A long time ago in a country far, far away a few of us had a vision....
to provide Astronautics for Anyone!

That vision became...



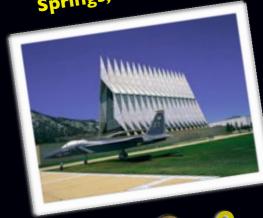
UNDERSTANDING SPACE

An Introduction to Astronautics

this is the story of the past, present and future of that bold endeavor

It all started in 1991...

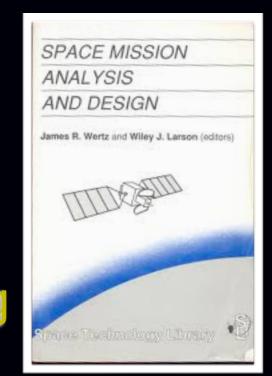
USAFA, Colorado Springs, CO USA





- Dr. Wiley Larson stepped up as editor, along with Doug Kirkpatrick
- raised my had to volunteer
- The rest is history...





VOLUNTEER

Sign Up

The Vision...





Cover A to Z of space missions with roughly equal breadth and depth



The Approach...

The Space Mission Architecture

The Mission - need, goals, ConOps

Trajectories and Orbits

Spacecraft

Launch Vehicles

Mission Operations Systems

Mission Management & Operations



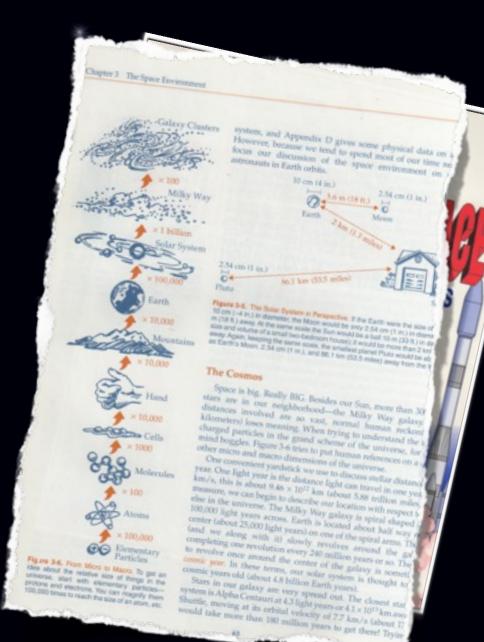
The first draft...1992

- Rough, black and white edition
- Used by cadets in core astro classes at USAFA
- Great feedback



The first edition...1993

- 3-color (red, blue, black)
- Widely published by McGraw-Hill
- Used by thousands of students around the US

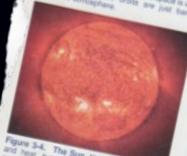


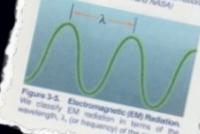
The second edition...2000

- Full color
- Expanded space systems sections
- Used by thousands more students around the US and



Figure 3-9. Shuttle Orbit Orewn Closer to





wispy air molecules in the upper atmosphere drag it back to Earth. This occurs above an altitude of about 130 km (81 ml.). That's about the drag in least case an hourt So the most tier. distance you can drive in your car in just over an hour! So the next tire distance you can drive in your car in just over an nouri 50 the next times someone asks you, "how do I get to space." just tell them to "turn straig the assessment out."

up and go about 130 km (81 ms.) until the stars come out." As you can see, space is very close. Normally, when you see drawin As you can see, space is very close Normally, when you see drawin of orbits around Earth (as you'll see in later chapters), they look far, of orbits around Earth (as you'll see in later chapters), they look fat, it away. But these diagrams are seldom drawn to scale. To put low-Ea away. But these diagrams are seldom drawn to scase, to put sow tay orbits (LEO), like the ones flown by the Space Shuttle, into perspective and the seldom of the seldom o orons (LEO), like the ones hown by the Space Shuttle, into perspects imagine Earth were the size of a peach—then a typical Shuttle off models and the list above the large. A discount of the large language is a coale that were the size of the large. imagine Earth were the size of a peach—then a typical summe on would be just above the fuzz. A diagram closer to scale (but not exactly)

Now that we have some idea of where space is, let's take a grand tor Now that we have some idea of where space is, set's take a grand me of our "local seighborhood" to see what's out there. We'll begin it of our local pergressmood to see what's out there, we'll begin looking at the solar system, then expand our view to cover the galaxy, The Solar System

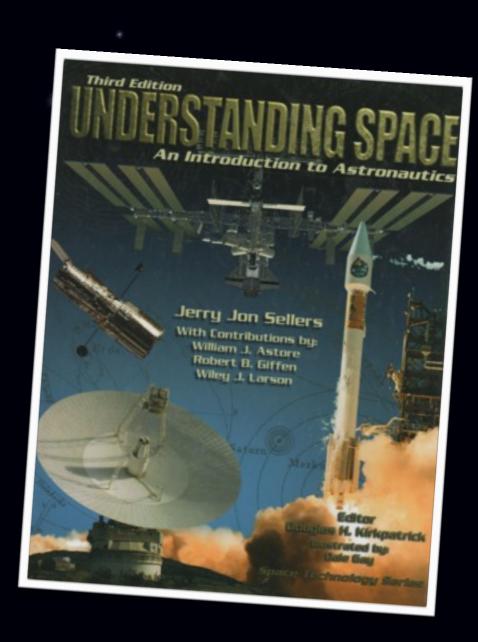
At the center of the solar system is the star closest to Earth—the Solar System is the star close to t At the center or the solar system is the star cosest to Earth—the Set (Figure 3-4). As we'll see, the Sun has the biggest effect on the space of the environment. As we'll see, the Sun has the biggest effect on the spon environment. As stars go, our Sun is quite ordinary. It's just one small state of bellions in the state of the state of bellions. yellow star out of billions in the galaxy. Foeled by nuclear fusion. yellow star out of billions in the galaxy. Foreign by mixture manner combines or "fuses" 600 million sons of hydrogen each second. (Den worry, at that rate it won't run out of hydrogen for about 5,000,000,00

The energy released by nuclear fusion is governed by Einstein's famo The energy released by nuclear russon is governed by Einstein's Italian E = m c² formula. This energy, of course, makes like on Earth possible. the San produces lots of energy, erough each second to supply all the state of the energy the United States needs for about 624 million years! This energy primarily in the form of electromagnetic radiation. In a clear, blue sky. Sun appears as an intensely bright circle of light. With your eyes closed a summer day, you can feel the San's heat beating on your eyes come heat are only part of it's electromynetic (EM) radiation. The term "ta tion" often conjunes up visions of nuclear wars and mutant sp then other corpans up visions or nuclear wars and mutant a creatures, but EM radiation is something we live with every day. radiation is a way for energy to get from one place to another. We think of the Sun's interse energy as radiating from its surface in directions in waves. We classify these waves of radiase energy in term

the distance between wave crests, or uneviringth, \(\lambda\), as in Figure 3-5. What difference does changing the wavelength make? If you've seen a rainbow on a surmy spring day, you've seen the awesome bea of changing the wavelength of EM radiation by only 0.200003 m ft. Jr The colors of the rainbow, from violet to red, represent a very small fraction of the entire electromagnetic spectrum spectrum spans from high energy X-rays (like you get in the de

The third edition...2004

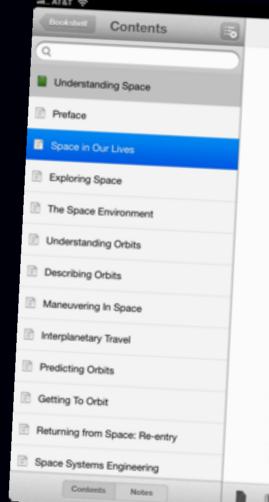
- Full color
- Complete update and corrections
- Expanded propulsion and systems engineering discussion



eBook...

- Take Understanding Space anywhere!
- Full searchable text available as e-book from McGraw-Hill Create
 - Can run on up to 3 devices, Mac, PC, iPad, iPhone, etc.

iPad e-book screenshot



metal for various industrial uses. It is also possible that water ice may be trapped in eternally-dark craters at the Lunar poles. These resorcoupled with the human drive to explore, mean the sky is truly the limit

Understanding Space

1.1 Why Space?

Finally, space offers an advantage simply as a frontier. The human condition has always improved as new frontiers were challenged. As a stimulus for increased technological advances, and a crucible for creating greater economic expansion, space offers a limitless challenge that compels our attention. Many people have compared the challenges of space to those faced by the first explorers to the New World. European others explored the apparently limitless resources, struggling at first, then slowly creating a productive society out of the wilderness

We're still a long way from placing colonies on the Moon or Mars. But already the lure of this final frontier has affected us. Audiences spend millions of dollars each year on inspiring movies such as Star Wars, Star Tree, Independence Day, and Contact. The Apollo Moon landings and scores of Space Shuttle flights have captured the wonder and imagination of people across the planet. NASA records thousands of hits per day on their Mars Mission websites. Future missions promise to be even more aptivating as a greater number of humans join in the quest for space. For each of us "space" means something different, as illustrated in Figure 1-6.



Figure 1-4. Space. Space is many things to many people. It's the wonder of the start collets, spacecraft, and all the other sapects of the final frontier.



In the Classroom...Around the World

- Undergraduate
- Graduate

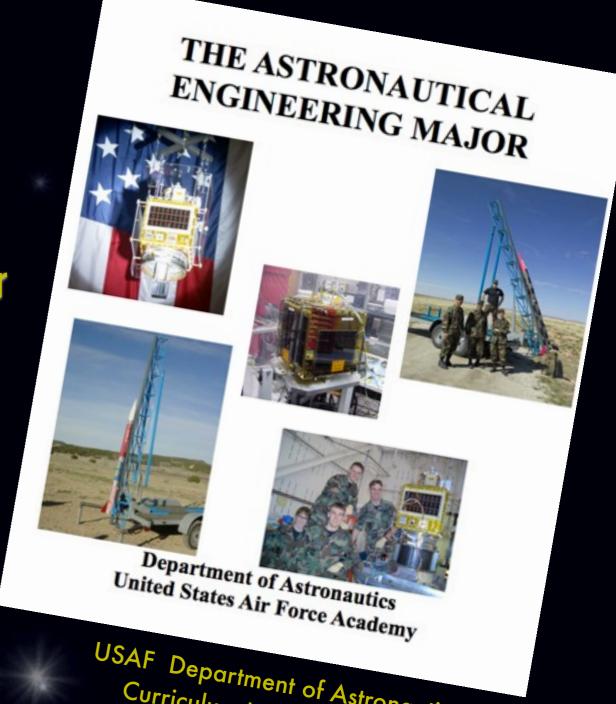






Foundation for a complete curriculum...

- Example: Undergraduate **Astronautical Engineering major** at USAF Academy
 - Oldest @ 50 ys, (and only?) astronautics only major in the US (world?)



USAF Department of Astronautics Curriculum Handbook 2012

Goals of USAFA Astro Curriculum...

Program Curricular Outcomes are listed below. Upon successful completion of the Academy program in Astronautical Engineering, cadets will have the ability to:

- •Use fundamental knowledge of orbital mechanics, space environment, attitude dynamics and control, telecommunications, space structures, and rocket propulsion to solve astronautical engineering problems,
- •Plan and execute experimental studies and formulate sound conclusions, analyzing empirical data,
- Apply modern technology tools to solve astronautical engineering
- Communicate effectively using oral, written, graphical and electronic
- Recognize the ethical and professional responsibilities of Air Force Officership and the engineering profession,
- Work effectively as a member of a multi-disciplinary design team,
- Recognize the benefits of and possess skills needed to engage in life-long
- Informatively discuss the impact of engineering on present-day societal and global contemporary issues to include Air Force aerospace capabilities and requirement

USAFA Course Requirements...

USAF Department of Astronautics Curriculum Handbook 2012

COURSE REQUIREMENTS: 148 Semester Hours

A. 97 Semester hours of Dean's academic core courses to include:

- Aero Engr 241 Aero-Thermodynamics
- Astro Engr 210 Introduction to Astronautics (Understanding Space!)
- Math 356 Probability and Statistics for Engineers and Scientists
- ECE 231 Electrical Circuits and Systems I
- Astro Engr 437 Small Spacecraft Engineering II

B. 3 Semester hours of Academy Option, e.g. Astro Engr 423 Space Mission

C. 43 Semester hours of major's courses:

1. Math 243 (or Math 253)

Math 245

Math 346

Engr Mech 320

Engr Mech 330

Engr 341

7. Engr 342

8. Astro Engr 201

9. Astro Engr 321

10. Astro Engr 331

11. Astro Engr 351

12. ECE 446

13. Astro Engr 445

14. Physics 37

15. Astro Engr 436 (F)

Calculus III (or Advanced Placed Calculus III)

Differential Equations Engineering Math

Dynamics

Mechanics of Deformable Bodies

Linear Systems Analysis and Design

Linear Control System Analysis and Design

Technology Skills for Astronautics

Intermediate Astrodynamics Space Systems Engineering

Rocket Propulsion

Applied Communications

Spacecraft Attitude Dynamics and Control

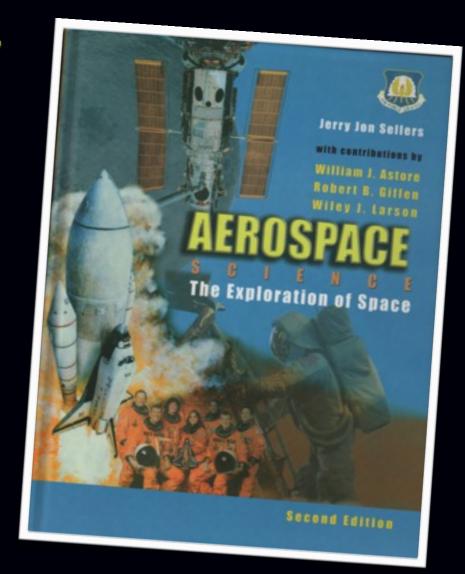
Upper Atmospheric and Geo-Space Physics

Small Spacecraft Engineering I



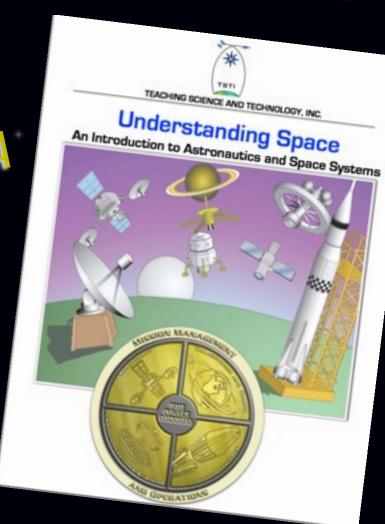
High School, Middle Schools....

- Versions developed tailored especially for middle school (12-14 year olds) and high school (14-18 year olds)
- Includes:
 - Teacher notes
 - Student workbook



Short Courses...

- Starting in 1996, Teaching Science & Technology Inc. (TSTI) began offering Understanding Space as a short course around the industry
- Now the basis for
 - NASA Introduction to Aerospace @ NASA
 - Lockheed-Martin New hire program
 - Numerous other organizations



Impact...

- University Students
 - **>30,000**
- Short Courses
 - >15,000 students and counting!
- But that's not enough!







Now...Online...

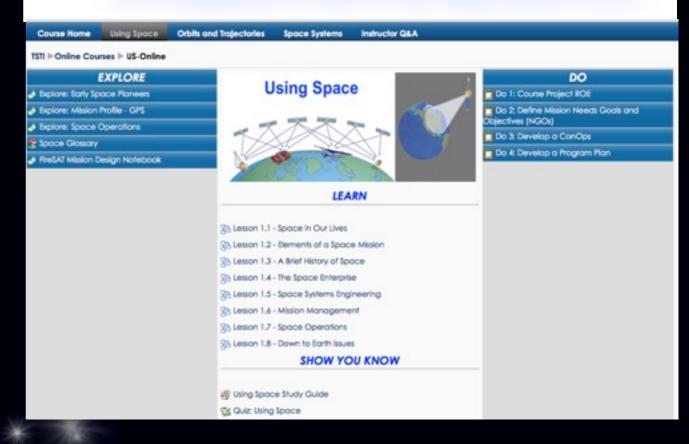
- Launched in 2012
- Official online training for USAF Space & Missile Center
- Available to <u>Anyone</u> today
 - Learn
 - **Explore**

 - Show You Know



An Introduction to Astronautics and Space Systems

An integrated online learning experience



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Welcome to...

TSTI

SUNDERSTANDING SPACE

An Introduction to Astronautics and Space Systems

An integrated online learning experience

Since the dawn of the Space Age just five decades ago, we have come to rely more and more on space for a variety of earthly needs. Daily weather forecasts, instantaneous world-wide communication and navigation, as well as the ability to keep an eye on not-so-friendly neighbors, are all examples of space capabilities that we've come to take for granted.

This course is designed to make you "space smart," by building your understanding and appreciation for the complex requirements of space missions. This course will help you....

- · Gain core Space Knowledge
- Comprehend space mission capabilities, trade-offs and limitations
- Apply space concepts to real-world problems
- Analyze typical space problems
- Synthesize concepts to design a space mission
- Evaluate basic technical and programmatic space issues

Getting Started

Your space adventure starts here...

Step 1:

Read through the Course Handbook and watch the introductory videos

Course Handbook

Step 2:

Complete the Initial Personal Study Plan Questionnaire

M Initial Personal Study Plan

Step 3

Take the Pre-course quiz (no need to study! just take to see where you're starting from!)



tep 4

Create your student profile (click on "profile" under the Administration block on the left).

Step 5:

Access your Understanding Space e-Book using the access code provided by your course mentor. Read and follow the e-Book access instructions by clicking the link below.

e-book Access Instructions

Finishing Up

C Online Course Survey



Tinal Personal Study Plan



The course reference:

UNDERSTANDING SPACE

An Introduction to Astronautics

.

by Jerry Jon Sellers, et al., published by McGraw-Hill



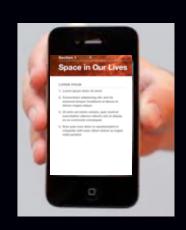
Available as an e-book (access code required).

The future?...in your hands?

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 - JAXA? UN? CNES? UK Space Agency?
- Understanding Space-lite free online course?
- Understanding Space App?
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Questions..?

about past, present or future episodes

