Batteries not included.

Two books







Advanced Book

Stiquito^{tm}: Advanced Experiments with a Simple and Inexpensive Robot, James M. Conrad and Jonathan W. Mills

Chapter 1: An Introduction to Stiquito, the Book, and the Kit

Chapter 2: Stiquito: A Small, Simple, Inexpensive Hexapod Robot

Chapter 3: Building Stiquito II and Tensipede

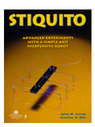
Chapter 4: Increasing Stiquito's Loading Capacity

Chapter 5: Boris

Chapter 6: A PC Based Controller for Stiquito Robots

Chapter 7: A M68HC11 Microcontroller-Based Stiquito Controller

Chapter 8: A Microcontroller-Based Stiquito Colony Communications System



Advanced Book (Cont.)

Chapter 9: A General Purpose Controller for Stiquito

Chapter 10:SCORPIO: Hardware Design

Chapter 11:SCORPIO: Software Design

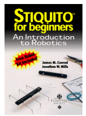
Chapter 12: Lukasiewicz' Insect: The Role of Continuous-Valued Logic in a Mobile Robot's Sensors, Control, & Loc.

Chapter 13: Stiquito, A Platform for Artificial Intelligence

Chapter 14: Cooperative Behaviors of Autonomous Mobile Robots

Chapter 15: The Simulation of a Six-Legged Autonomous Robot Guided by Vision

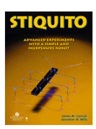
Chapter 16: The Future for Nitinol-Propelled Walking Robots

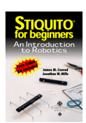


Introductory Book

Stiquito*tm *for Beginners: An Introduction to Robotics,
James M. Conrad and Jonathan W. Mills

Chapter 1: An Introduction to Robots and Robotics
Chapter 2: An Introduction to Engineering Design
Chapter 3: Electricity Basics
Chapter 4: Nitinol Basics
Chapter 5: Stiquito: A Small, Simple, Inexpensive Hexapod Robot
Chapter 6: A Manual Controller for Stiquito
Chapter 7: A PC Based Controller for Stiquito Robots
Chapter 8: A Simple Circuit to Make Stiquito Walk on Its Own
Chapter 9: Uses of Stiquito and the Future of Small Walking Robots





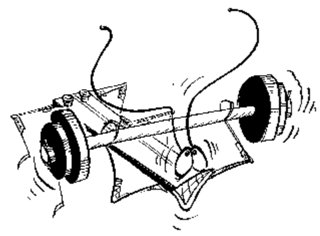
Book Availability

- *Stiquito*tm*: Advanced Experiments with a Simple and Inexpensive Robot*, ISBN 0-8186-7408-3, Catalog #BP07408, IEEE Computer Society Press, 1-800-CS-BOOKS. Available Now.
- *Stiquito*tm*: A Simple and Inexpensive Robot that You Can Build*, ISBN 0-8186-7514-4, Catalog #BP07514, IEEE Computer Society Press, 1-800-CS-BOOKS. Available December 1999.
- Each book comes with one Stiquito Kit.
- Other kits available from Parallax, Inc.

Engineering Education

What is engineering? What does an engineer do?

- Drives a train?
- Builds things?
- Designs things?
- Fixes things?
- Makes lots of money?
- Is a nerd?
- Most likely is male?



Why Do Students Choose Engineering?

- Career counselor suggested, based on correct (or incorrect) perceptions of the field.
- A teacher suggested, because the student was good at math and science. (Note: teachers also discourage based on this and perception).
- Second hand knowledge, like from a neighbor, relative, friend, books, newspapers, magazines.
- Direct exposure with the field through work, workshops, class assignments.

Students rarely have direct exposure of engineering.

How Do Students Learn About Engineering?

In a 1994 survey of freshmen engineering students at the University of Arkansas, students said they learned of engineering:

- From second-hand knowledge.
- In high school (where it was too last to adjust their plans of college prep courses).

Some said they knew little about the discipline they were currently enrolled.

All said they should have learned about engineering earlier

What Is Needed Freshman Year?

It is too late to help them in high school, so why not let them know the first semester?

- A NCSU survey found students switched from engineering based on poor performance in non-engineering courses like chemistry and math.
- NCSU Freshmen who worked in small groups tended to stay in engineering more than those in big lectures.
- Soft skills (planning, writing, stress management) are important to success in any business. Where do students learn these skills?

Stiquito: An Inexpensive Robot

Syllabus - 1 or 2 Hour Course

- Students will learn about the role of an engineer and the processes an engineer uses.
- Students will learn how to examine a task and apply problem solving techniques to implement a solution.
- Students will also learn the design processes and how to identify tools (logical and physical) required for a certain task.
- Students will work in teams to solve a problem associated with the Stiquito robot.

Lecture: 1 hour per week, 100-200 students per section

Lab: 1 hour per week, 12 students each section

Open lab time available

CompE and EE Introduction Course

- Can use the same format as above . . .
- . . . even describe other disciplines, and how CompE and EEs would interface with those engineers
- Include more detail on analog circuits
- Describe in more detail the path students will follow in the next four (five?) years
- Describe in more detail different CompE and EE sub-disciplines (digital, computers, circuits, materials, power, control, etc.)

Why Stiquito?

- Students learn best with hands-on activities.
- The walking mechanism is not complex. The analog circuit is not complex. (Less is more)
- Low cost - students pay for the supplies (the kit is in the book). Only one working robot needs to work between the three in a group.
- Immediate feedback on success or failure of design.
- Open ended: the kit is built. Now what?
- Exposure to several CompE and EE subareas (power, control, circuits, programming).

Possible Other Uses of Stiquito

Once Stiquito has been introduced in the curriculum, it can be used to demonstrate other technologies learned in other classes:

- Advanced design: microcontroller systems
- Control systems
- Programming
- Manufacturing PCBs

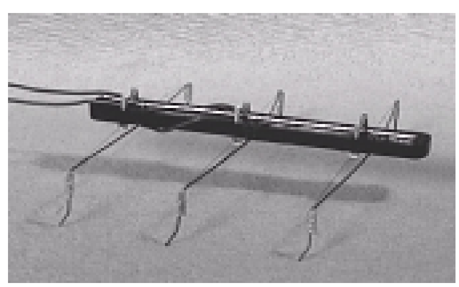
Stiquito can also be used for cross-disciplinary efforts (ME/EE/CompE)

Create contests, races, competitions

Summary - Engineering Education

- An introductory course is needed to help freshmen to understand engineering
- Freshmen need to learn problem solving techniques and team building skills early
- Freshmen also need to learn soft skills before they fall back on bad habits
- People like to understand "the big picture," like how all of the engineering disciplines work together
- Students want to have fun!

Summary - Stiquito



- Stiquito is an inexpensive platform to learn about engineering concepts.
- Making Stiquito walk requires knowledge of different engineering disciplines.
- Stiquito has been built by hundreds of people.
- Stiquito can be controlled manually, by a simple analog circuit, by a PC, and by a microcontroller
- Two books, and an enclosed Stiquito kit, are available

Questions and Demos

Questions?

Various items are available for viewing and playing:

- Stiquito with manual controller
- Stiquito with Analog controller
- Stiquito with PC controller
- Stiquito II
- PC controller for Stiquito II (12 control lines)
- Stiquito kit

Contact Information

James M. Conrad

Ericsson, Inc.
7001 Development Drive
Res. Tri. Park, NC 27709
(919) 472-6178
(919) 472-6515 FAX
jconrad@stiquito.com*
eusjcon@rtp.ericsson.se

North Carolina State University
Dept. of Electrical and Comp. Eng.
Box 7911
Raleigh NC 27695-7911
(919) 515-7382 FAX
jmconrad@eos.ncsu.edu

* Preferred method of contact