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P6 Gear

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In 2013, Sungi Cho earned a B.S. in Mechanical Engineering from the U.S. Military Academy at West Point. Over the next decade, while serving as a Black Hawk helicopter pilot in the Army, he encountered several deficiencies in standard-issue gear – a frustration shared by many of his fellow soldiers. However, addressing design flaws on a large scale in the armed forces was a nearly impossible task due to bureaucratic red tape and the dominance of a few large defense contractors.

Recognizing the need for equipment modifications and enhancements, Cho drew on his engineering background and interest in 3D printing, purchasing his first 3D printer to experiment with small-scale solutions. He observed that when soldiers were not in the field, gear organization in the barracks was suboptimal for quick deployment and space management. This observation led him to develop a plastic hook attachment that allowed soldiers to hang their warbelts and loadouts, including sidearms, spare magazines, and medical pouches – improving both equipment accessibility and storage efficiency.

After several design iterations, Cho produced a hanger prototype ready for field testing during a training exercise. His fellow soldiers, intrigued by the novel gadget, began using the spare units he had brought along. Encouraged by their positive feedback, Cho invested in additional printers and founded a company to sell his invention, naming it the Warbelt Hanger (**Exhibit 1**). He priced the product at $10.99.

During his off-duty hours, Cho managed the printers he had set up in a bedroom of his home. He also personally packaged and shipped orders received through his website and from e-retailers like Amazon and Etsy. His customer base soon expanded beyond the military to include law enforcement personnel, as the Hanger was compatible with many of their standard-issue belts.

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After establishing a smooth routine of printing, packaging, and shipping Hangers in his spare time, Cho focused on developing his company's second product: a universal base mount for modular lightweight load-carrying equipment (MOLLE) systems, which he named the MOLLE Backer (**Exhibit 2**). MOLLE systems consisted of either metal panels with a standardized grid of openings or rows of heavy-duty nylon panels stitched into gear for equipment attachment. Cho's product was designed to fit both hard and soft MOLLE systems, providing a base for attaching mounting plates for various gear. This innovation offered a significant improvement over the common practice of securing equipment directly to MOLLE panels using rubber bands, bungee cords, or rope.

Cho was particularly excited about the Backer's potential to reach a broader audience than the Hanger, including outdoor enthusiasts and tradespeople who utilized MOLLE systems for their adventures or workdays. After multiple cycles of product design and user feedback, the Backer launched at a price of $10.99 for a two-pack to strong demand, validating Cho's market insights. To keep up with the growing number of orders, he purchased additional printers to further expand his printing capacity.

Right around this time, Cho experienced significant changes in his personal life. He left the Army to pursue an MBA at MIT Sloan, relocating from Seattle, Washington, to Cambridge, Massachusetts. Among the belongings he drove across the country were the fifteen printers he had accumulated by that point for his business. Cho rented a small space near campus to continue his manufacturing operation, hiring two undergraduate engineering majors at $20 per hour to assist with both printing and order fulfillment.

After readjusting to student life, Cho found a little time to analyze demand for the Backer. Reviewing sales figures from the previous six months, he observed that monthly sales had stabilized at around 1,800 units (i.e., 900 two-packs) after the initial post-launch ramp up. Given this consistent demand, Cho began considering a shift in his manufacturing process to increase efficiency, specifically by transitioning to injection molding.

Injection molding forced molten material, typically plastic, into a pre-designed mold under high pressure. Once the material cooled and solidified, the mold was opened, and the finished part was ejected, producing precise and repeatable products for various applications. This method differed from 3D printing, which built parts layer by layer from a digital model. By creating a more uniform material structure, injection molding resulted in stronger parts compared to those produced by 3D printing.

Unlike 3D printing, injection molding would require Cho to outsource his manufacturing process to a third party. This method would also involve a significant up-front investment to create a high-strength steel mold. To assess the financial viability of injection molding, Cho gathered production and cost data for both methods (**Exhibit 3**).

Ten printers, each capable of producing 180 salable units per month, were dedicated to Backers.[1] These printers had been in use for one year and would need to be replaced after five years of use, with no salvage value at the end of their useful life. In contrast, the third-party manufacturer could produce 200 salable units per hour, fulfilling an 1,800-unit order in a single 9-hour production run.[2]

Polyethylene terephthalate glycol (PETG) plastic for 3D printing came in large spools, resulting in a cost of $0.50 per unit. For injection molding, the same plastic could be purchased in lower-cost pellet form, reducing the cost to $0.20 per unit.

Both methods resulted in some defective parts. The scrap rate for 3D printing was 18%, translating to $0.09 per unit. In comparison, the scrap rate for injection molding was estimated at 3%, or $0.006 per unit.

Two threaded inserts for the plastic base and two accompanying screws cost $0.48 and $0.50 per unit, respectively. These costs were identical for both methods. Packaging was also the same for both methods, at $0.11 per unit.

The electricity cost to run the printers was $0.04 per unit.

The third-party manufacturer quoted a price of $0.75 per unit, covering only the production of the plastic base and excluding the attachment of the threaded inserts.

At monthly sales of 1,800 units, the two part-time employees spent a total of 56 hours per month on tasks related to Backers, divided as follows:

- 40 hours setting up and monitoring the 10 printers used for Backer production
- 9 hours on assembly by attaching the threaded inserts to the plastic base
- 7 hours fulfilling Backer orders

The quote for the mold came in at $11,487, significantly higher than the $1,716 cost of a printer. With a production rate of 1,800 units per month, the mold would have an effectively indefinite lifespan.

Cho wasn't entirely sure how to structure the data to help him decide whether to pursue injection molding. He also knew there were several non-financial factors he hadn't yet considered. As he turned his attention back to schoolwork, Cho wondered if he should ask his accounting professor after class tomorrow for suggestions on how to approach this issue.

[1] Five printers were dedicated to Hangers.

[2] The third-party manufacturer required a minimum production run of eight hours.

Exhibit 1 Warbelt Hanger

Source: Company.

Exhibit 2 MOLLE Backer

Source: Company.

Exhibit 3 MOLLE Backer Production and Cost Data

	3-D Print	Injection Mold
Production capacity:		
Units per printer per month	180	
Units per hour		200
Costs per unit:		
Polyethylene terephthalate glycol (PETG)	$0.50	$0.20
Scrap	$0.09	$0.006
Threaded inserts	$0.48	$0.48
Screws	$0.50	$0.50
Packaging	$0.11	$0.11
Electricity	$0.04	
Third-party manufacturer price		$0.75
Labor per month @1,800 units:		
Hours setting up/monitoring printers	40	
Hours on assembly	9	9
Hours packaging/shipping	7	7
Hourly wage	$20.00	$20.00
Capital costs:		
Printer	$1,716	
Mold		$11,487

Source: Adapted by casewriters from information provided by company.