Additive Manufacturing

Ed Israel, Co-founder of Plural Additive Manufacturing (PAM); additive mfg. integrator; help people from design all the way to post-processing.

Susan McDermott, Process Engineer with Next Target. PAM Associate; helps businesses transition from mfg. design to manufacturing. As people move from prototyping into actual manufacturing and using end parts, there are processes that must be considered that are different than in traditional manufacturing. See folder entitled, Manufacturing Process Design for High Mix Operations.

Additive Manufacturing Definition: Think about Rapid Prototyping. Additive Manufacturing is thinking about the whole process, not just printing a part but, basically, taking that part and moving it to production; in metal or in plastic. The additive process is nothing more than printing something from nothing, as opposed to traditional manufacturing that is more of a subtractive process. One point: complexity is very expensive in traditional manufacturing.

There isn't only one technology for 3D printing; there is filament-based technology where a filament gets heated and layed out on a print bed. There is also liquid polymers; powdered plastics, powdered metals that get laser-sintered into solid—or, hollow—parts.

Some of the current 3D Printing Technologies are designed for form and fit, but not for function.

One point of frustration in their industry is that people use 3D Printing and Additive Manufacturing in the same breath; they are really different processes. When you talk about 3D Printing, it's just that: rapid prototyping; one or two parts. Ed presented two definitions of Additive Manufacturing:
1) The simple definition is simply producing the part in a repeatable and dimensionally-accurate way; because we are manufacturing that part to a tolerance, to specifics.
2) The not-so-simple definition, and the one that is absolutely critical, is: starting to think outside the box. Ed cited some customers like John Deere, GoogleX (producing autonomous stuff), Sikorsky; all they do is think outside the box all of the time. This technology really enables those businesses to work in their preferred manner.

You design the constraints of the machines that will produce the parts, whether inject mold, machining, whatever. With 3D Printing, the complexity is free; you can design to your heart's content.
DFA: Design For Additive Manufacturing. A part does not have to be solid; it can be half its weight. It's data capture; for example, lot manufacturing. It impacts the supply chain; you can now keep your inventory in spools or in powder, at minimal cost, instead of having to order finished parts to store on your shelves. So, it's about re-thinking both your internal and your external supply chain. It's a whole range of things ... If you start thinking about how you approach your customer: instead of going to the customer and saying, “here's the price for the design that you wanted, boom!” you have the capability of re-designing the part, in house, and then offering either the part as designed by the customer, or the version re-

designed by you, in house, which may cost half as much (to produce) as their original design.

Inventory On Demand. Some suppliers have contracts with their customers that require them to have finished goods on the shelves so their customers can demand shipment on demand.

Spare Parts On Demand. Coleman (camping equipment). Instead of storing all the spare parts they might need, for equipment going back decades, they can manufacture spare parts on demand, and all they need to store is design specs. Ed told a story about a friend of his who purchased a tent (manufactured in China) and stored the tent for a year before opening the box, only to discover that one of the parts was broken. He contacted Coleman and was told there are no spare parts; they were sold in kits. Coleman ended up sending the man a whole new tent, in place of a part that may have cost ten cents to manufacture. If the part does not need to be structurally-sound, it might be able to be printed on a $3,000 printer. Coleman could have a few $3,000 printers sitting around—or even, contracted-out the part replication to a shop with a 3D Printer. Considerations for a company like Coleman include: What's the ratio of cost? Coleman has to look at: number of parts; what is their spare parts problem, in general; and whether they have connections to sub-contractors they can refer customers to. For example, if you paid $800 for a tent, you might be willing to pay $50 to an individual who runs a shop out of their garage to get a replacement part.

The cost to Coleman is the cost of the printer, training an operator, and customer relations.

Another example: Seat part for an Airbus A320 (first slide on page 3); structurally-sound (30% increase in structural rigidity than the original design), less weight (very important for airplanes), cheaper. Possibly using plastic instead of metal; 3D printing instead of machining the parts. The key is: engineers are comfortable with their CAD tools; if they can be more creative with their existing tools, that is a turn-on for them.

Example of Design For Manufacturing (because there's a limitation on creativity, based on the machinery used for manufacturing) vs. Design For Additive Manufacturing.

Example of part for GE Leap Engine: a nozzle. Each engine requires 18 of these nozzles, and each nozzle has 17-20 parts that must be welded-together, which requires a welder. GE bought a company that already had the skill-set to 3D print metal. Bought $180,000 metal printing machine. They also redesigned the part to be simpler, faster, and to get 15% more fuel efficiency. That's an example of Design for Additive Manufacturing.

You don't have to build a whole factory to do this. You can put up a printer in a shop somewhere. So, instead of flying part assemblies all over the world to gain economic advantage, you can set up 3D printers all over the world. Fewer miles. Less dollars.

So, if you want to manufacture closer to your customer or even bring the process in-house, that's an option. There are also service bureaus out there to whom you can email the design files, and they will produce the part for you.

Case Study #1: PMT Shielding; based in Portland
PAM went to them because they need to do something for Techtronix. The part pictured is an RF Shield that screws down over a circuit board. The shield isolates signals that come in so they don't penetrate other parts of the circuit board; you want the signal to discretely go into the desired area, and you need metal to accomplish that. Currently, one of these parts costs $500 to have the part machined out of aluminum, took 4-6 weeks to get the part. Ed requested the design file, printed the part overnight (took about 11 hours to print), took about $15 worth of ABS plastic, and then submitted the part to PMT for metalizing through a vapor-deposition process, which is different than metal plating. They replicated the part in 3 days (because of their pipeline), cost about $50, and Ed took the fabricated part back to Techtronix for testing against the original aluminum version. The new part worked almost as good as the original metal one and, with a conductive gasket, would probably have worked as well. The vendor that produced this part for Ed has now converted to the DFAM process and is saving about $75,000 per year and they have more capacity and more flexibility for their customers. Faster. Cheaper.

Case Study #2: Jevo; Jello Shot Machine Maker; based in Portland
With this company's Jello Shot Machine, a bartender can produce 20 Jello Shots in 10 minutes, and the company makes their money on the powders. The machines are not very expensive. Their customers for the commercial version are bars and expo centers, and they are now making a home version. Where the company is heading, though, is: Medical Dosing; delivering medication to children that don't want to get a shot in the arm. All they need to do is get approved by the FDA. Result: zero tooling costs (originally, $5,000 a pop; after multiple interations, maybe $75,000), $3,000 investment to get the final field test parts. The parts are highly-toleranced and repeatable; that's the difference between industrial 3D and hobby printers.

Case Study #3: A-dec; Dental Equipment Manufacturers; based in Newberg.
The part shown on page 5, top block, has six critical dimensions, with very high z machining tolerance. With special tuning, Ed's company was able to print the part that met the requirements. The company acquired a printer for $45,000 and will save $60,000 the first year.

Savings are logarithmic, not linear.

Additive Manufacturing has been around for a decade—or more. The problem has always been cost. The machines are expensive and the materials are held captive by OEMs. So, when you do the cost-per-part math, it's no contest; might as well inject-mold the part. But with the new generation of printers that can handle open materials and that are properly-tuned, you can see the cost curve move in favor of the manufacturer. Ed predicts that this will be transformational in the industry. He suggested that this is not an "if" but a "when" in terms of how it might impact your business. Beauty of the thing is: Learning the process is not risky.

From a costing standpoint, Plural has developed a financial model that enables you to look at your own parts, maintenance, amortization of costs, materials, everything, amortized over a period of years, to find out how many you can make a month at what cost, and compare that to your current costs. Or, if you're doing new product development, compare your current estimated costs to costs using Additive Manufacturing. All that's required is a parts files; these files are converted via software to the G-Code (machine language for CNC machines) so you can print the part. When PMT gets the parts files, they run a spreadsheet and show you the cost to produce one part, 20 parts, 100 parts, and tell you when you have to move to a second printer; you can absolutely see if this technology works for you before you spend a dime.

Requirements: Native (parts) file for CAD System or a Step File.

Degree in Mechanical Engineering with a second in Material Science. Materials for 3D Printing is one of the fastest-growing technologies in the world, right now.

Check out the last slide for a checklist to see if Additive Manufacturing can save you money.

Higher return on low volume manufacturing

How do you decide whether you want to get into this biz?
High Cost, Low Volume Mfg.

In Additive Manufacturing, Complexity is free; in traditional manufacturing, complexity is very expensive.