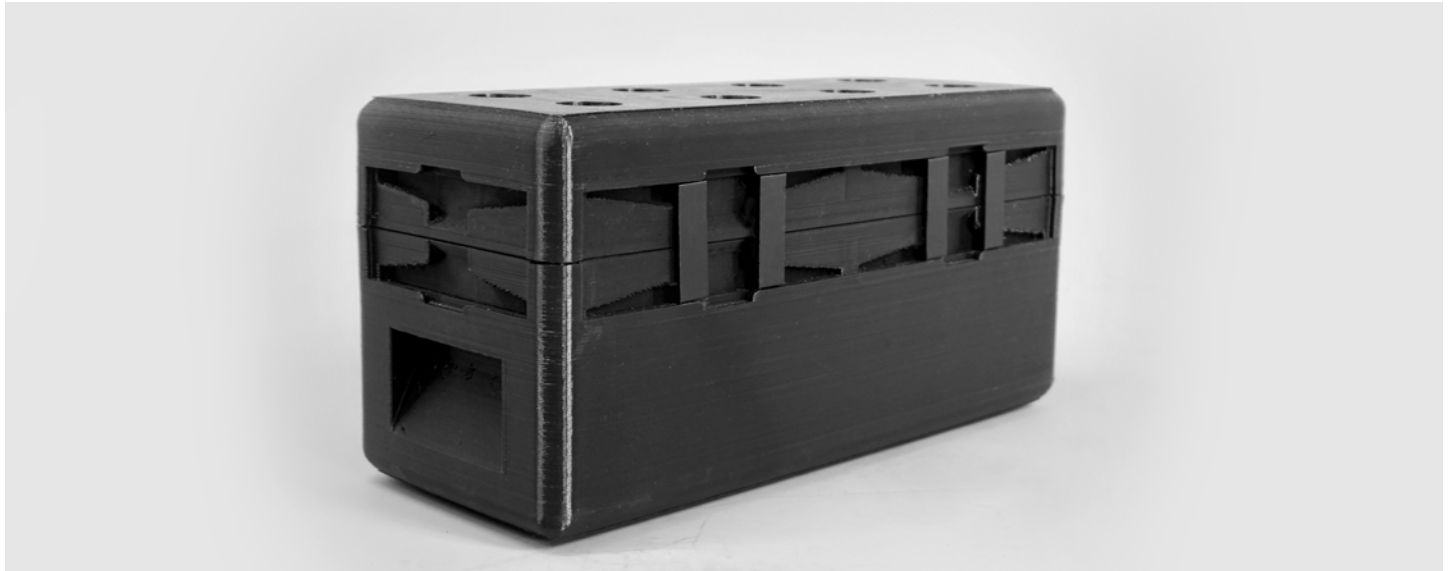


HOW AIRBUS MANUFACTURES SHIPPING CASES IN-HOUSE WITH LARGE-FORMAT ADDITIVE

Modernizing traditional packaging workflows with BigRep large-format 3D printers to create affordable, on demand investment shipping cases.



As delicate equipment breaks down or otherwise requires off-site maintenance, organizing its transportation takes detailed consideration and significant investment. When complicated technical equipment for industries like aviation is involved, the expenses required just for logistical preparation are startling sums long before any solutions are actionable. In large part, high costs surrounding the transportation of delicate equipment are due to longstanding inefficiencies in the manufacturing of “investment shipping cases:” specialty, high-quality secure custom cases that are individually manufactured in a highly manual process and certified to transport sensitive equipment safely.

Acquiring investment shipping cases can be a complicated process as businesses plan not only for the equipment’s safe transportation, but also the time their advanced tools – often representing a significant investment – aren’t available for use. Businesses transporting equipment like aerospace imaging cameras must accurately predict their need for investment cases years before the problems they’re meant to solve even begin. But for case manufacturers, investments in productivity must be balanced between meeting demand and spending on highly skilled laborers to create their complicated, high-standard product. Unfortunately, due to the limited number of suppliers,

manufacturers’ balancing is rarely in the purchaser’s favor. As a result, wait lists for the cases often exceed two years – a disastrous lead time for businesses with unforeseen complications.

Airbus and Ralf Schlueter, Managing Director, of Flugzeug Union Süd (an Airbus subsidiary), have turned to additive manufacturing and digital design solutions to modernize the investment shipping case industry. They’ve submitted a patent application for an additive production process using BigRep large-format 3D printers. The process involves designing the investment cases in a data-driven, automated process and manufacturing them additively with a single material inside and out: BigRep’s TPU filament, a shock-absorbent engineering-grade material. By enabling overnight production and eliminating manual labor the new process promises a massive reduction to the cases’ manufacturing costs and lead times, creating an attractive solution for businesses stranded by its current problems.

AIRBUS

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MODERNIZED MANUFACTURING

Traditionally, investment shipping cases are designed, assembled and certified individually in a highly manual process. Their production involves a variety of traditional manufacturing workflows including a prototype design cycle, usually using foam or reductively manufactured plastic (but potentially involving an additive rapid prototyping cycle), and a company's preferred traditional end-use production processes; such as reductive milling, injection molding, or vacuum forming. Internal foam is designed by scanning the equipment to be transported and using waterjet cutting to create foam inserts later glued inside the case's hard shell. Finally, any latches or pressure valves are mounted by hand. The resulting products are certified individually through rigorous tests that include temperature, vibration, drop, and water and airtight approval.

Because of the complicated traditional manufacturing process, highly paid specialists and generous lead times are required to ensure the rigorous standards of investment shipping cases are met. Given their high level of customization and demanding manual production, cases can take up to nine months to manufacture. Their demanding production process swells expenses, with cases often costing over fifteen-hundred dollars to purchase and sometimes exceeding ten thousand. Their custom nature means manufacturers can't keep a product stock and are forced to carefully balance labor investments with demand, gambling whether it will maintain a high or reach a low that would then be financially devastating. The resulting cautious logistics of manufacturers in a seller's market have led to limited investment shipping case production capabilities that simply can't meet global demand while waitlists for investment cases extend beyond two years. Consequentially, businesses with a greater need for the cases than expected can be stuck with equipment worth hundreds of thousands of dollars stored for years awaiting repairs.

To find a solution, Airbus is working in collaboration with BigRep's additive innovation consultancy, NOWLAB, to create a design template using data-driven processes that quickly generates final, unique designs for individual custom investment shipping cases. The design process takes advantage of the versatile qualities of BigRep's TPU filament which has firm material properties when printed in a thick wall but soft, flexible qualities in thinner compositions that make it highly shock-absorbent. The design of additive investment shipping cases has capitalized on Fused Filament Fabrication's (FFF) common internal infill patterns and TPU's dynamic material properties to replace the traditional foam



cushioning of shipping cases. Instead, the equipment's shape is simply left empty in the infill resulting in a design that can be manufactured as a single piece in a completely automated process. Latches are created simultaneously in a second firm material and can be easily added to cases by end users.

"The infill is usually just meant to keep printed objects solid. Here, thanks to TPU's versatility, we've given it a practical function," said Marco Mattia Cristofori, a lead designer at BigRep's NOWLAB who worked closely with Airbus on the project. "We're happy that we've found a way to rethink these natural features of additive manufacturing and make them even more functional."

With the new additive process, production steps have been drastically reduced from a manually daunting eight to a mostly automated four:

Traditional process

1 | Equipment measurement

2 | Case design

3 | Shell production

4 | 3D scan of equipment

5 | Foam insert design

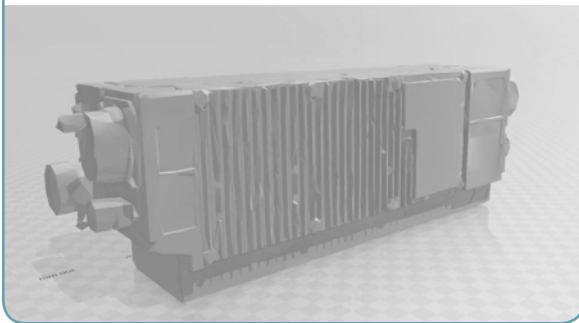
6 | Waterjet cut inserts

7 | Glue inserts in shell

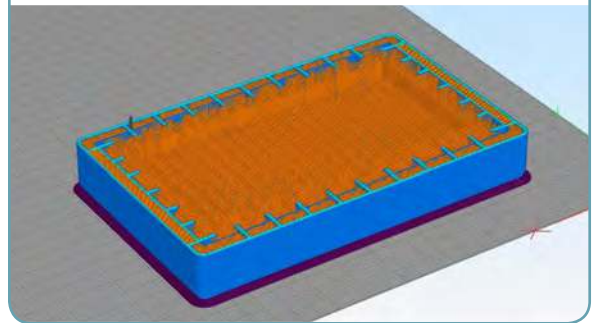
8 | Attach latches

Additive process

1 | Scan equipment



2 | Run data-driven design process



3 | Print



4 | Attach latches



“We’ve already started testing to qualify the design for certifications,” said Schlueter, discussing plans to certify the digital design process rather than each individual case – potentially cutting an incredible expense and bottleneck from the process. “So far the TPU cases have been drop tested, successful in deceleration of 20 to 40 Gs, and had no physical changes in high-temperature tests.”



LOGISTICAL CHALLENGES

The current difficulty in acquiring investment shipping cases has caused tremendous logistical challenges for many businesses who depend on them. Predicting need, finding storage, and ensuring that reasonable redundancies are in place are all challenges increased by the current limited availability and excessive cost of the cases.

Being an industry dominated by only a few manufacturers, investment shipping case facilities are sparsely located throughout the world. Unfortunately, the result is significantly larger expenses for more distant businesses. After finally receiving the cases expenses only continue to increase as the often large and plentiful cases are stored in valuable facility real estate to await their use.

There are expensive consequences when a company’s logistical planning around investment cases falters, or when any margin of error is simply unacceptable. “We’ve seen companies with over 300 refab units stuck waiting for shipment because they don’t have these cases,” said Schlueter. “Some companies have even risked damaging very sensitive equipment further by transporting them in an unsecure case – just cardboard and Styrofoam.” Rather than risk damaging equipment further many

companies have turned to massive investments, increasing their stores of redundant equipment and investment cases at a major expense to avoid desperate gambles with their delicate equipment.

Modernizing the manufacturing of investment shipping cases with additive manufacturing eases these logistical challenges. The combination of data-driven design and versatile TPU filament results in an investment case that can be autonomously manufactured on-demand in just about 60 hours, depending on size and geometry. If Airbus is successful in certifying the manufacturing process instead of individual cases, they plan to roll out BigRep large-format 3D printers in over 20 locations to produce cases locally on demand. By shortening the supply chain with local production units, their strategy will create a massive reduction in procurement cost and time by eliminating excessive acquisition expenses on top of savings to the greater manufacturing process. “It’s exciting and beautiful to find a meaningful application that increases efficiency in demanding industries,” Cristofori said. “To do it while reducing the environmental and economic stress of present supply chains is a welcome bonus.”

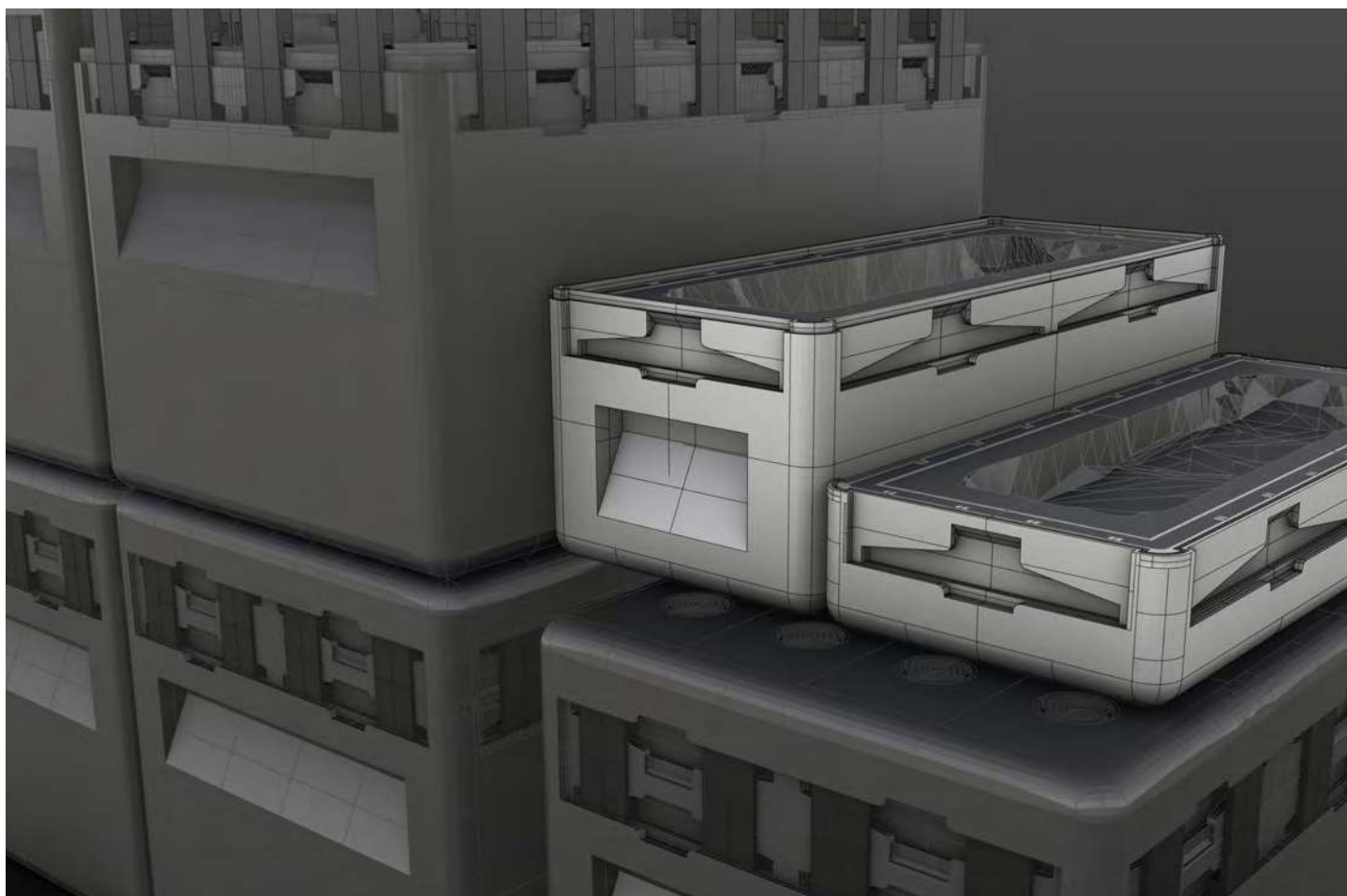
Beyond Airbus' current plans for the cases, this new process promises continued innovation with opportunities to take advantage of closed-loop manufacturing that further ease logistical difficulties. A combination of local and closed-loop manufacturing would eliminate many excessive storage requirements and enable Airbus to limit the amount of raw material needed to meet demand. Companies in need of shipping cases could order one to be quickly produced locally, paying a deposit to incentivize the case's return to its manufacturer. After they're returned, cases can be shredded in-house and their material reused in future products.

For Airbus, a revolution in investment shipping cases was inevitable – it simply came down to the right combination of process and manufacturing technology to ignite the change. By implementing a fleet of BigRep large-format 3D printers around the world Airbus has the means to quickly, autonomously, and affordably produce not just reliable cases up to a cubic meter in size but also significantly reduce the economic and environmental burdens of a complex supply chain.

By implementing a digital solution for the design and, potentially, the certification of investment shipping cases, Airbus and BigRep have created a manufacturing concept to transform this once laborious and restrictive industry into an efficient and accessible service.

By creating easily transferable certified design files and allowing the local manufacturing of cases in small batches, additive manufacturing has eliminated a complex, expensive and environmentally damaging supply chain in the investment shipping case industry.

By working towards a certified production process to replace the current exhaustive individual case certification process, Airbus is leveraging additive to tackle their production challenge holistically. If successful, they'll have optimized the manufacturing and procurement of investment shipping cases at every conceivable bottleneck and created a modern product evolution that enables businesses to purchase the cases reactively or opt to uniquely manage previously daunting logistics.



REDEFINING **ADDITIVE**

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