From Classroom to Showroom: 
Developing a Classroom Alpha Prototype into a 
Marketable Product

by

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Abstract

What do you get when you take one professor, two instructors, four mentors, seventeen mechanical engineers and $6,500? One coffee table! Well, at least in our case. During the fall of 2008, our team of senior mechanical engineers enrolled in MIT’s capstone design course, 2.009 The Product Engineering Process, designed and prototyped a high-end, spiral-folding coffee table named Elika, a product borne out of months of idea generation, brainstorming, market research, machining, testing, troubleshooting, and re-machining. Perhaps our judgement was muddled by the high we got after the final presentation, or maybe we finally realized that we were in fact workaholics, but a group of us decided we couldn’t stop working on the table and needed to start a company to bring it to market. This is the story of how we went from a bunch of students trying to fulfill a graduation requirement, to a team of founders of a design company. Along the way, we’ve learned about patents, business, and manufacturing options; we’ve explored engineering, industrial, and graphic design; we’ve anticipated our market niche and how to capture it. But through it all, and despite the set-backs, low points, and YouTube-ing, we’ve had a blast diving into the unknown to chase after an idea we developed together. We hope this document can be a guide and source of comfort to those who hope to do the same.
From Classroom to Showroom
Developing a Classroom Alpha Prototype into a Marketable Product

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Geoff Tsai
For everyone who helped us during 2.009 and afterwards, we’d like to say,

Thank You!

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I. Introduction

Who we are

What do you get when you take one professor, two instructors, four mentors, seventeen mechanical engineers and $6,500? One coffee table! Well, at least in our case. During the fall of 2008, our team of senior mechanical engineers enrolled in MIT’s capstone design course, 2.009 The Product Engineering Process, and designed and prototyped a high-end, spiral-folding coffee table named Elika, a product borne out of months of idea generation, brainstorming, market research, machining, testing, troubleshooting, and re-machining (figure 1).

Figure 1: Picture of Elika staged at a furniture showroom

After all we’d been through during the semester — going to the bar after design reviews, enjoying early morning doughnuts and coffee before the machine shop opened, making pancakes on a Foreman grill in between milling operations, plus a couple hundred hours of working together — a few of us weren’t ready to say goodbye to the team or the idea (in fact, a few of us still came back to the machine shop just to sit and have lunch, even though the class was over). Perhaps our judgement was muddled by the high we got after the final presentation, or maybe we finally realized that we were in fact workaholics, but a group of us decided we couldn’t stop
working on the table and needed to start a company to bring it to market. This is the story of how we went from a bunch of students trying to fulfill a graduation requirement, to a team of founders of a design company.

**How it started...**

If you're an undergraduate at MIT, there is a 45% chance you are an engineer, and if you are an engineer, there is an 26% chance you are a mechanical engineer, and if you're a mechanical engineer there is almost a 100% chance you will take 2.009. The class represented the culmination of years of problem sets, tests, and lab reports. It freed us from our typical assignments, and loaded on a whole new set of issues. The objective of the class was to teach students about the design process by having them work in teams to create a prototype of a new product idea. Every couple of weeks there was a milestone: brainstorming, sketches, sketch models, and prototypes. Presentations replaced problem sets, and they marked our progress and provided feedback as we worked to narrow down our many ideas to one that would become our alpha prototype for the final presentation.

**...and where it’s going**

The final presentation included our assessment of the table's business potential, and after having done the research and taken the table to a showroom, we were starting to feel confident we could actually sell the table if we wanted. After a series of meetings, a subset of the original team members agreed to start a company to keep working on the table, but we were all wondering how we would be able to do it without the funding we had received during the class. As luck would have it, the head of the Mechanical Engineering Department, Professor Mary Boyce, liked our table enough to give us $7,000 of department money to build a table for her office and to help get our business going — making the head of one of the most prestigious mechanical engineering departments in the country our first customer.
II. Engineering

Reevaluate the design

Now that we were working on our own, we had free reign over our design, and an entire semester to everything perfect. We read through and organized all the feedback from the final presentation and identified areas we could improve on with a new design.

One of the most important aspects we wanted to improve was the weight of the table. The version we built for 2.009 weighed almost 50 pounds. Since 2.009 took up so much of our time during the semester, we were all behind in our weight lifting routine, and we quickly realized that if the table were going to be something we could unfold from floor level to table height or lift to hang on a wall, the weight needed to be reduced.

During the course, we had experimented with a design for damping the table’s descent so that it could not accidently fall too quickly while someone was trying to lower the table. The success of that design can be seen in the dents in the polycarbonate where the top surface slammed down on the bottom hinges (whoops). In order to have the table done in time for the course we scrapped this damped design in favor of a simpler, undamped version, but now that we had another semester, a working design with damping seemed just around the corner.

The locking mechanism that keeps the table folded together turned out to be quite the challenge. After a marathon brainstorming session complete with idea presentations, Pugh charts, and several rounds of voting, we finally settled on a design that used a rotating handle to clamp a rubber pad down on the ball of each hinge, preventing it from moving using the friction between the two materials. The locking mechanism did a decent job of keeping the table closed, but we wanted something more elegant and easier to use.

After the presentations were over, we had pages and pages of review forms to read through, as well as our own notes about what people had said to us at the presentations. Sorting through all the feedback was an interesting process, and a tricky one to figure out what conclusions could be drawn from it. Different people would often provide contradictory comments. Some would say they didn’t like the clear table top, others said they wanted it all clear, and still others insisted that stainless steel, polycarbonate, and carbon fiber were the wrong choices for materials and we should have gone with all wood instead. From all of this feedback, we began to realize that we
would never be able to please everyone; a design that attempted to cater to everyone’s desires would excel at none of its traits. With that in mind, we sorted the feedback into piles for “useful” and “not useful” and attempted to extract the advice we wanted to consider.

Fortunately, the vast majority of the feedback we received was positive, rather than pointing out problems or requesting changes. All of the congratulations and “oohs” and “ahhs” were a great payoff for all of the hard work we had put in during the semester and really increased our confidence in our design. Our biggest boost came when a few industrial designers from Deka and Adam Simha of MKS Design came to our final presentation. We had consulted with them during the semester, and while it was nice for our table to earn the respect of our fellow classmates, it meant a lot to us to earn the respect of professional designers. If people experienced in industrial design and furniture were impressed with our design, then we knew we had done our job.

From the great amount of positive feedback and the mixed criticisms we received, we felt like we had a direction for how to improve the table. We realized, though, that it's important to not get too caught up with all the advice you receive: just as important as knowing what to change, is knowing what to keep. As students working on a class project, it was tempting to make every change that was suggested in the hope that it would help us do well in the class, but as designers we were learning the importance of knowing when to listen to other people, and knowing when to listen to ourselves.

**Brainstorm**

Serious work began again only a month after the final presentation when a couple of us started the process of addressing outstanding issues with the prototype. Using our criticisms of the table from 2.009, we focused our brainstorming efforts to reduce the overall weight of the table, reduce the force required to lift the table top using a spring assist, and add dampers to reduce the velocity of the table top as it was being folded.

In addition to these functions that we wanted to add to the table, we wanted the new design to remain faithful to the industrial design of the first table that had received such high praise for its looks. This is easier said than done. Maintaining the industrial design of the table meant that any new functional addition had to be invisible or at least complementary. It’s a slippery slope
making one concession on the industrial design for the sake of a functional addition, and we almost fell into the trap. The only way we stayed on top was to be unyielding and uncompromising. We had to push ourselves, refusing to accept excuses like “it will be improved later” or “this design is acceptable because its added function makes up for its decreased appearance”. Although it was more difficult, sticking to this approach long enough meant that the next design would be either as good, or better than the previous one.

The good thing about brainstorming new mechanisms for the table in January, about a month after our final presentation, was that the break had given us time to take a step back from the original design and hopefully approach the design challenges from a new direction. Working on the table in January, instead of during the semester, also meant that we could concentrate more on the design without having to spend time on other classes.

Just as important as having a fresh start on the design, is having multiple people working on it. We had two or three people working constantly to create new designs, bringing their individual perspectives to the development. In the brainstorming stage it was key to have lots of ideas since a good idea couldn’t be developed if it wasn’t thought of in the first place. Having three people working on the design also meant that we could bounce ideas off of each other. This was incredibly helpful because one person’s idea can spark a whole new line of thought for someone else, and discussing ideas with other people very quickly identifies its merits and faults.

By the end of January, we had come up with a new mechanism to spring load the ascent of the table top, dampen the descent, and keep the table locked in the closed position (figure 2). The new mechanisms didn’t require us to change the industrial design of the table at all, and in fact let us do something we had wanted to do with the original table which was to embed the sockets in the table top surface, like they were in the table base. After a few weeks of brainstorming and

Figure 2: Exploded view of potential integrated locking, damping, and lift-assist mechanisms
drawing in SolidWorks™, we were ready to begin prototyping our new design.

**Prototype**

If you like building things and working with your hands, this can be one of the most fun parts of the design process. By the end of January, we eagerly awaited for materials to come in from McMaster-Carr: stainless steel tubing for the table legs, springs and dampers for the internals, and aluminum rod for the fittings. We spent the next few days in the machine shop turning different parts on the lathe and 3D printing some of the parts with more complicated geometries. The prototyping stage is really important, especially given Professor Wallace’s wise saying “If it hasn’t been tested yet, it doesn’t work.” And our case was no exception either. Our first prototype of the table leg didn’t work as we had expected, and we spent almost half of the semester trying to get the mechanism to work properly.

At some point, though, you have to know when to quit, or at least to change directions. After weeks of work, the locking mechanism wasn't quite working yet, and we were starting to have doubts about the ability of the spring assist and damper to work properly. We were starting to feel the end of the semester approaching, and so given that our design still didn’t work yet, we were forced to start over with a new design we could finish by the end of the semester. It can be one of the hardest things to do, to abandon a design you’ve spent months on and start from scratch, but sometimes it’s the only alternative to not finishing at all.

As is often the case, the prototyping stage feeds cyclicly back into the brainstorming stage. This is what design iterations are about, and you can go through several cycles if you don't get the design right the first time. For us, with each design iteration we came closer to a solution, until finally we came up with a new, elegant design that incorporated locking only, instead of springs or dampers (figure 3).
Currently, as this thesis is being written, we are almost in the stage ready to test. We've had some successful first-order tests of our rapid-prototyped parts for the locking mechanism, and we're now ready to manufacture what we believe to be the production version for final testing.

III. Manufacturing

Design for manufacture

When we started to re-engineer the table, we had these great plans to simplify our parts and design them for mass production; if we could investment cast or stamp the hinges, the cost of making them would decrease significantly, reducing our manufacturing cost and increasing our profit margin. However, without a long list of orders and storage space, we were not in a position to hold any kind of inventory. Plus, the tooling costs needed to cast were way too high...
manufacturing was just way out of league for the time being, and so our great plans were tucked away to be revived at a later time.

**Source parts**

During 2.009, we asked a couple of local machine shops for a quote on how much it would cost to make our custom socket with a track in it. To our dismay, one of them told us they couldn't do it all, and the other told us it would take over a month and cost us $3,000 — time and money we definitely couldn't afford. We were floored by the cost and the difficulty of having a professional machine shop fabricate our design. However, we weren't ready to give up on the design yet and instead decided to make the parts on our own. Once our 100 pound log of 304 stainless steel arrived in the mail, we got to work according to our machining schedule that kept production going all day, every day.

In 2.009, the ability to fabricate all of the parts on our own was due both to the number of people on our team who were machining constantly, as well as the professional machinists in the shop who were devoted to helping us. What started off as a design project came down to a face-off between us and the machines — a fight to see who would emerge victorious after machining for weeks on end. We finished the majority of our parts a few weeks before the final presentation, but the timing was close and we felt lucky. If there had been major problems with the design, we might not have had enough time before the presentation to redesign and re-machine.

Once the class ended, so did the luxury of having a team of 4 dedicated shop guys and 17 mechanical engineers working on our side. Because of our difficulty before, we knew if we were going to produce our table outside of the class, we were going to have to face the reality of finding a way to economically manufacture the parts. This time it was essential we find a way to source them — both to determine an accurate manufacturing cost for pricing and to test the viability of our business plan. If the "real world" couldn't manufacture our part at an economical rate, our production cost might end up forcing our sale cost up and out of price range of even the super-modern, uber-rich. And since we were banking on capturing the super-modern-uber-rich market niche, if we weren't able to meet that criteria we would have to re-think our business plan.
Unsure of the best way to proceed, we reached out to everyone we knew with manufacturing experience, but almost everyone we asked had something different to say about how to proceed: "Use online sourcing sites, it's cheap and fast." "Don't trust anyone overseas." "Manufacture in China, it's dirt cheap." "Use local manufacturers, and meet the guys who will be working your parts so they can get it right." "Don't try to manufacture it yourself, source all of that to a furniture manufacturer." Inundated and overwhelmed with advice, we sat down to re-evaluate what our goals were with this company and the table. We thought about our options, and found ourselves having a hard time giving up too much control over our manufacturing. We were in fact mechanical engineers, and we wanted to be part of the process — to build, assemble, and ultimately control the quality of our final product. Realizing this, we threw out the idea of licensing our design and having a furniture manufacturer take care of the fabrication for us. But how were we going to make the parts ourselves? On top of theses, senior projects, papers, lab reports, and PE classes, no one on our team was ready to revive our long-term relationship with the CNC machines. Our only choice was to source our parts.

During one of our meetings with an MIT alum, he recommended we sign up for an account with MFG.com in order to help with sourcing our parts. MFG connects engineers and designers with manufacturers and suppliers, removing the need for us to find and contact individual manufacturers to receive quotes on different part designs. MFG works like a sort of eBay for designers and manufacturers where a designer can post a design for a part and manufacturers from all over the world have a chance to quote the job and vie to be awarded the contract. The buyer awards one supplier the job and, voila! you get your parts. At first a bit skeptical of the process, we posted our socket top, our most complex machined part, on MFG.com, putting out requisitions for sand casting, investment casting, milling and turning, and 5-axis machining in both aluminum and stainless steel. Setting our target price at $35 per part, a price that seemed impossibly low after our original $500 per part quote, we submitted the requests and hoped for the best. Within hours we began getting quotes from factories all over China and the United States, some even as low as our target price; it was like Christmas in April. We chose to go with three different manufacturers to get a feel for quality, customer service, and delivery time.

We ordered the same part from three different suppliers through MFG.com: two from China to get our parts in stainless steel — one that was well rated and another that remained
unrated — and one in Michigan for our parts in aluminum. The aluminum parts are the only parts that have arrived so far. For six of our complex socket tops, it cost us $377 including shipping. Not bad considering our original quote was ten times that amount. We were so dazzled by the ease with which we received them that we decided to do the whole table in aluminum, and sent the manufacturer designs for some more parts to machine.

**Research outside contractors**

We continued to look for suppliers for our parts, generally using either local suppliers, or ones that we used to build our original prototype. Okay, so you know that we’ve received parts from one supplier but now you might be wondering about the rest. One of those companies is still making our parts, and we should be receiving them soon, however with the third company we had a fairly traumatizing experience worth mentioning. Initially, our correspondences with the supplier seemed legitimate, although they didn’t seem quite as organized as the other companies. Finally, just as we were finalizing the order, we received a kind email thanking us for our business, but it ended with these words “By the way, my girlfriend who is [an] America girl will be in Shanghai at the end of June …. Before she [was] 18 years old, she lived in California. Now she is outside of [the] USA [but] her Dad is still there.” Attached to the email was a model-esque picture of his supposed girlfriend’s face. We were stunned. We tried to change the terms of payment in order to ensure that we were not being taken by a scam artist or a dishonest businessman. Instead of catering to his customer’s requests, the supplier replied saying that “the amount is so small to us, I think it reflects the financial conditions of your company.” Hey! Now, that’s not very nice. Slightly offended we decided to contact our MFG representative to ask her about the situation. When she read the email, she herself confessed, “to be honest, I was completely floored.” She helped us retract the job award from the supplier, put him on our blacklist, and sent MFG's Shanghai office to speak with the supplier about his communication skills. In the end, everything worked out all right. We didn’t needlessly lose any money, and we were still going to receive the parts we needed from a different manufacturer. And, despite the trauma, we learned to stand up for ourselves, regardless of our small size and lack of a real office space. Our money was ours, and it was our prerogative to ensure it was spent correctly.
IV. Business

Draft legal documents for incorporation

Draft legal documents? Sure. Easier said than done, right? This is one of those statements that when said matter-of-factly sounds straightforward enough, but when you begin to think about it starts to sound daunting. After all, what did we know about business incorporation?

As graduating mechanical engineers from MIT, we were empowered with the ability to communicate. We knew how to write long lab reports, short lab reports, medium length lab reports, and (some may argue) an occasional paper on the importance of perspective in Kurosawa’s Rashomon. However, we knew little about how to “draft legal documents for incorporation.” We imagined this process would involve long hours working with lawyers wearing suits and half-rimmed glasses, all sitting around dark oak conference tables with engraved brass nameplates. Lucky for us, drafting documents for incorporation turned out to be nothing like the horror we expected.

Early on in the semester we figured out how to become legal participants of this "business world" we had heard so much about. Step 1: fill out a two-page form. Step 2: mail it in. The form asked us to declare a class of incorporation, a state of incorporation, and a company name. We learned that there are two different ways to incorporate: as a Limited Liability Company (LLC), or as a Corporation. The main differentiator is that when you incorporate as a LLC, you have limited liability. Duh. But what does this actually mean?

Limited liability is a concept whereby a person’s financial liability is limited to a fixed sum, most commonly the value of a person’s investment in a company or partnership with limited liability. A shareholder in a limited company is not personally liable for any of the debts of the company, other than for the value of his investment in that company. - Wikipedia.org, “Limited Liability”, May 2009.

Thank you, Wikipedia. So, as long as we take the necessary precautions to separate our personal and business finances, if our company tanks, our personal assets will be all right. Additionally, if you register as an LLC, you are only taxed on the money you take home, rather than on all earnings at the corporate level. As a Corporation, you are taxed on both the corporate and personal earnings, meaning that you are essentially being taxed twice. Corporations have a defined structure, involving bylaws, a board of directors, stock certificates, and a stock ledger.
The board of directors is what manages the company in a Corporation, whereas in an LLC, a member or manager can oversee the business. Lastly, in an LLC, members rather than stockholders are the main contributors of money and services to the company, and they receive interest in profits and losses. A Corporation’s strict organizational and financial structures make it much more attractive to investors since this means that when Mr. Investor puts $4 million into a hot new MIT start-up, he knows exactly how much his investment is worth in terms of stocks. With a Limited Liability Company, the organization is less defined, making it easier to setup from scratch but less attractive to investors. If you feel confused, don’t worry, that’s how we felt too, but with a little research we figured out enough to decide to incorporate as an LLC.

We decided to incorporate in Delaware because... well, because everyone was doing it. Literally. Delaware’s laws, in order to entice companies to the small state, are extremely friendly to businesses. The main requirement is that there be a physical address within the state in which you can receive court orders. Twist! There’s no way we’re going to move to Delaware! Not to worry, some crafty lawyer already figured this one out. In Delaware, you can hire a service of process agent to be your physical address. Someone along the way figured out that you can pay someone to sit behind a desk at a traceable address and just wait for the court to issue you an order. Thus, for a nominal yearly fee, we could continue to operate in Massachusetts, but still be incorporated in Delaware so long as we are registered to do business in Massachusetts. It might sound a bit convoluted, but this is actually how a lot of businesses operate.

So we had our class of incorporation and our state of incorporation. Check. Next, we had ahead of us the long and arduous process of how to choose a name for our company. After 2.009 was over, and we were thinking about starting a company, we did a little brainstorming to come up with a company name. At the time, the best name we had come up with was "304 Concepts". The "304" comes from the alloy of stainless steel we used to make our table — an ironic grade since we actually meant to get 303 stainless steel, a more machinable alloy. The 304 grade we used for our table caused us to break countless taps, bits, and boring tools, but the satisfaction of finally getting the right surface finish after six hours of machining overrode our frustrations and we came to love that pesky grade of steel. So even though 304 Concepts had a special significance, we weren’t sure it worked as a company name and so we set aside company naming until the spring.
When we met again in the Spring semester, the first several meetings had time devoted to brainstorming company names. Unfortunately, these sessions always degenerated into a competition to see who could think of the most ridiculous and impractical name, closely followed by a group YouTube-ing session for “inspiration.” Two notable ideas that stemmed from these sessions are Mullet Designs (pronounced "moo-lay" -- it's French) and Awkward Turtle Designs. Mullet Designs had two main appealing factors: 1) the ability to make our tag line "Business in the front, party in the back" and 2) getting to watch people squirm as they try to reconcile an MIT-based start-up with a hair-style popularized by 80’s rock bands. Awkward Turtle Designs parodied the popular design company naming scheme of picking an animal, an adjective, and attaching the word "Designs" to the end. We even found a design company name generator called "Name My Design Company Machine", a fun web application that parodies the "ludicrous number of design studios using colored animals as company names (figure 4). Additionally, Awkward Turtle Designs got a huge boost in popularity when Jared sent out an email to the team with a link to a YouTube video of a turtle trying to mate with a hiking boot.

![Figure 4: Screenshot of Breadline Design Company Naming Machine in action](image)

In any case, the upshot of two months of brainstorming was that 304 Concepts was the best idea we had, and when tested against other ideas such as "3F Designs", the 3 F's deriving from the mantra "form follows function", 304 Concepts won out. On the Wednesday before Spring
break, Andrew dropped a skinny letter envelope in the mail, and we officially started our first company.

**Agree on operating agreement**

Now that we were a legal company, it seemed logical that we figure out how to operate as a legal company. The document that outlines these guidelines is known as an Operating Agreement, a document stating the financial and operational structure of the company. Naturally, these agreements are written in legalese, so Andrew found some sample agreements, dissected them, and then endured the long, slow process of explaining the agreement to his legally incompetent teammates. After a marathon meeting lasting over three hours, we seemed to make sense of most of the document, but still had some major decisions to make about how profits are divided, how ownership is divided and awarded, and what happens when a founder leaves. Unfortunately, this decision was put on the back burner as other issues took priority, so we are still waiting to finish this agreement and sign it. Once that’s settled, we’ll also open a bank account and register in Massachusetts to finally be a legitimate company.

**Determine financial structure**

For admission to the International Contemporary Furniture Fair, an annual furniture convention held in May in New York City, we all registered as part of the company as “owners”, an ironic description since our company doesn’t actually own anything except the intellectual property — we don’t even own our own prototype, yet have six owners. So, in light of our cashless situation you can see how it was quite easy for us to ignore the financial aspect of setting up a company. Hopefully, this period will pass, but for the time being we have yet to determine exactly how our profits (knock on wood) will be divided.

Our initial thought was to do time-based vesting, meaning that the longer you stayed on with the company, the larger your portion of the profits grew. However, after thinking about it some more, we realized that this option would not be very fair. As a start-up, there would be times when one aspect of the company needs to be worked on more than the rest, yet the reward is the same. Additionally, after graduation, we were all going off to do different things and the amount of time we would be able to individually commit would vary from person to person. After talking with another product-based start-up company, we decided that milestone-based
vesting would be the most fair way to reward our efforts. This meant that each person would be tasked with completing a milestone, and they would be rewarded when that milestone was completed. The big drawback is that implementing this strategy can be very difficult. Milestones differ from one department to the next, and sometimes concrete goals are hard to define. How do you evaluate the worth of brainstorming ten “good” ideas? Though we all agreed this system seemed best, we decided to wait to flesh out the details until things settled down.

**Establish personal and company goals (long term and short term)**

One of the first things we were warned about was that it would be difficult to get everyone on the team to think along the same lines and have the same goals. Thus, we made a point to collaborate and share our ideas and goals for the company and for ourselves. When we first decided to move past 2.009 and assemble a team to bring the table to market, we created a space on the class wiki for interested people to post a statement outlining their interest in continuing and their motivation behind their interest. We did this again as a team of six, and then again as we started finalizing our post-graduation plans. This communication of ideas was essential not only in building our relationships with one another, but also in driving the company and it’s direction. We established early on that for all of us, being part of the company was about gaining experience in the start-up process; none of us were in it for the money or fame. Thus, when we were deciding how to distribute the table, after long discussions about our options, we opted to sell the table ourselves, assemble and outsource most parts for manufacture, but keep the assembly and finish machining within the company. Within in the furniture industry, this option is traditionally seen as the least efficient way of distributing furniture; many people within the trade recommended we either license our design to a design firm, or go under the umbrella for a furniture manufacturer that would take care of both manufacturing and distribution. However, this option was inconsistent with our goals since we would lose control over essential aspects of the company and miss out on the experience of tackling these challenges. So here we are fighting our way as independent designers, but are loving every second of it because we know we're following our own vision, not one that someone else told us to see.
V. Patents

Huh?

This subtitle exactly describes our sentiment when we first approached the idea of patenting our invention. Initially, we weren’t quite sure what to patent, or if we even had anything to patent. Preliminary prior art searches told us that our table was unique, but did that mean we should patent it? If so, what would we patent? Should we get a design patent or a utility patent? Do we need to write a provisional patent application? What is a provisional patent? How do we get the entire team to agree to get a patent? Dazed and slightly confused by our options, we turned to a patent attorney and MIT alumna for some guidance. At our first meeting with her, we threw out question after question about filing for a patent, patent lawyer fees, types of patents, patenting deadlines, how to write patents, and every other possible topic with the word “patent” in it. Her calm demeanor and clear explanations eventually quelled our anxieties, and we switched from furiously asking questions to furiously taking notes. After consulting Professor Wallace and other industry professionals a bit more, we met as a team, reviewed what we learned, and figured out what to do next.

To patent or not to patent

After a bit of Googling and some conversations with other patent holders, we quickly realized that when people casually say “Oh, I’ll just submit a patent application for that,” what they really mean is, “Oh, I have several thousand dollars lying around to hire a patent lawyer to write and file a patent application for that.” When faced with this reality as a team of broke, second-semester seniors, we were forced to ask ourselves if we really needed a patent.

We talked to several MIT alumni who had started companies about whether we should apply for a patent. Confusingly, some of them told us a patent was a good idea, while others made the argument that it wasn’t worth the expense or the effort. In addition to the advice we received, we reasoned that any idea or product really worthwhile was going to get copied anyway, and a patent wasn’t going to stop that from happening. If we were going to nail those idea thieves and give them a piece of our mind, we would have to do it in court in the form of a lengthy, unaffordable, and undoubtedly boring legal hearing. Plus, if we ever did get to the point
where people were trying to rip off our invention, since imitation is the greatest form of flattery, we would take it as a sign of our success rather than a loss.

But, soon enough, Professor Wallace gave us a piece of advice that would reverse our thinking: in a world where commercial products inundate the marketplace, patents are not a technical tool, but a marketing tool. To be able to write in your product description “patent pending” not only makes you more popular at school, it more importantly makes your technology and business more attractive to investors. A patent tells investors that you’re serious about your invention, that your technology is unique, and that when you make it big they’ll get huge returns without worrying about knock-offs. (And as if Professor Wallace’s sound advice wasn’t enough, the next day Victoria’s Secret sent out a weekly newsletter announcing the introduction of their new line of bras that were, lo and behold, patent pending.) Intrigued by the idea of a patent as a marketing ploy, and driven by the desire to be popular at school, we decided to pursue patent. We had one year from the date of public disclosure to file something before the intellectual property in our table became public property, so we geared up to do some major learning.

**Design vs. utility patent**

**Table 1:** Chart outlining differences between a design and utility patent. Italicized is an explanation of what the different attributes mean to us.

<table>
<thead>
<tr>
<th></th>
<th>Design Patent</th>
<th>Utility Patent</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Protection</strong></td>
<td>Only protects how something looks (“ornamental invention”)</td>
<td>Can protect any “new and useful” process, method, material composition, machine, or improvement</td>
</tr>
<tr>
<td></td>
<td>Protects how our table looks as a combination of surface shape, veneer layout, base shape, leg shape, etc.</td>
<td>Protects a method in which we constrain two surfaces, or a machine that allows to surfaces to move in a screw motion in relation to one another</td>
</tr>
<tr>
<td><strong>Specificity</strong></td>
<td>Specific to one design</td>
<td>Applies to a broad range of applications and embodiments of the invention</td>
</tr>
</tbody>
</table>
Would only apply to the one current design we have more. If we wanted to make a square table top, that would require another design patent.

Could apply to any range of spiral-folding objects we might want to invent (tables, stools, shelves, etc) that uses the technology.

| Costs (small entity fees) | • Small entity filing fee = $110  
|                          | • Every 50 pages over 100 = $135  
|                          | • Design search fee = $50  
|                          | • Design examination fee = $170  
|                          | • Design issue fee = $430 (if awarded)  
|                          | • Electronic, small entity filing fee = $82  
|                          | • Independent claims in excess of 3 = $110  
|                          | • Claims in excess of 20 = $26  
|                          | • Multiple dependent claim = $195  
|                          | • Every 50 pages over 100 = $135  
|                          | • Utility search fee = $270  
|                          | • Utility examination fee = $110  
|                          | • Utility issue fee = $755 (if awarded)  |

Having a patent to call your own = priceless

Defendability
- Very difficult to defend
- Still very difficult to defend, but since utility patents are more broad, it is easier to win a case

Writing a cease-and-desist letter is not that expensive; some people will stop when sent one. Someday we should be able to defend a patent in court, but for now, this option is completely out of the question because we wouldn’t have enough money to do it.

Contents
- Cross-references / related applications
- Description of drawing figures
- Feature description
- One claim
- Drawings or photographs
- Oath or declaration
- Specification
- Background
- Summary
- Detailed description
- Cross-references / related applications
- Several drawing views
- As many claims as necessary
- Abstract of disclosure
- Detailed drawings
- Oath or declaration

Much less work

Usefulness
- Usefulness mainly lies in the ability to claim to have a “portfolio of patents.” More useful if you have a product that is primarily sold on its aesthetic design, and you have the money to sue offenders (ex. Apple’s 3G iPod).
- Allows you to defend your patent in a court of law in your patent is violated in any embodiment. Good for protecting the uniqueness of your invention. Still expensive to enforce, though.
Apply for a provisional patent

Okay so we had just spent all this time figuring out the difference between the utility and design patent, but now we realized that what we actually wanted to do first is file a provisional patent application. So first things first: what is a provisional? A provisional patent application can basically be viewed as placeholder for a non-provisional utility patent and buys you a year to file for a non-provisional patent. A provisional tells the patent office, “Hey there! I’ve got this cool invention. It’s going to rock your world. But all I have so far is this invention description, and I’ll get the real application to you within a year.” From a provisional, provided it is written thoroughly enough, you can pull utility or design patents from its contents and still claim inventor’s rights over them. Thus, it is imperative that the provisional be written in an extremely detailed and thorough manner; you can always take subject matter out of your patent, but you can’t put new material in. The ironic part about this is that no one actually reads your provisional patent application for content. It just sits there until it becomes public when you are awarded a non-provisional patent from it.

We were looking for a source that would guide us through the provisional application process when we heard about a do-it-yourself patent DVD. The lecturer was an MIT graduate, and the provisional patent course was free. We like MIT, and we also like free things, so we decided to give it a shot. Despite initial impressions, the DVD turned out to be incredibly useful. We learned that a provisional is basically an invention brain dump; a document stating every possible embodiment, variation, permutation, and method of use for your invention just in case you want to file a non-provisional patent for it later on. For example, it wasn’t enough for us to just say our invention contains a leg. Instead, we should write: the invention may comprise of a leg with a circular, rectangular, or any other shaped cross section, may be made of wood, metal, plastic, or any other material, and may be of any length, preferably between 25 and 30 inches.

What seemed like a fairly straightforward description of an invention now seemed like a book
report on a materials supply catalogue; we were up for the challenge and started drafting our provisional patent application.

Get everyone to agree

As a small subset of a very large team, we were quite apprehensive about getting the rest of the team to agree with our decision to file for a patent. We had heard of other 2.009 products that never made it out of MIT because people on the team either refused to sign off on the patent or were too hard to track down after graduating. An MIT alumna offered to help us out with the patenting process. She reminded us that only the people on the team who actually came up with a novel idea would be on the list of inventors. Even if one person did 90% of the work needed to make the idea a reality for the class, the person from whom the idea originated from is given the credit for the invention.

We then had to consider the issue of patent ownership. Would we be able to control the implementation of the patent if it were licensed to us as a company, even if the list of inventors included people not currently part of our endeavor? One solution for this dilemma was to get the entire team to agree to waive their rights to patent to the company, giving the company sole ownership of the invention, including the ability to file and prosecute the patent. Drafting this document was relatively simple — our patent advisor already had a template she altered slightly to fit our situation. We took copious notes too as she deciphered for us all the legal jargon (appendix A). After the meeting we felt educated enough to be able to competently explain the content of the agreement and write an accompanying invention summary (appendix B). Armed with these documents, we went forth to start obtaining signatures.

Over the course of the class, our entire team had become quite close, and because we saw each other as equals and friends, it made it even harder to approach our peers with a document that signed away their rights. We arranged individual meetings with each of our teammates where we regurgitated our knowledge. Although extremely nervous at first, we tried to be honest and open with them as we explained what the agreement said and why we wanted them to sign it. Friendship triumphed once again, and surprisingly, almost everyone seemed perfectly okay with it. Some people were even ready to sign without reading it, putting complete faith in our good intentions. As flattering as that seemed, we just couldn't let that fly and insisted on boring them
with the details of the document. One person dissented to a clause requiring team members to allow us access to their design notebook in order to determine the list of inventors. While we’re still working on sorting that out, it was the only issue that was brought up out of seventeen different people signing the same contract. Not bad, huh?

**Find a lawyer**

A competent patent lawyer or agent costs $150 - 500 per hour. Whoa. Although our legal competency may be questionable, we’ll work for just about anything edible. Since our budget from the department seemed meager in comparison to legal fees, we decided that the only way to file a provisional patent application would be to write everything ourselves. In the future, when we go to file for a non-provisional patent, we’ll probably hire a lawyer, but until then, it was just going to be us, the Do-It-Yourself Patent DVD, and a lot of coffee.

**Determine the inventor list**

Having to determine an inventor list was going to be tough. Although we can still remember back to the night the spiral-folding coffee table was first proposed, the other aspects that evolved with it start to run into a blur of brainstorming, sketches, and CAD. But never fear, design notebooks are here! After we draft our provisional patent and determine what we want to put in there, we plan on going through the design notebooks from everyone on the team and using the sketches and dates to determine who the inventors were.

**Apply for a non-provisional patent**

Once we file a provisional patent application, we will have an extra year from the date we file the provisional to file for a non-provisional patent. Talk about a great way to procrastinate. The most challenging part of a non-provisional patent is writing the claims, they need to be broad enough to prevent infringers, but specific enough to be patentable. We took a stab at claim writing just for kicks, and that is exactly what we got out of it. It was surprisingly difficult trying to word our claims broadly and succinctly enough to capture the essence of the invention. For this, we are going to need a lawyer. If you would like to help us make this patent a reality, and will accept a coffee table as compensation, please contact us at sales@304concepts.com.
VI. Marketing and sales

Understand market and competitors

Market research for our table was something we had begun in 2.009. While it started off as an assignment during the class, understanding our market became increasingly relevant as we would be faced with the problem of how to market our table if we were actually going to turn it into a viable product and business.

Complicating the issue of understanding our market was that we weren't quite sure who exactly our market was. Some products have the luxury of a very clear market or can draw their market from a similar product, but in our case, our market was less defined because we didn't have a product similar to ours. There aren't really any high-end, folding coffee tables out there, so what would we compare our table to? Other high-end furniture, or low-end, folding furniture?

Additionally, we were constantly asking ourselves if our table even had a market, let alone one similar to it. A question that was often brought up was "if people can afford this high-end table, why would they be short on space and need it to fold?" One potential market segment would be those living in an urban environment, who didn't have a lot of space in their apartment but could afford the table. Finally, towards the end of 2.009, we began to realize that no one needed our table, but they could want it. While there would definitely be the set of luxury apartment owners who buy our table, there would also be those who liked the way it looked and were intrigued by the folding motion. This epiphany meant that we could compare our table to other high-end furniture, both on the expected quality and design, as well as the price.

After 2.009 was over, and when we started working again in January, we met with different MIT alumni, former employers, and people working in the furniture business to hear their advice about the market we were trying to target with our table. Many of the people we talked to were initially skeptical of our market, and wondered if we could really sell a table for $3,000. Showing pictures of the table to them generally changed their opinions, but there were still some lingering doubts about the price. A few of the people we talked to suggested we come up with a design for a similar folding table but at a much lower price point, a price students could afford. Their advice did make sense; after all, a folding table would have more utility if it were available
for cheaper. The problem is that designing for a much cheaper price point would not be a trivial matter.

For one thing, significant engineering and design changes would need to be made in order for the table to be sold at a lower price point. We wouldn't be able to use carbon fiber on the table top, probably plate glass would replace the polycarbonate, and almost all of the stainless steel components would need to be cast or made out of plastic. There would also definitely be no spring assist, damping, or locking features for the table. It wouldn't be impossible to make all of these changes, and it might be kind of fun to re-imagine the table, but we would be giving up on our original vision if we were to change the table so drastically.

What's more, we also worried about our ability to be competitive at a lower price point. Most furniture in that market is mass produced by large companies like IKEA, with well established relationships with suppliers and manufacturers. If we went with a lower price point, we weren't sure if we could make it low enough to appear attractive next to something of the same quality as IKEA. So while we weren't sure if we could compete on price, we did think we could compete on quality and design, things that would necessitate we compete in the high-end market.

Our meetings with designers gave us some ideas and insight if we were to build a table for a lower price point, but in the end they mostly helped convince us we could stick with the high-end market; a low-end table to pursue a different market could be something we did in the future, an addition rather than a substitute.

**Research distribution channels**

Knowing what your target market is helps a lot for figuring out how your product is going to be distributed. Once we knew for sure our table would be for the high-end, it meant that if it were to sell, it would be sold in only a few furniture galleries, probably located in urban areas. Talking with other furniture designers we found out that high-end furniture that's sold in low volume is typically only sold in a few stores around the country. These boutiques have a well established clientele base and rely on customers to come in to their store to find out what furniture to buy, rather than seeing it in a catalog. In addition to selling through these furniture galleries, designers can also make sales online where a customer can place an order directly
through them. Both of these sales models work well for a furniture company that doesn't want to keep inventory and can fill product orders as they are placed.

**Create marketing materials**

As a bunch of mechanical engineers who designed a coffee table, we're definitely concerned about people taking us seriously as designers. Since we are not looking to sell the design to another company, it's up to us to create the image for our product and our company. Good marketing materials — website, business cards, company logo — are extremely important in any business environment because they create expectations about your product. Even a well designed product can seem shoddy if it isn't represented well. Also, for the market we're competing in, design and aesthetics are vital to the sale. We're not selling merely a product, but an experience, and if the marketing materials don't complement our table, then we're creating an inconsistent and inferior experience.

Because of how important we think marketing materials are, we've been waiting until we think everything is ready — logo, business cards, etc. — before we go public with it. Basically, we want to make sure it is up to our standard of quality when introduced to potential customers.

**Generate interest and publicity**

Since our newest version of the table hasn't been built yet, we haven't had much opportunity for generating publicity so far. But in the future, once the new version is done, we'll be able to pursue many different mediums in order to increase interest. The Internet, of course, is great for anyone looking to get their product out there. For us, we'd be looking at design blogs as well as blogs featuring carbon fiber products, or because of our combination of materials and overall techy look, automotive blogs. Other than blogs, ads in design magazines, such as Dwell or Metropolitan Home, and brochures for real estate would be good ways of getting the table out into print media. Once the table is built, it would be possible to take it to different art galleries, hopefully having it displayed for a few weeks next to other art pieces.

There's also the International Contemporary Furniture Fair (ICFF). As registered industry members, we can talk to other furniture designers, manufacturers, and sellers and it would be a great way to learn more as well as establish connections within our industry.
VII. Making it on your own

Get organized

For us, starting a company was like riding a unicycle down a mountain right after riding a tricycle around a cul-de-sac. During the course, we had our instructors, mentors, and professors guiding us through the entire design process, giving us a higher authority to default to if our self-run leadership fell through. We had milestones we had to meet, grades to keep up, design reviews to prepare for, and assignments to complete. Finally freed from the institutional oppression of classes, we immediately started setting up our own rules. We organized ourselves into specialist divisions, set up a mailing list, posted our class schedule for reference, and arranged a weekly meeting time. We also used Google sites to set up a wiki and to force everyone to use it, we agreed to use the email list only for emergencies and outside correspondence (figure 5). Every meeting had an agenda, and minutes were posted for all meetings. To share files and work collaboratively on common documents, we used a common server through a free service called Dropbox (www.getdropbox.com). We felt like a mean, lean communicating machine.

Figure 5: Screenshot of our Google Sites wiki
Despite our attempts to maintain order and discipline, there was no way a team of four guys and two girls could stay focused during the entire meeting. Our conveniently scheduled Monday “business” meetings also became a way for us to catch up after the weekend. For example, a discussion on how to divide up time-critical work went as follows: the discussion of everyone’s availability that week would prompt questions about the last weekend, which also happened to be the weekend of the Boston Marathon, so naturally someone mentioned how fast the Kenyans ran. At that point all the guys started yelling “Sound the alarm! You are about to become uncomfortably energetic” in the deepest voice they could muster, leaving the girls utterly perplexed. The ensuing confusion necessitated that we all watch the YouTube video for PowerThirst, an energy drink spoof. But, there is no way we could just watch the video for PowerThirst, we also had to watch the video for PowerThirst 2: Re-Domination. In a feeble attempt to nip these forays into useless conversation in the bud, we developed a highly sophisticated term for any side conversations that inevitably would spring up: later-talk. Effective in some instances, not so much in others, but that’s what makes us a team, and no one’s going to fight that.

**Get help (in order to make it on your own)**

One of the most useful things we did just starting out was to reach out to as many people as possible and ask them for advice. Over the course of a month, we spoke with people from 2.009, from other MIT classes, from previous jobs, from references and introductions, and people we found in a directory of furniture designers. Our thirst for knowledge could not be quenched (or maybe it was just that we were so confused we didn’t know what else to do), and we met with someone new almost every week, sometimes even scheduling in meetings with two people a week. We got advice from CEOs to furniture designers, and almost every one had something different to say. Despite all the great advice we got, all these meetings started to take a toll on our morale. With each meeting, it felt like we were farther and farther away from “the right track”. For a couple of weeks, it seemed like the only way we were going to make money as a business was if we changed the functionality of our product, re-did the industrial design, and then sold it to a furniture manufacturer. Morale seemed low, and it looked like we had a very long road ahead of us.
Enter Adam Simha, an MIT graduate who went from studying physics to designing beautiful, modern steel furniture and knives. A great role model, he found a way to make it in the design world coming from a technical, rather than artistic, background, and has had incredible success after years of hard work. He is the man that initially inspired our active furniture theme in the very beginning of 2.009, the man who assured us after the final presentations that our table could compete on the market, and he would again be the man who re-invigorated our self-esteem, reminding us that our table was damn good and that we shouldn’t let people tell us otherwise. Believe in yourself, and don’t give up, he said. And so we did.

VIII. Final thoughts

This semester has been a roller coaster of work, confusion, stress, and fun; there are a lot of things to juggle in this whole process from designing the product to forming a company, from designing a logo to submitting a provisional patent application. Though we were given fair warning there would be no end to the work ahead, and that most startups fail to ever start, we pressed on anyways; we’ve given it our best shot and so far have had a blast in the meantime.

In the beginning, we had imagined that the work we would do to bring Elika to market would merely be an extension of the work we did in 2.009. Wrong. The work we did this past semester was more varied and unfamiliar than anything we had ever attempted at MIT, and gave us the chance to learn things we had never even heard of before. Maybe it’ll take ten years for our business to be successful, or maybe it won’t ever be, but at least we’ll have stepped into the shoes of an entrepreneur and chased after a dream.
IX. References

Introduction: How it started...


Manufacturing: Source parts


Business: Draft legal documents for incorporation


Business: Agree on operating agreement


Patents: Huh?

Patents: Design vs. utility patent


Patents: Apply for a provisional patent


Making it on your own: Get organized


AGREEMENT

In consideration of One Dollar and other valuable consideration paid to Jane Smith of Cambridge, Massachusetts (TEAM MEMBER) by ABC Company, a <type of entity> of <state of entity>, having its principal place of business at <street address> (COMPANY), TEAM MEMBER and COMPANY enter into this AGREEMENT and agree as follows:

I. Background of Agreement

1.00 TEAM MEMBER is a member of the Fall 2008 2.009 <color> team at the Massachusetts Institute of Technology in Cambridge, Massachusetts.

1.01 TEAM MEMBER participated in the development of prototypes of <NAME OF INVENTION> (INVENTION) described in the attached Exhibit A: Invention Disclosure Form.

1.02 TEAM MEMBER wishes to release any and all rights in INVENTION to COMPANY so that COMPANY may commercialize INVENTION.

1.03 TEAM MEMBER is willing to assign to COMPANY all of TEAM MEMBER’s right, title, and interest in the INVENTION and all PATENTS based in whole or in part on INVENTION.

II. Definitions

As used herein, the following terms have the meanings set forth below:

2.00 INVENTION means the item described in the attached Exhibit A as well as all past and future improvements and modifications thereof.

2.01 PATENT or PATENTS means any United States or foreign country patents and patent applications based in whole or in part on INVENTION, including all provisional, nonprovisional, divisional, continuation, continuation-in-part, reissue, substitute, and extension patents and/or patent applications.

2.02 DISPUTE or DISPUTES means any claim, dispute, controversy or disagreement between the parties or any of their respective representatives, successors and assigns arising under or related to this Agreement or any document executed pursuant to this Agreement or any of the transactions contemplated by this Agreement.

TEAM MEMBER: _____     COMPANY: _____

This agreement is considered a "contract". It is not an assignment document, but it means that by signing this contract, an individual is agreeing to sign an assignment document in the future.

"consideration" = what each person gives, and we have to give them something — even if it’s only $1.

Any amount, if they demand more, can add another section titled "considerations" with a more detailed account.

Examples: putting them on a patent, employment, royalties

Name of person signing the document, defined as "TEAM MEMBER" for the rest of the document so you only have to write their name once. This also could be multiple people.

For us, LLC

This doesn’t necessarily mean they have any rights, but if they do, they’re giving up their rights.

Why the person signing this document: general statements

Or "was"

Need a document that describes what they're giving up their rights to

This differs from 1.02 b/c it mentions patents --> you have to be specific.

Basically means that if they make a suggestion to you, they still waived their rights to that

Describing all types of applications and patents; covering all bases

This clause is optional

Continue numbering the pages all the way through the appendix

Person should initial each page to ensure that they agree to the entire document. Can either sign two copies, or have one original copy that is photocopied

Ming Leong, Geoff Tsai
Professor Wallace
May 11, 2009
III. Patent Rights

3.00 TEAM MEMBER hereby transfers, grants, conveys, assigns, and relinquishes exclusively to COMPANY all of TEAM MEMBER’s right, title, and interest in INVENTION and PATENTS.

3.01 COMPANY will have the sole right to file, prosecute, and maintain PATENTS covering the INVENTION and will have the right to determine whether or not, and where, to file a patent application, to abandon the prosecution of any patent or patent application, or to discontinue the maintenance of any patent or patent application.

3.02 COMPANY will have the sole right to determine who are the inventors on PATENTS.

3.03 COMPANY will have the sole right to determine the scope of PATENTS.

3.04 COMPANY will have the sole right to enforce PATENTS.

3.05 TEAM MEMBER agrees not to file or to help a third party file, prosecute, maintain, or enforce PATENTS covering the INVENTION.

IV. Cooperation

4.00 TEAM MEMBER agrees to communicate to COMPANY any facts known to TEAM MEMBER respecting INVENTION and testify in any legal proceedings, sign all lawful papers, execute all provisional, nonprovisional, divisional, continuing and reissue applications, make all rightful oaths, and generally aid COMPANY, its successors and assigns, to obtain and enforce proper patent protection for INVENTION in all countries.

4.01 TEAM MEMBER agrees to provide COMPANY with TEAM MEMBER’s design notebook respecting INVENTION so that COMPANY may make a copy of TEAM MEMBER’s design notebook for COMPANY records.

4.02 TEAM MEMBER agrees to provide COMPANY with TEAM MEMBER’s current contact information for at least the next <XX> years from the EFFECTIVE DATE, so that COMPANY may send necessary documents to TEAM MEMBER for TEAM MEMBER’s signature in order to assist COMPANY in obtaining PATENTS.

V. Dispute Resolution

5.00 The party with a Dispute must send Notice of the Dispute to the other party at its last known address by certified or express mail, return receipt requested.

TEAM MEMBER: _____ COMPANY: _____
5.01 TEAM MEMBER and COMPANY agree to act in good faith to promptly resolve Disputes.

5.02 If the parties cannot resolve the Dispute within ten (10) days after receipt of the Notice of the Dispute by the other party, the Dispute shall be submitted for resolution to a third party mediator mutually agreeable to the parties selected in accordance with <insert name of rules for selection> within seven (7) days.

5.03 For fourteen (14) days after the Dispute is submitted to the third party mediator, mediation shall be the exclusive method of resolving the Dispute.

5.04 If the mediator is unable to amicably resolve the Dispute during the fourteen (14) day period, then the Dispute shall be settled by arbitration in accordance with the Patent Dispute Rules of the American Arbitration Association [or maybe JAMS] before a single arbitrator selected in accordance with those rules.

5.05 Judgment upon the award rendered by the arbitrator may be entered in any court having jurisdiction thereof.

5.06 Each party agrees to bear half of the costs of any mediation and arbitration undertaken pursuant to this Agreement unless the mediator or arbitrator awards costs to the prevailing party.

VI. Miscellaneous

6.00 This Agreement shall be binding on TEAM MEMBER and COMPANY, including their respective legal representatives, successors, and assigns.

6.01 This Agreement shall be governed by and construed in accordance with the laws of the State of Massachusetts and of the United States.

6.02 TEAM MEMBER and COMPANY agree that if any part, term, or provision of this Agreement is found illegal or in conflict with any valid controlling law, the validity of the remaining provisions will not be affected thereby.

6.03 TEAM MEMBER and COMPANY hereby consents to the jurisdiction and venue, at COMPANY’s election, of the state and federal courts in the State of Massachusetts and, without limiting the foregoing, specifically waives any objections to venue or personal jurisdiction in any such courts on the grounds that the forum is inconvenient or otherwise improper, or personal jurisdiction is lacking.

6.04 In the event of any action at law or in equity to interpret or enforce the provisions of this Agreement, each party shall be responsible for paying its own attorney fees unless otherwise authorized by specific statutory remedy.

TEAM MEMBER: _____     COMPANY: _____
This Agreement merges and supersedes all prior and contemporaneous agreements, assurances, representations, and communications between or among the parties hereto concerning the matters set forth herein.

This Agreement may not be modified and none of its terms may be waived, except in writing signed by both parties. The failure of either party to enforce, or the delay by either party in enforcing, any of its rights shall not be deemed a continuing waiver or a modification of this Agreement.

The section headings in this Agreement are inserted only as a matter of convenience and in no way define, limit, construe or describe the scope or extent of the section or in any way affect the section.

This Agreement shall be effective on the date of signature of the last party to sign [could also pick a specific date] (EFFECTIVE DATE).

This Agreement governs the rights of the parties in perpetuity.

In Witness Whereof, the parties have executed this Agreement.

Jane Smith

By: ________________________ By:  ________________________

Address: ________________________ Name: ________________________

Date: ________________________ Date: ________________________

Sam Jones, ABC Company

By: ________________________ By:  ________________________

Title: ________________________ Name: ________________________

Date: ________________________ Date: ________________________

In Witness Whereof, the parties have executed this Agreement.
XI. Appendix B: Invention Summary

Exhibit A:
Invention Summary
Compiled: March 18, 2009

Title of Invention: Spiral-folding surfaces

Circumstances of conception:
As part of their course requirements, all MIT mechanical engineering undergraduates are required to take 2.009: The Product Engineering Process. This course is structured as a senior design course; students are divided into teams of around fifteen people and are charged with the task of designing and developing innovative products within the course’s theme. In the fall semester of 2008 on October 2, 2008, the Green Team presented the design for a collapsible coffee table, a product that fit within that year’s theme of “the home.” The Green Team comprised the following people: Shamus Cunningham, David Hill, Fiona Hughes, Cyril Koninski, Eddie Lei, Andrew Leone, Ming Leong, Cathy Mancuso, Terance Neal, Jared Sartee, Kathryn Shroyer, Katie Stanchak, Geoff Tsai, Phil Vasquez, Cindy Wang, Yuki Wikman, Yi Fei Wu.

The coffee table design stemmed from our familiarity with the pitfalls of card tables; since users have to collapse each individual leg, the collapsing process takes a long time, and oftentimes the collapsing mechanism or lock would jam or break. By using this invention for spiral-folding surfaces, the legs of this table can be collapsed simultaneously in one continuous motion.

This document discloses the unique way of constraining two parallel surfaces that collapse and expand using a spiral-folding motion. This invention can be applied to the collapsible coffee table developed and designed by the Green Team or it can be applied to a variety of furniture pieces such as stools and TV tables, as well as other applications where space is a concern.

Purposes and advantages of invention

Purpose of invention:
The invention is used as a way to constrain two surfaces together so that the distance between the surfaces changes as the surfaces rotate in relation to one another. Our initial use of this invention is for a coffee table that can be collapsed flat.

Advantages of invention:
While many methods to collapse and expand two surfaces in relation to one another exist, our invention allows users to collapse the two surfaces in one fluid motion with few exposed moving parts.

Previous mechanisms that allow for two surfaces to have an adjustable distance, such as a collapsible card table, make use of scissor links and piano hinges. These mechanical methods pose significant pinch points, making them a hazard to the user. Additionally, these types of hinges are susceptible to jamming, buckling, and other modes of failure.
Previous collapsible tables have mechanical locks to hold the table legs in the “extended” and “folded” positions. The user is required to move each leg individually from one locked position to another. In addition to providing a simpler motion, our invention also eliminates the need to lock the legs in the extended position.

Description
The invention (Figure 1) comprises a table top, a table base, six customized ball-and-socket hinges, three locking mechanisms, and three table legs.

![Figure 1: Overview of entire table](image)

Table Top
The table top (Figure 2) was constructed from a sheet of $\frac{1}{2}$ inch, scratch-resistant polycarbonate. The shape is a Reuleaux rotor, a shape unique for having a constant diameter, but not a constant radius. Three 0.030 inch deep pockets were routed out of the corners of the top to accept thin carbon fibers sheets of the exact shape and thickness (Figure 4). The carbon fiber acts as an aesthetic veneer. Around the edge of the table surface, there is a $\frac{1}{2}$ in wide thin steel ribbon that trims the edge.

![Figure 2: Top view of top table surface](image)
Table Base
The table base (Figure 3) is made from $\frac{3}{8}$ inch piece of plywood, laminated on both sides by a piece of carbon fiber of the exact shape (Figure 4). The shape of the table base is designed to fit into the space created by the carbon fiber veneers on the table surface. The pieces of carbon fiber were all cut at the same time from the same sheet to ensure that the fibers lined up. Around the base there is also a steel trim.

Figure 3: Bottom view of bottom surface

Figure 4: Detail of table surface construction. Detail K shows the pocket routed in the polycarbonate and thin sheet of carbon fiber that fits in to it. Detail L shows the table base and the layering of the carbon fiber on the plywood.
**Locking Mechanism**

The user activates the locking mechanism by turning a knob on the surface of the table directly above the top surface hinge (Figure 7). There are three knobs, corresponding to each of the table legs. When the knob is turned, threaded rod that is attached to it lowers through the socket of the hinge. On the end of the rod, there is a rubber pad that presses down on the ball of the hinge. When enough pressure is applied to the ball by the rubber pad the friction between the rubber pad and the ball prevents the ball from moving any further, fixing the leg in that position.

**Customized Ball-and-Socket Hinges**

The ball-and-socket hinges have a customized track in one half of the socket that constrains the leg of the table to a specific path and also provide a stop for the leg in the table extended position (Figure 5). This customized path was found using a model of the table in SolidWorks. The table surfaces were constrained in SolidWorks to be a certain distance from one another. At that distance, the angle of the leg and the rotation of the leg were recorded. This process was repeated over small incremental changes in distance until the path of the leg over the entire motion could be mapped using the recorded angles. Using these angles, a three-dimensional line was plotted in SolidWorks that maps the path of the leg onto a sphere (the socket). Using that line, a track was made in the socket that could be machined using a three-axis CNC mill.

![Figure 5: Top view of socket with customized track cut in to it](image)

Both the balls and sockets were made from stainless steel. The sockets were machined from a 3 in steel cylinder log that was cut down and machined using a CNC lathe and mill. The balls were bought from an ornamental metal ball company. Holes were drilled and tapped in the balls so that the legs could be properly attached (Figure 7, 8). The socket is held together by long machine screws that hold the two halves together, as well as attach the socket to the top surface or bottom surface.

Another version of the hinge was also explored in detail during the course, although it was not used in the final prototype. A description of that hinge can be found in Appendix A.
Figure 6: Overview of leg assembly with ball and socket hinge

Figure 7: Cross-section view of the top hinge with locking mechanism showing ball and leg attachment
Table Legs
The table legs are made of stainless steel hollow tubes. At the ends of the tube, a steel plug was welded to the leg. This steel plug fit partially fit inside the leg, strengthening the area in which the leg is under the most stress when in the fully extended position. The end of the plug protruding from the leg has a threaded post that screws in to the ball.

Figure 8: Cross-section view of the bottom hinge showing ball and leg attachment

Figure 9: Side view of leg and ball assembly
Figure 10: Cross-sectional view of ball and leg assembly using the threaded steel plug.

**Operation**
When the table is “extended”, it can be used as a regular coffee table. The table is collapsed by rotating the table top relative to the base. The ball-and-socket hinges attached to the top and base cause the table legs to rotate and lie flat, bringing the table top near to the base. A user activates the locking mechanism (described previously) to prevent any rotation of the hinge, and thus locking the table in the closed position. The table can then be lifted as a single rigid body and relocated or stored. To extend the table, the lock is released and the table top is rotated in the opposite direction and lifted to its extended height. During this rotation, the legs start in a horizontal position, rotate up 90 degrees so they are vertical, and then continue rotation another 25 degrees past vertical. It is not necessary to lock the table in this extended position because gravity causes the table legs to rest against the ends of the socket tracks.

**Ramifications**

*Different Uses*
- The hinge mechanisms presented could be used to provide a similar collapsing motion to any two surfaces.

*Different Materials*
- Aluminum, magnesium, or any other material capable of supporting the required loads could be used for the hinges and the legs.
- The table surface material can be clear, opaque, or a combination of the two. Any material or combination of materials that can support the required loads could be used.
- The carbon fiber sections of the table surface are optional.
Possible Modifications

- The top and bottom surfaces can be any shape that allows the hinges to be positioned correctly.
- Any number of extra legs can be added to the table.
- Other locking mechanisms can be used to secure the legs in the “folded” position. These mechanisms could function by preventing motion of the balls within their sockets or by limiting the movement of the two surfaces.
- These locking mechanisms could be placed in or near each hinge or located centrally in the table base or table top.
- Any of these mechanisms could be added to secure the legs in the “extended” position or to secure the table at an intermediate height.
- In place of ball-and-socket hinges, the table can use two-axis rotational hinges described in Appendix A.

Possible novel features

- The ball-and-socket hinge mechanisms
- The use of gravity to secure the table in the “extended” position.

Previous Disclosures of Invention

During Fall 2008 we presented the table to students, instructors, and mentors associated with the Product Engineering Process course. The concept of the collapsing table was first presented on 10/02/08. As the design matured, further presentations were given on 10/16/08, 10/31/08, 11/24/08, and finally an alpha prototype was presented 12/08/08.

An animation of the collapsing mechanism was uploaded onto YouTube on 11/06/08. A website including pictures of the prototype and a movie of its motion was created 12/15/08.

We displayed an early prototype of the collapsing table in the MIT student center on 10/09/08. We later brought the table to several furniture stores and design outlets to receive feedback from industry professionals and consumers. It was taken to Bo Concept in Cambridge, MA on 11/02/08. The alpha prototype was shown at Montage in Boston, MA on 12/08/08 and on 3/13/09 and at the New York Design Center and the Design & Decoration Building in New York City on 2/25/09.
Appendix A: Description of two-axis rotational hinge (refer to Figure A1)

In place of the ball-and-socket hinges, two-axis rotational hinges may be used. By allowing rotation in both the yaw and pitch directions, these hinges are capable of providing the same range of motion as the ball-and-socket hinges, and thus would not affect the ability to spiral-fold a coffee table or other similar device. Therefore, the two-axis rotational hinge sub-assembly is capable of fully replacing a ball-and-socket unit.

The two-axis rotation hinge consists of a flange which can be mounted in any surface — the table surface being one possible use. A thrust bearing is mounted to this flange and allows motion in yaw. The rest of the hinge body is mounted orthogonally to this same thrust bearing, and allows motion in pitch.

The hinge body has bosses on its underside which correspond and slide within arc-shaped tracks in the flange. The combination of these two limit yaw movement to less than 360 degrees, determined by the engineer.

The hinge body contains two bearings which allow motion in pitch and support rotational loads applied via the lever mounted to their central axis. In the case of the coffee table, this lever corresponds to a table leg.

Additionally, the hinge body may also contain one or more uni-directional rotational dampers mounted to the central axis of the bearings and lever. These dampers would provide damping for rotation in one direction, and allow free rotation in the other direction. In the case of the coffee table, these dampers allow the table to be unfolded without any damping, but provide damping for the re-folding, or possible accidental closure, of the table.

Additionally, the hinge body may also contain spring plungers which provide a tactile conformation for when the lever is at either extremes of its range of motion in pitch. These spring plungers may be mounted in the region of the hinge body that contacts the lever. Through the course of its rotation, as the lever nears the limit of its rotation, it passes by the end of the spring plunger and compresses and then releases the spring plunger. This provides tactile feedback that the lever is at the limit of its range of motion. In the case of the coffee table, these spring plungers provide feedback both for when the table is folded to its most compact state and for when the table is unfolded for use.
Figure A1: Part drawing of two-axis rotational hinge