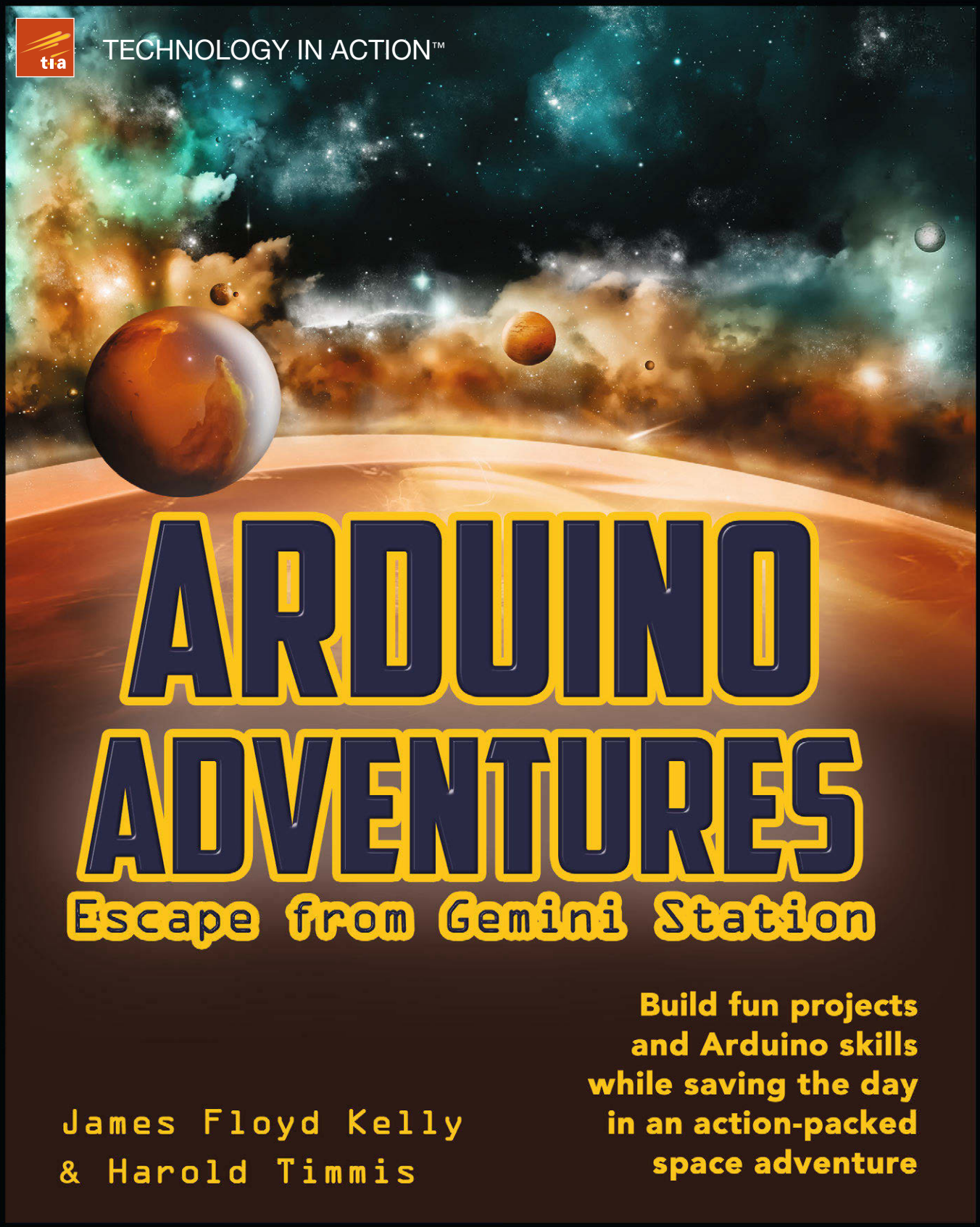
TECHNOLOGY IN ACTION™
ARDUINO ADVENTURES
Escape from Gemini Station
Build fun projects and Arduino skills while saving the day in an action-packed space adventure
James Floyd Kelly & Harold Timmis

Arduino Adventures

Escape from Gemini Station

James Floyd Kelly
Harold Timmis

Apress®

Arduino Adventures: Escape from Gemini Station

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To all those who aspire to learn, and teach, for the betterment of society

—Harold Timmis

This book is for Decker and Sawyer – my two little inspirations.

—James Floyd Kelly

Contents at a Glance

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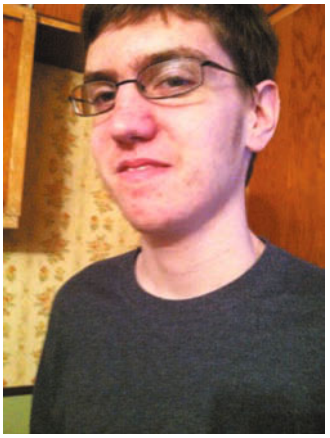
About the Authors

James Floyd Kelly has degrees in English and engineering, the perfect combination for writing about science and technology. He lives in Atlanta with his wife and two young boys, and he always loves to learn new skills. He has written books that teach readers how to build their own CNC machines and 3D printers, books for kids that teach them how to build and program LEGO robotics, and books on many other topics. He loves to tinker in his workshop and is hard at work on more books.

Harold Timmis studied computer engineering at the Florida Institute of Technology in Melbourne, Florida. He has been working as a test engineer for the past four years at several corporations, including General Electric, Mercury Marine, and Avidyne. He also enjoys integrating hardware and software into complex robotic systems.

About the Technical Reviewers



Jeff Gennick is an avid gamer and all-around technology enthusiast. He is a high school junior from Munising, in Michigan's Upper Peninsula. Jeff lives six blocks from Lake Superior, in a snow belt though he is decidedly not a snow person and prefers to spend a cold winter's evening huddled around a hot, Steam-powered game on the gaming rig he spec'd, paid for, and assembled himself. Jeff enjoys technology and sometimes helps his father test the projects in hands-on books, such as the one you're holding now.

Andreas Wischer lives in Paderborn, Germany. While reading about Gemini Station in this book he found astonishing similarities to the world's biggest computer museum located in his home town. Andreas holds a degree in electronics and has worked as a software consultant throughout Europe for more than 10 years. He currently works as an IT professional for a big electronic supplier.

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Harold Timmis

Getting this book written, edited, and in your hands required a lot of hard work. I'd like to offer a very big thank you to Kevin Shea at Apress for his patience, hard work, and tenacity in keeping his two authors on track. If you like this book, Kevin had a big part to play in that.

Another thanks goes to Jonathan Gennick at Apress. I've been writing for Jonathan for quite a few years now and I consider him a good friend. Most readers are unaware of the hard work that goes on in just getting a book approved; Jonathan believed in our idea and made it happen.

This book also had some great technical reviewers, Jeff and Andreas. They caught our errors and helped make this book that much better. Any errors you may find are those of the authors. Just be sure to check our web site, arduinoadventurer.com, for any updates or fixes to problems we discover later. A special thanks goes to Jeff, who has been with us since the first few chapters and provided some great feedback that helped us improve the book from the start. His suggestions on how we could better explain wiring up the hardware are much appreciated.

Of course, my family has been completely supportive as I've worked on this book. My wife, Ashley, has always encouraged my career, and my two boys are my daily inspiration as I see their wide eyes taking in all the cool gadgets in my office. It's hard not to be excited about a book when the end result is something that will almost certainly benefit my sons once they're a bit older.

James Floyd Kelly

Introduction

Fun. We (your authors) wanted a word to describe our ultimate goal for this book, as well as a word we hope you (our reader) will use to describe it, and that's the one we chose. There are others goals, of course, but in the end, when you've finished the book, we're hoping you'll have enjoyed the activities described in these pages.

Many books use the Introduction to explain exactly what the book is about, what the reader will learn, what the reader needs (a skill or maybe an item or piece of software), and what the reader will be left with when that last page is completed. And this Introduction will do those things, but … hopefully it'll make you excited to get started.

So, welcome to Arduino Adventures. We won't make you spend too much time on this Introduction—just give us a few pages and let us tell you how this book works. You'll find a bunch of useful information that will help make the rest of the book more enjoyable.

What Is Arduino Adventures?

That's an easy question to answer! First, the book is about the Arduino. Hmm … okay, well, that sort of assumes you know what the Arduino is, right? Don't worry, we'll get to that. For now, just take a look at Figure I-1. You're going to use that little electronic device to make some fun and interesting gizmos. Think of it as a teeny-tiny computer (of sorts) that can do some amazing things when you add power and a few other tiny components to it. It's called a microcontroller, and by the time you finish this book, you'll know how to do quite a few things with it.

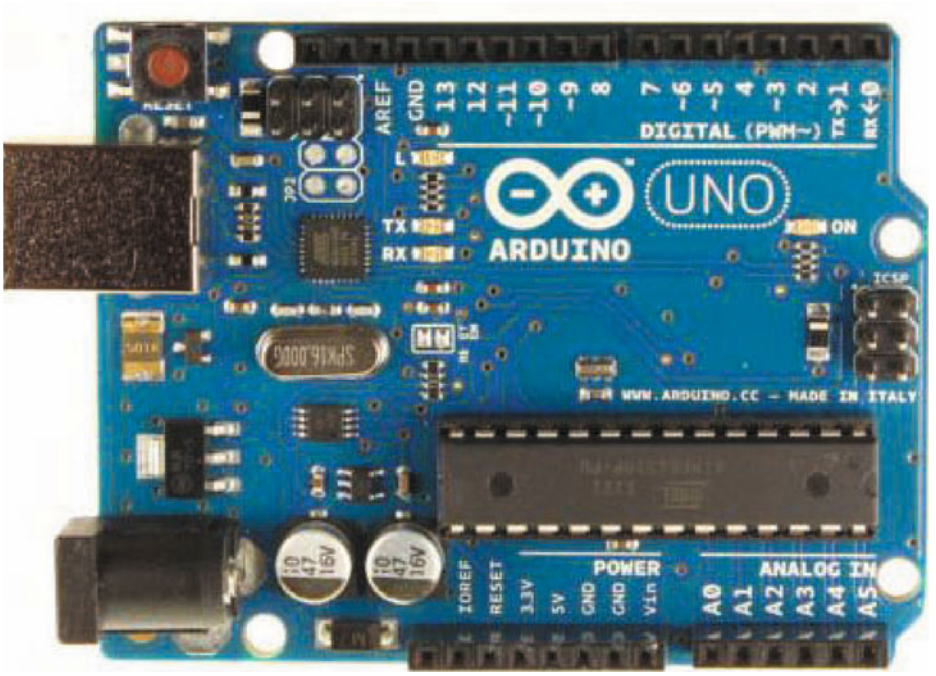

Figure I-1. *The Arduino Uno microcontroller*

As for the Adventures part of the title, that we can answer right away. You're going to learn how to use the Arduino microcontroller by putting yourself in the shoes of the hero and heroine whose fictional story is told throughout the book. You see, we could have just written a book that tells you to take the particulmaxinator and plug it into the fibulonical port and then tells you to upload the program called MaxFibV2 … snore! Did your forehead just smack the table? Boring, right? And not the best way to learn.

We're guessing you'll enjoy learning about the Arduino a bit more if you feel involved in the activities. So the storyline is used to present a particular challenge that can only be solved using the Arduino. How many challenges? Eight of them! You'll read a bit of the story, discover the problem our hero and heroine are facing, and then wire up the Arduino and some other components to build a working solution to the problem. That, in a nutshell, is what Arduino Adventures is all about—using a fun story with unique challenges to help you gain a real understanding of how to use the Arduino microcontroller—by actually using your hands to create things. Trust us—it'll be fun!

Will I Be an Arduino Guru When I'm Done?

Ummm … no. With a limit of 400 pages placed on your new favorite authors, we'll certainly try to give you as much training as we can, but there's only so much we can show you. But don't stress! As you progress through the book, we're going to introduce you to web sites where you can go to learn more about the Arduino. We're going to tell you which books to seek out so you can continue expanding your Arduino skills. And we're going to offer plenty of tips and advice on how to avoid reinventing the wheel—you're going to be pleasantly surprised to find that a lot of work has already

been done for you, with shortcuts and tutorials available to do just about anything you can imagine with the Arduino.

When you finish this book, you will have moved from Arduino Novice to Arduino Explorer. You'll have enough of an understanding of the Arduino to feel comfortable working with it, programming it, and tinkering with it to create your own special projects.

What we want you to walk away with when you finish this book is a sense of confidence that you know what the Arduino is, what it can do (and what it can't do), and how to get your own answers and solutions using all the resources that are currently available for Arduino Novices, Arduino Explorers, and Arduino Gurus. If your goal is to become an Arduino Guru, this book will get you moving in the right direction quickly.

What Skills Do I Need?

While we would love to make no assumptions about the basic skills our readers will bring with them and provide a comprehensive, start-to-finish book on everything you'd ever need to know to use the Arduino … it's just impossible. First, a book like that would be around 1,500 pages and weigh about 45 pounds (20 kilos for our metric friends)—and that's not a book we'd want to carry around. And sure … you could always get the digital ebook version, but honestly we don't have the time to write a 1,500 page book. So we're going to have to make some basic assumptions about what our readers possess, such as:

Basic computer skills with either Microsoft Windows or Mac OS. This includes things like being able to use a mouse (or touchpad), knowing how to save files in folders, and a good comfort level with one of the best tools around, the Internet. Chances are good that a large percentage of our readers were handed a laptop or smart phone almost as soon as they were born, so technology is unlikely to faze them in the least. If, however, you are lacking in some basic computer and Internet skills, please just ask your children or grandchildren to assist you—they're really good with this stuff.

A brain. For some reason, people who want to learn about the Arduino tend to do better when they have a real brain, not a foam one that you squeeze when you get stressed or use to play fetch with the dog. If it's been verified that a brain does exist inside your skull, you're going to do well. If you don't have a brain, please put the book down and have someone drive you to the hospital—you'll need to have some tests run. Sorry.

A parent, teacher or good friend. Not only do these people make good partners for working on the challenges in this book, but they're also really useful when it comes time to show off what you've done. Bonus points will be awarded if a look of surprise is visible on their faces. Double bonus points are awarded if they shake their heads and have no idea what they're looking at and ask you to explain. Seriously … you know you've made something cool when people look at you like you're a mega-genius or something.

How is the Book Organized?

As we mentioned, there are eight challenges in all. This means the story will be broken into eight parts (okay, nine if you include the story's conclusion). But the fictional story isn't going to offer you the information you need to solve the eight challenges. Nope! To solve those challenges, you'll be getting some additional instruction that, again, we hope you'll find easy and fun to read.

The book is broken into eight parts. Each part starts with a chapter containing a piece of the overall story. Following the fiction chapter is a theory chapter that offers information on the skills and components needed to complete the challenge. Each theory chapter is followed by a hardware chapter that shows how to build the Arduino-controlled solution to the challenge. A software chapter concludes each challenge with details on how to make the solution work using what's called a sketch. Don't worry, we know these may be new words to many of you, so for now just know that all Arduino-controlled devices require both a hardware and software component. You'll gain experience in both areas as the book progresses. Also, at the end of each software chapter you'll find extra problems to solve to help you become a better Arduino tinkerer.

So, here's a summary of how the book flows:

Fiction Chapter – You'll read the story and discover the challenge that must be overcome using something you're going to build using an Arduino microcontroller. Yes, the story is fiction, but the challenge is 100% real—and by buying this book you PROMISE to not move forward to the next challenge until you've successfully completed the current challenge. Agreed?

Theory Chapter – You'll get a basic education on the hardware that will be used to solve a challenge, as well as some more detailed explanations on relevant topics involving electronics and programming. This is the kind of chapter that would typically put us to sleep, too, so we promise to try and make it somewhat entertaining so your eyes don't glaze over and you start snoring.

Hardware Chapter – When you finish this chapter, you'll have a solution to the challenge introduced in the fiction chapter. It'll look cool … we promise—lots of wires and cool-looking extras you can show off to your friends and family. You'll also be introduced to other electronics components that we might not use in the book but that we think you'll find cool and fun to know about for your own projects.

Software Chapter – That gizmo you put together in the hardware chapter isn't finished yet. In this chapter you'll be given basic instructions on how to make the gizmo work using simple programs we'll provide. But we're not just going to give you a program—we'll also explain how and why it works so you'll be able to experiment and modify it if you like.

Do I Need to Understand Electronics?

Not at all. That's not to say any electronics knowledge you do have won't come in handy, but we'll be introducing you to the concepts you need to know about in the book, so no electronics experience is necessary. Still, just as you won't be an Arduino Guru when you finish this book, you won't be an Electronics Guru either. But we'll make sure to point you to resources that will help you move in that direction if that's your desire.

The challenges presented in this book involve a variety of electronics components, but we'll go over all of them as needed and give you the information you need to finish a challenge and understand how it works.

Do I Need to Know How to Solder?

In case you don't know, soldering is a method used to more permanently connect electronic components and wires. Heat is used to melt a mixture of various metals that quickly cools and solidifies. You can use this mixture (called solder) to make two wires stick together or make an electronic component maintain its connection with other components.

But … no soldering is required. If you know how to solder, great! But you won't need to do so for the challenges in this book. And if you don't know how to solder, we'll point you later on to some good tutorials that show you what's involved. If you do decide to go deeper into electronics and Arduino tinkering, it's a skill you'll definitely want to learn.

What Do I Need Besides This Book?

Appendix A includes a complete list of all items you'll need to complete all eight challenges. You'll also find part numbers for the various vendors we recommend. If you prefer to get the items a little at a time, you'll want to read the theory chapter for each chapter to discover the specific items required for each particular challenge. We want to be upfront and let you know that if you purchase all of the required components for this book individually, you'll end up spending around $175.00. But be sure to check out the book's web site because we'll be telling you how to save money by buying pre-bundled packages that contain the components at reduced prices. We're pushing you to the web site because this information will likely change frequently, so whatever we put in this book may well be out of date (and higher priced) by the time you read this. So, again … check the web site for the latest information on pricing and parts required!

The one item that's required for all challenges, however, is the Arduino Uno. You'll find a number of vendors that sell the Arduino, but you'll be happy to know that Radioshack is currently an Arduino retailer. This means if you've got a Radioshack in your town, it probably carries the microcontroller. If you prefer to purchase online, you may find an occasional sale that has Arduinos at a reduced price. But the Arduino is already a very inexpensive microcontroller (typically between $20 and $30), so just buy one at the best price you can find. Just one! You won't need multiple Arduinos for the challenges in this book.

You'll also want Internet access as you'll use it to download full-color wiring diagrams for the challenges on the book's web site, www.arduinoadventurer.com. And although it's not required, you'll find when you get to the first challenge that you can download some PDFs that will make some of the challenges a bit more fun. We call them Challenge Cards, and if you decide to use them, you'll want to print them out on 8.5x11 card stock (more sturdy than standard paper).

We'll also be sending you to an occasional Arduino-related site. We're not doing that in order to save on typing—we just want to show you how to search for and find particular solutions that already exist online.

The Arduino can be powered by either batteries or AC (wall) power. For this book, however, we'll be using battery power and a USB cable. This means you'll want to purchase a number of batteries depending on how you wish to provide power to your Arduino and a USB A male to USB B male cable is used in some of the challenges to power the Arduino as well. Appendix A provides you with a few options for power; choose the one you like best.

Finally, you'll need some specialty electronics items that most likely you won't find locally (at a Radioshack, for example). While we'll do our best to keep costs down, realize that learning to use the Arduino requires you to purchase a few unique items to make the Arduino work and the challenges successful.

What Do I Need For the First Challenge?

Well, for Chapter 1 you're going to need to know how to read. If you've made it this far into the Introduction, then it's safe to say you'll be okay and can move forward.

You're also going to want to make a shopping list for the components used in the first challenge. We've made this easy for you and placed the first challenge's list of required components at the beginning of Chapter 3. For all remaining challenges, consult Appendix A for the rest of the components you'll need.

Finally, you're going to need to a pep talk. So here it is:

You're going to have fun. And you're going to learn some really cool things that are going to amaze your family, friends, teachers, and pets. (Yes, even dogs and cats appreciate a well-designed gizmo.)

You can do this. There is nothing in this book that is beyond your skills. If you get confused or lost, it's a book—you can easily go back and reread any sections you like. And we'll also be sharing with you some great online resources where you can go and ask questions. You're fully qualified to accept the challenges in this book, so don't get discouraged.

We (your authors) want you to enjoy this experience. Arduino Adventures was written specifically for people like you. We promise that when you finish this book, you'll have a LOT of reasons to smile and be proud.

So … let's get to it. Your first Arduino challenge awaits. All you need to do is turn the page …

Chapter 1

Trouble at Gemini Station

“Do you just look for ways to get us into trouble, Cade?” asked Elle. She looked back over her shoulder to make certain no one else had followed them down the dark hallway.

“Are you telling me you actually wanted to stay with the tour group?” Cade flashed the same grin he always used when he tried to convince Elle he could do no wrong.

Trouble Begins

Sneaking away from the rest of the class just as the tour of Gemini Station began was pure Cade. The two students were both convinced that listening to lectures on the history of computing and electronics during the pre-gateway period would have them yawning and looking for a quiet corner to sleep. Mrs. Hondulora and the the other two instructors had made the mistake of being at the head of the line, allowing Cade and Elle to drop their location beacons in the backpacks of two other students who weren’t paying attention before sneaking away.

“No, but you just know Mrs. H. is gonna pull a pop quiz on us next week about some little bit of trivia we’re going to miss,” replied Elle. “My grades aren’t bad, but if I fail a quiz my mom and dad’ll put me on a drop-ship to the outer ring.”

“You’ve got the best grades in the class, Elle. Give it a rest,” said Cade. “Hey, here we go.”

Elle followed Cade’s gaze to a digital display mounted at the edge of the intersection. Colored lines on the floor were finally given meaning as the pair read instructions color-coded to indicate which line to follow for various exhibits.

“Pre-2050 Video Game Technology,” said Cade. “Red line. That could be interesting.”

Elle shook her head. “No, the blue line. Hologram Storage Solutions 2020–2085. I’ve always been curious to know how they solved the distortion problem.”

Cade frowned and slowly turned his head to look at Elle. “You’re kidding, right.”

Elle tried to hold back the grin, but it lasted only a few seconds. “Almost had you.”

"Well, we've got five or six hours to burn and an entire station turned into a technology museum, so I thought you might be serious. You really do get into this stuff more than anyone else I know," said Cade.

"How about that third option?" asked Elle. "Yellow line."

Cade looked back at the display. "History of Processors 1960–2015. Yeah, you've picked another winner, Elle."

Cade dodged just in time to avoid Elle's hand aimed for the back of his head. "We're running out of options," she replied. "We can always just go back and see what the group is doing."

Another grin crossed Cade's face.

"I don't like that smile," said Elle.

"How many levels did Mrs. H. say were on this station?"

Elle shook her head. "No way, Cade. That'll get us banned from field trips for the rest of the school year."

"Come on, Elle. How many?"

On the Level, or Not?

Elle bit her lip and thought back to the small presentation the students had watched prior to the trip. The space station had been decommissioned back in 2091. The twenty-three levels that made up the cigar-shaped station circling M-392 were originally used for deep-space research and provisioning of outbound ships, but the station had been literally cut in two to form Gemini Station and Taurus Station. The latter had been towed to the opposite side of M-392 so both stations were in geosynchronous orbits above the two largest settlements, Gemini for mining and Taurus for energy production to power the gateway for this system. Elle had to concentrate to recall the number of levels on Gemini Station, but then one of her memory tricks fired and she saw twelve rocks arranged to form the letter G.

"Twelve for Gemini. Eleven for Taurus."

Cade sighed and pointed at Elle's forehead. "It's really creepy how much information you store up there, you know that? I'll bet you a week's worth of 'Net access tokens that you probably have the entire station's layout memorized, don't you? Come on. . . admit it."

"The map was in the data pack. It might be on a test or something," Elle replied, her face red.

"Yeah. A test or something."

"Shutup."

"So, twelve levels. The shuttle dock is what, level twelve?"

"Eleven. Command and Control is level twelve," said Elle. "Think of it as a tube standing upright. Level twelve at the top. . ."

"And we took the elevators all the way down to the bottom. This big number one painted on all the walls seems to be important," asked Cade. "I'm guessing restrooms?"

"Funny," said Elle. "But the answer is still no. I'm not getting too far from the group, Cade."

Cade took a deep breath and exhaled. “Fine. You stay here. But if you’re not going to go with me, at least do me a favor and tell me what else there is on this station that might be interesting and where it’s located?”

Elle knew that if she didn’t offer up more details, Cade would just continue to bug her. And he could be annoyingly persistent. She frowned for a brief moment and then nodded. “Alright. What are you wanting to see?”

Cade looked back down the hallway they had just crossed to the set of double elevator doors. “What’s on level two?”

Elle once again called up the data pack from memory. She had read the museum summaries of each level numerous times, and the holographic tour of the main tourist levels were a bit dull but she’d run it at triple-speed, listening to the AI’s high-pitched helium voice and trying not to laugh.

“Let’s see. . . level two was food court, gift shop, and a couple of holo-rooms. Basic stuff, really. Interactive historical views of various breakthroughs in technology. Supposedly you can have lunch and chat with some of the titans of tech. Hey, that might be fun to go and talk to those original Google guys. . .”

“Stop. No, thank you,” said Cade. “What about level three?”

“Um. . . let me see. More exhibit space. Microcontroller antiques. The Andrew 5.0 Experience. Some early tablet technology,” said Elle.

“Wait. . . Andrew 5.0?”

“Yeah,” said Elle. “The first AI. You like that kind of thing?”

“Absolutely!” Cade smirked and looked down the hallway, hoping his voice hadn’t carried and alerted the teachers to their absence. “Come on, Elle. You’ve got to come with me.”

“Not a chance,” she replied. “I think I’m going back to the group. Maybe they won’t notice me trying to blend in.”

“I’ll never find my way around up there by myself,” said Cade. “Please, please, please?”

“Lame,” said Elle. “There are signs everywhere, moron. Like that one.” She pointed at the one directly over Cade’s head.

“If you come with me, I’ll do all your formatting work for a week.”

Elle cringed. Of all the things she hated to do, formatting her written assignments to fit Mrs. H.’s picky standards was at the top of the list. And Cade knew it.

“A month,” she replied.

“What? No way!”

“See ya,” Elle said and turned to walk away.

“Alright,” said Cade. “One month. But you’re going to have to get me to more places than the Andrew 5.0 location.”

“This is not going to end well for me,” said Elle.

Cade laughed. “Yes! Okay, come on. The elevators look clear.”

Andrew 5.0

The elevator doors opened. “Level Three,” said a polite voice. “Be sure to visit the Andrew 5.0 Experience to hear the history of artificial intelligence from a splinter node of the original Andrew 5.0!”

Cade poked his head out the door, looking left and then right. “All clear.”

Elle pushed him aside and walked quickly out of the elevator. “You don’t have to be all sneaky, Cade. We’re the only ones on the station today. Come on, let’s hurry.”

Cade walked fast to catch up. “Are you sure?”

“Yep. The entire station is automated. Didn’t you notice that our two shuttles were the only ones docked?”

“Uh, yeah. That’s right. Two shuttles.” Cade tried, and failed, to sound informed.

“We were supposed to share the tour with a group of Japanese students gating in from Earth, but I heard that a bunch of them came down with a bug. And Gemini is pretty strict about its quarantine rules.”

“Yuck,” said Cade, turning left at a display of old LCD screens. He stopped to look. “This is how kids used to have to read? With a screen?”

“Would you come on?” hissed Elle.

“I’m coming,” said Cade. “Calm down.”

Elle pointed down a hallway. “This way. I assume you want to visit Andrew 5.0 first?”

Cade nodded. “Yeah, let’s go there first.”

Elle continued speed-walking, making a right turn at a large display of rectangular boxes. A sign read “PC Case Mods 2010-2015” and Cade was tempted to stop for a quick peek, but a stern look from Elle convinced him to keep moving.

“What’s so interesting about Andrew 5.0?” Elle asked.

“Family history,” said Cade. “My great-great-grandfather was on the original programming team when Andrew achieved sentience.”

“Really? That’s cool.”

“Yeah, I’m curious to know if he remembers him.”

“Well, he should,” replied Elle. “It’s just a splinter node, but since we’re on a station dedicated to technology history, I’ll bet this node has kept that stuff in local memory.”

“I hope so,” said Cade.

Boom!

Elle stopped and looked up at a sign. “Microcontroller Hands-On Exhibit in that room over there. The Andrew 5.0 Experience is on the other side. Let’s cut through and save some time.”

“Sounds good.”

The door opened as Elle approached and the interior LED lights instantly awakened. Cade followed Elle as they walked by dozens of tables. Large black toolboxes and strange equipment lay scattered across the tables. Clear bins contained hundreds, maybe thousands, of small electronics components that were colorful and completely alien to Elle and Cade.

“This room actually looks fun,” said Elle. “Wish we had time to play.”

“With this stuff?” asked Cade. “Really? This tech was outdated when your grandmother was a baby.”

“Maybe, but I’ve always liked learning about how people in the early days did things.”

“I tell you what, Elle,” said Cade. “If we have time, maybe we can come ba. . .”

BOOM!

The floor shook hard enough to knock Elle and Cade off their feet.

BZZZZZT!

BZZZZZZZZZT!!!

The lights flickered off, then on, then off again. There was a small electrical pop, followed by a whining sound that dwindled in the distance.

And then the alarm began to wail.

“Cade! Cade!”

“I’m okay,” Cade replied. “Are you alright?”

Emergency lights had turned on, not quite as bright as the standard LED lighting, but enough that they could see that the floor was covered with dented toolboxes and small pieces of metal. A few tables had overturned, and a red light on the wall was flashing.

“Yeah. Yeah. . . I’m fine. What was that?” yelled Elle.

Cade stood up and helped Elle to her feet. “We need to get back to the group. That felt like an explosion.”

Elle’s eyes widened. “Are you sure? Maybe it was something else.”

“Anything else is just as bad,” said Cade. “It was enough to knock us off our feet, Elle. Let’s go.”

Elle followed Cade toward the entry door and then bumped into him as he stopped short. The door didn’t open. Cade waved his hands in the air, hoping to set off whatever motion sensor was supposed to trigger the door, but there was no response.

“No good,” said Elle. “Try the keypad.”

Cade pointed at the bits of melted plastic hanging from the small white rectangle mounted to the right of the door. “You mean that bit of junk?”

“Oh, this is not good,” said Elle.

Cade turned to look to the other side of the room that led to the Andrew 5.0 Experience. A matching burned and melted control panel hung by a few wires from the wall. “Other keypad is damaged, too.”

"Do you know how big a power surge it would take to do that?" asked Elle.

"We need to get out of this room, Elle," said Cade. "Look for another exit."

Escape, or Not

"All visitors, please make your way to the emergency escape pods located on levels one, six, and ten. For other levels, ladder access tubes for visitors to reach levels one, six, and ten are now open. Please follow the blue and yellow flashing lights to the nearest ladders and escape pods. Visitors on levels eleven and twelve should proceed to the level eleven docks. Repeating. . ."

"No exits on that side," Cade reported as he joined Elle at the main entrance that was now blocked. "The ceiling is fifteen or twenty feet up and I'm not finding any ladders or other way to climb up there."

"The floor is tiled, but none of the tools I found will let me pull them up," said Elle.

"Do you know anything about electronics?" asked Cade. "Maybe we can fix the keypad?"

Elle leaned in closer to stare into the burned circuitry that made up the keypad. "I wouldn't know where to start."

"Me either," replied Cade.

"We could try yelling for help. Maybe someone will hear us."

Cade and Elle began yelling and pounding on the door.

"HELP!"

"Let us out!"

"Anyone out there? Please help us!"

The banging slowed as the two students tired. And that's when they heard a faint voice from the opposite side of the room.

"What is the problem?"

Elle and Cade ran to the opposite door in the room.

"Hello? Hello? Can you help us? Who are you?" asked Elle, putting her ear to the door.

"Hello. I am Andrew. What is your name?"

A Plan

Five minutes later, Cade and Elle finished explaining the situation to Andrew 5.0. Andrew couldn't provide any explanation for the alarm and evacuation, but he did verify a significant amount of damage being reported on the station via an internal damage-control network he was able to monitor.

"Are you able to communicate with the station AI?" asked Cade. "Can you let someone know we're locked in this room?"

“I am sorry, but I am unable to communicate outside of my current location. I can pick up certain reports traveling over the station’s communication grid, but my programming was modified to limit my capabilities, including interfacing with other AIs.”

“Is there anyone on this level besides us?” asked Elle. “Is there any chance an emergency team will be sent to check out the station?”

“Unknown, Elle,” replied Andrew. “There are probably protocols in place for emergencies.”

“So we just sit tight and wait,” said Cade.

“But we don’t know what’s happened,’ said Elle. “What if the station is venting oxygen? Or what if there’s a fire?”

“Way to stay positive, Elle.”

“Sorry. I’m just saying we need to get out of here. We can’t assume anyone is coming to get us. We did drop our personal beacons into other people’s backpacks.”

Cade’s face reddened. “That was a bad idea. Sorry.”

“Hey, I went along. I’m not blaming you. But it means we’re on our own. No one knows we’re here.” Elle put her hand on Cade’s shoulder.

Cade nodded. “Well, not to sound cocky, but we are the two smartest kids in the class. We should be able to figure out how to escape a locked room, right?”

Elle laughed. “And we’ve got an AI in the next room.”

“That’s right! We’re unstoppable! Andrew, we need to figure out how to get out of this room. Any ideas?”

Andrew had remained quiet but responded instantly. “You said the two keypads are damaged. Can you tell me if the circuit board behind the panel is also damaged?”

“The green board?” asked Cade.

“Yes.”

“Yeah, it’s toast. I see black burn marks across it.”

“Above the circuit board is a small sealed metal case with four or five wires going into it. Are the wires still intact?”

Elle poked at the wires going into the small metal box. Each of them stayed in place. “Yeah, they’re fine. I think.”

“Good. We’ll need to spoof the entry code, but you can easily do that with a variable resistor and a small power source. Of course, you’ll need to do some custom programming so that will require some processing capabilities. Do either of you have an Intellitab with you?”

Cade turned and stared at Elle. “Is he kidding?”

Elle frowned. “Andrew, we don’t have our tabs with us today. Sorry.”

There was a slight pause.

“Andrew?” asked Elle.

"I was just consulting my database inventory of the station. You are in the Microcontroller Hands-On Activity Lab Room. We'll just use what's available."

Once again, Cade shook his head and stared wide-eyed at Elle. "Seriously. . . is he kidding?"

Elle held up her hand.

"Andrew, this stuff is ancient. Old-style electronics and stuff we don't even recognize."

Andrew's voice changed, becoming slower and sounding much more patient. "Elle. Cade. It will be a challenge, but I can help you get that door open using some of the components in the room. You'll have to listen to me carefully, but if you follow my instructions, you'll be able to open the door. Are you ready?"

Cade exhaled and nodded his head slowly. "Sure, I don't think we have any other options."

Elle grinned. "Looks like we're going to get some hands-on time whether we like it or not. Okay, Andrew, tell us what we need to do."

"First, I need you to locate something called an Arduino microcontroller. My inventory tells me there are hundreds of them in a cabinet in the room in labeled boxes. Find one now."