Indoor Model Airplane Design

Rubber Motors

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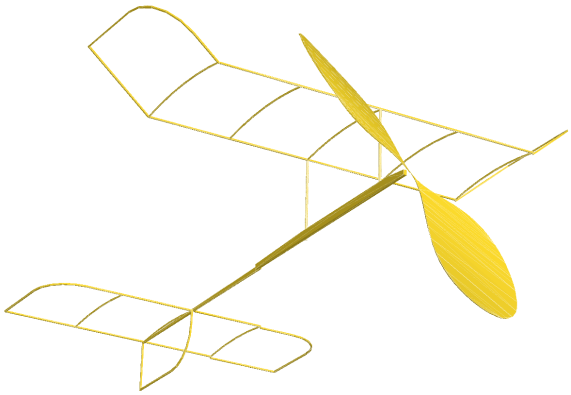

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Preface

For almost two decades, I taught a course titled *Computer Architecture and Machine Language*. The course was offered to second year college students intending to become computer scientists. This course was by far my favorite one, since it let me take students on an exciting journey of discovery.

When I first was offered this course, the basic material covered assembly language programming for the Intel 8086 processor. Architecture took a back seat to learning another programming language. I found that odd that the course focused on a 16-bit processor since most computers at the time were using 32-bit Pentium processors. Upgrading the course required new development tools, and I decided to make the course vendor neutral. That meant getting rid of the Microsoft bias present in many courses at my school. I started off by deciding to introduce my students to tools commonly found in open-source projects. Those tools included programmer's editors, build tools, source code control tools, and standards compliant compilers capable of building projects on any platform. Many of my students were shocked to learn that they could build software without using some magical *Integrated Development Environment*. My theory was simple. Choosing an IDE is something best left to that first job the student will land. That job will have an development process and tool chain that

the new employee will need to learn.

As the course evolved, I added more emphasis on the inner workings of the machine the students were learning to program. At first the focus was still on Intel chips since they power most of the computers students are familiar with. However, the world is changing, and more and more work is being done on systems that use other processors. The most common chips in mobile platforms today are variants of the *ARM* processor.

The *ARM* processors are complex chips, maybe too complex for beginners in my course to study. There was a simple alternative available though. The *Microchip AVR* processor found on the new —emphArduino development boards was available very inexpensively. I decided to buy enough of these boards to set up lab kits for my classes so students could do hands-on development work on real hardware.

The course became very popular. It was challenging, but prepared students well for their future jobs.

I continues to add material focusing on what was going on inside the processors they were learning to control. Then in 2017 something interesting happened. The Texas body charged with setting standards for college courses changed the course requirements for my course in an interesting way. The new guidelines asked students to write a simulator for a real processor as part of the course. They also added a focus on embedded processors intending to get students ready for those mobile platforms found everywhere. I was already doing most of what they asked. I only needed to add the simulator to my course to meet these new guidelines.

This book is designed for this course. Although I have now retired, I decided to write this book based on my lecture notes but with a new twist.

Instead of producing yet another dry textbook, I decided to write a book

along the lines of one of my favorite books: *Godel, Escher, Bach* by Douglas Hofstadter Hofstadter (1999). The result is not so much a textbook, but more of a novel. I want the student to want to read this text, not just scan it looking for answers to exercises they are given. I hope the result is interesting enough to show them why they are learning all this new material. I also hope to produce more professional candidates for that job market waiting for them in their near future.

I hope you enjoy reading this book as much as I enjoyed producing it.

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Chapter 1

Rubber Motors

Rubber in its natural form comes from trees found in places like the Amazon, Indonesia, and others around the world. Chemists have determined that an organic compound found in these trees helpds protect them from temperature fluctuations. The compound is called *isoprene* and looks like this when drawn as a chemical figure:

Here is a nice website that has more information about this molecule. .

Natural rubber is stretchy and has properties that were interesting to many folks. However, it had a few deficiencies, so chemists played with this moleculr and discovered that if they heated it up and mixed in some sulfer

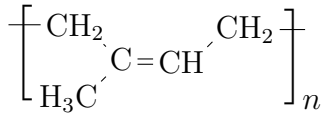

Figure 1.1: Natural Rubber: polyisoprene molecule

under high pressure, a process called vulcanization, something interesting happened.

At the molecular level the sulfer caused two polymide submolecules to bone together, effectively connecting two adjacent polymer chains together. Not ever submolecure became linked, just enough to provide new properties.

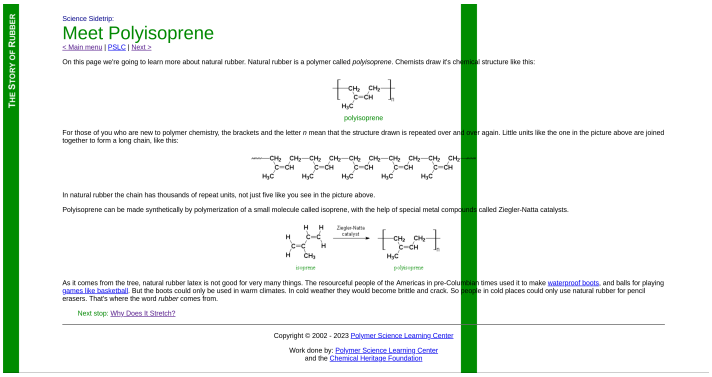

Figure 1.2: test figure

This article needs a reference Maheswaramma and Chugh (2015)

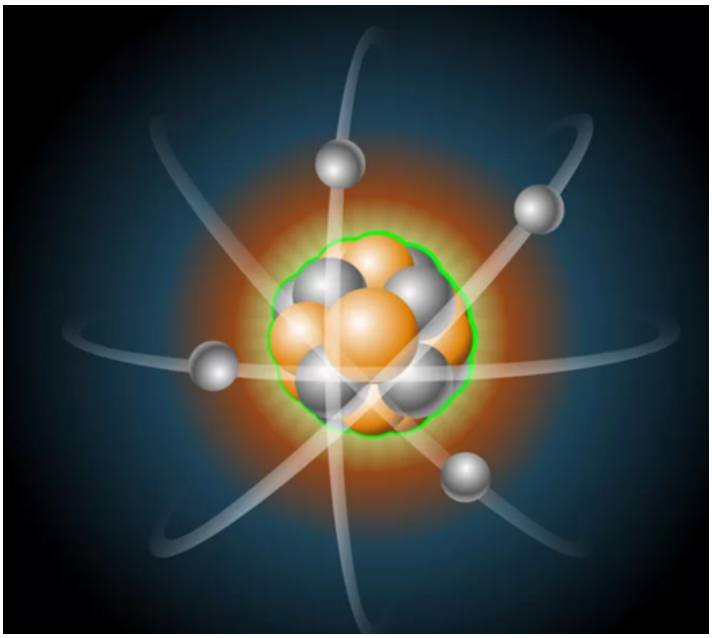

Figure 1.3: Atomic structure.

Bibliography

Hofstadter, D. (1999). *Godel, Escher, Bach: An Eternal Golden Braid*. Basic Books. Basic Books.

Maheswaramma, K. and Chugh, M. (2015). *Engineering Chemistry*. Pearson Education India.