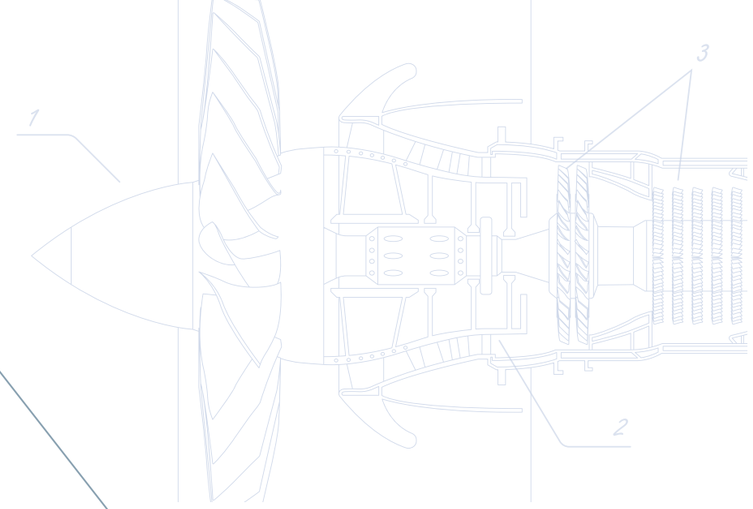
MOTION CAPTURE, VIRTUAL REALITY AND IMMERSIVE AEROSPACE DESIGN

HOW MOTION CAPTURE CAN MAKE THE DIFFERENCE BETWEEN A DESIGN TWEAK AND GROUNDING 400 AIRCRAFT



'Digital transformation', the process of recreating every last component of a physical product as a digital object, is the newest frontier for industrial production. At aerospace company Northrop Grumman, Sibo Chou is using motion capture technology to bring a human touch to that process.

In a given year the cost to operate and maintain a military aircraft can be astronomically high, sometimes leading the operators to cannibalize working components from multiple aircraft to keep a single plane in use. Meanwhile, aerospace hardware and the process of designing it continues to grow in complexity. That complexity breeds opportunities for design flaws, and each issue at the design stage can generate a cascade of unforeseen production and maintenance costs.

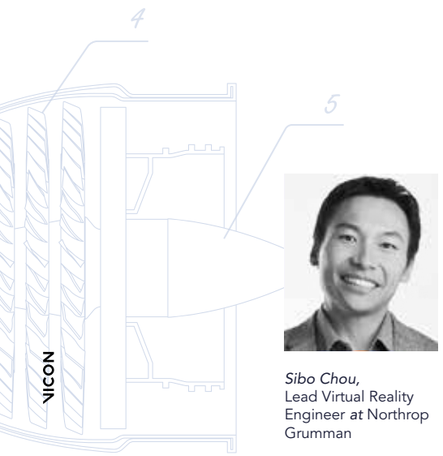
HIVE (Highly Immersive Virtual Environment), a virtual hardware testing system that uses motion capture to allow Northrop Grumman engineers to interact with designs, is built to enable the early discovery of those flaws, unlocking exponential cost and resource savings across the lifespan of an aircraft.

ASSEMBLING VIRTUAL AIRCRAFT

The overall concept isn't dissimilar to gaming-focused, location-based VR, but the process and the application differ significantly.

"We stream motion data directly into a piece of digital manufacturing software," explains Chou, who is lead Virtual Reality Engineer on HIVE. "Using that software, we're able to bring in the engineering 3D models. With motion capture and a virtual

Chou and his team estimate that for every 30 assessments they save around $4 million.



Sibo Chou, Lead Virtual Reality Engineer *at* Northrop Grumman

reality environment, now we can assemble and maintain the airplane way in advance, even before we go and buy the parts. This allows us to simulate the manufacturing and maintenance sequences of our product.

While the exact cost savings are difficult to calculate, Chou and his team estimate that for every 30 assessments they save around $4 million. "This estimate only accounts for labor and is extremely conservative," adds Chou, noting that every issue that the assessment catches could, unchecked, have led to numerous associated costs.

HIVE operates across various sites, utilizing more than 30 optical motion capture cameras in 20 ft x 20 ft x 10 ft volumes. It was a substantial investment up front, but Chou notes that the first two HIVEs recouped their initial costs after their first assessments.

"You always need 3D models," says Chou, "because without models we can't really analyze anything. But the thing is that a lot of the 3D models already exist. So when you use the HIVE, you're really reusing something that you already have."

A FIX IN TIME

Chou stresses that the ROI figures he provides are very loose estimates, but as he unpacks the potential cascading production challenges that can come from not using HIVE early in the design phase, the benefits become very clear.

He gives the example of an access panel that might be too small for the majority of technicians, but is only discovered once production has begun. "If you find a problem in the production line and you've already made 50 of these access panels, you're talking about scrapping all 50 access panels that are on the dock. Or maybe you've got to go in and retrofit, drilling additional holes. That's more money now, but that's just for those 50 that have already been made."

Chou said that this would have to be followed with new engineering drawings and approval, and parts and labor costs that could reach into the millions. And it doesn't stop there. "Now you've got to flow that change down to your suppliers," Chou goes on.

"That's probably a month. So for that month, you told the supplier, 'stop making this item, because we're going to give you a newer version'. But what if that item's lead time is six months? Potentially, now you're impacting your delivery schedule, because you tell the supplier to stop for three months, in order to do manual design. Now, it's going to take them an additional three months, and maybe they shut down the factory, and it costs money to restart the factory. So the supplier is going to come back to ask for more money, because shutting down and restarting is going to cost them as well."

It could be an order of magnitude worse if a fleet of planes has already been delivered. "Now you're talking about everything I just mentioned: design change, supplier redesign, but you have to figure out how to go out to the customer's fleet and retrofit all 400 planes. They could be all over the world. If they're on an aircraft carrier in the Middle East, how do I deal with that? And if it's a safety issue, now you've grounded the whole fleet."

MOTION CAPTURE AS A PLATFORM FOR COLLABORATION

Effectively, HIVE is enabling engineers to frontload the design process, surfacing issues that might previously have only come to light at the physical prototyping stage or, worse still, when aircraft are already in use. Crucially, it allows multiple engineers from different parts of the business to collaborate in an effective way.

"When we identify a problem, we always find the best solution with the correct stakeholders in the room," says Chou. "As programs and aircraft get more complicated, you're not just designing an aircraft with 400 people in the same building. You're talking about 5000 people all across the world. And a lot of times, a simple phone call is not good enough – you need to show the person what you're talking about in 3D space, along with movement."

Chou says that there are five questions his team asks at the beginning of any process assessment, and some of them can only be answered with a high-spec optical motion capture setup: "Can my hand reach? Do I need both my hands to reach? Can I see what I'm doing? Does my body fit? And what size maintainer fits into this access zone?

"That's what is different between the HIVE and other motion capture technologies. A lot of people think that [a commercial VR] headset and two controllers is motion capture. Well, it's quite limited. I don't know if my elbow is crashing through the bulkhead. I don't know if my hips or my legs are fitting through this access panel."

The accuracy provided by a gold standard tracking solution removes that doubt, Chou says.

BEYOND MAINTENANCE

HIVE is increasingly being used in other parts of the company. "We want to use the HIVE to win programs.

"...we've been doing digital transformation for a while now. And obviously, they're finally catching on. But with HIVE, we've already done it."

A lot of times, when we're in the competition phase to win a program, we already have draft models. And by then we can use the HIVE to engage the customer, to show the customer that we are really 100% on board with this digital transformation our company is pushing."

As well as rolling HIVE out to other parts of Northrop Grumman, Chou hopes to improve the level of immersion that HIVE offers, bringing more users into a session.

Currently, the person performing an assessment wears a capture suit and headset while onlookers get that person's view through a TV screen. "I'm thinking that in the future, I would have either VR or augmented reality headsets for everybody. They will see the product in the room in 3D. The cameras will track the orientation of each headset, so that any guests with a headset can walk around the product and get their own perspective."

While there might always be ways to improve, HIVE is already on the leading edge of aerospace design. "I always tell people they're late to digital transformation," says Chou. "We've been doing digital transformation for a while now. And obviously, they're finally catching on. But with HIVE, we've already done it."