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CONTACT:

Casey Perkowski
nScript Inc.
Email: cperkowski@nscript.com
Phone: 407-275-4755 ext.1115

US Army & nScript Direct Digitally Manufacture 3D Printed Circuit Structure

The fully functional “Simon Says” game, shown below, was the result of a recent joint project of the US Army Armament Research, Development and Engineering Center (ARDEC) (Picatinny, NJ), Army Research Laboratories (ARL) (Aberdeen, MD), and Orlando, FL-based nScript to Direct Digitally Manufacture (DDM) a 3D Printed Circuit Structure (PCS).

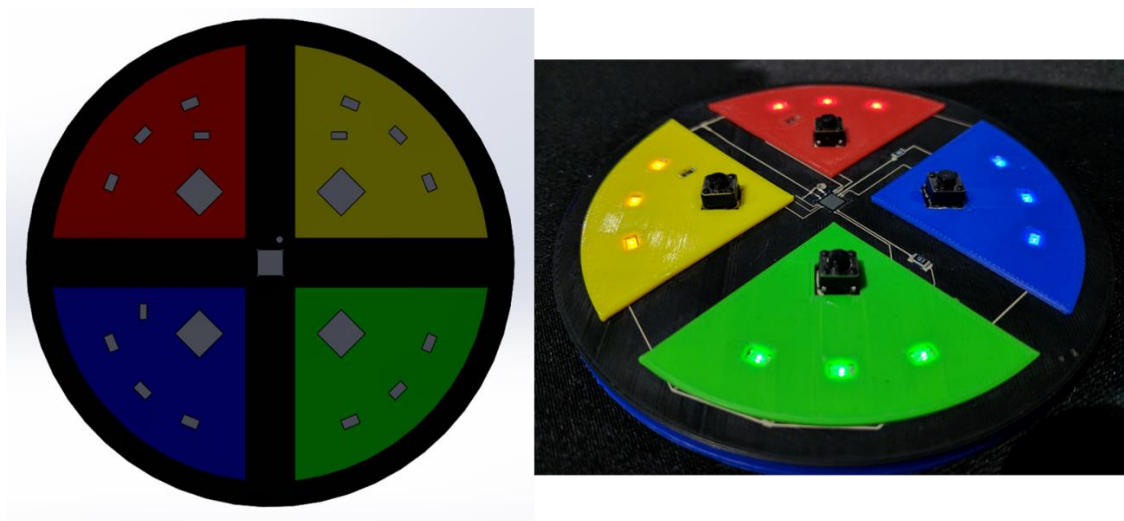


Figure 1: Finished Simon Says (Design and Actual)

nScript’s Ken Church said:

“Direct Digital Manufacturing is going from a CAD file to a final, multi-material electronic product, like the Simon Says, in a single machine, without retooling. People love to play with the Simon Says, which we bring to our trade show booths, and they are amazed that it was made in a single build.”

To DDM the device, the team used an nScript 3Dn series “Factory in a Tool” (FiT), which simultaneously runs multiple tool heads with multiple materials for Material Extrusion, precision Micro-Dispensing, precision micro-milling, pick-and-place, thermal processing, and vision feedback in a single machine.

The team first extruded the game's main structure with ABS, then milled the surface to accept the main circuitry and dispensed 100-200 μ m conductive traces (20 μ m tall) using NovaCentrix Metalon HPS-FG57B, dispensed conductive pads for battery terminals, and then extruded four colors of PLA, leaving open cavities for LEDs and a button, resistor, and microcontroller, which the machine inserted by pick and place. To provide an electrical connection to the components, fresh material was dispensed on all of the pads where they attach.

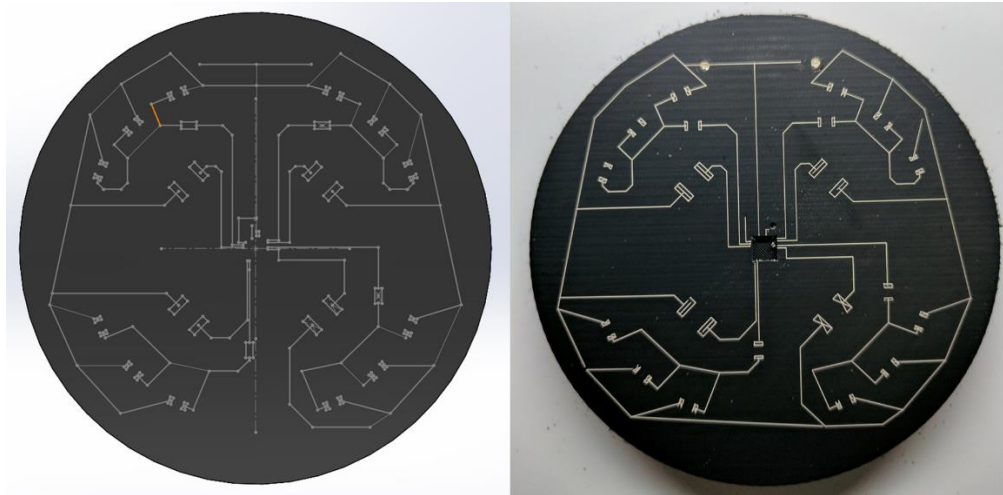


Figure 2: Main Circuit (Design and Actual)

The team's results are reported in a paper entitled "[Direct Digital Manufacturing For 3D Electronic Packaging](#)," authored by James Zunino (ARDEC), Jaret Riddick (ARL), Ken Church, CEO of nScript, Inc., and nScript engineers Sam Leblanc, Casey Perkowski, and Dasan Costandi.

Their paper distinguishes between 3D electronics packaging, which stacks semiconductor chips in an essentially 2.5D approach, and true 3D "Printed Circuit Structures," like the Simon Says game, which they manufactured using 3D printing, printed electronics, pick-and-place, and traditional manufacturing processes, all in one machine. The authors said:

The next generation of 3D packaging is borrowing from 3D printing and printed electronics, [a]dding additional and proven processes such as drilling, milling, polishing, pick and place, and coupling these processes with post-processing steps such as photonic curing, laser sintering, heating, and finally adding to this post inspection using vision enhances the electrical performance of Printed Circuit Structures. This next generation of processes on a single tool is Direct Digital Manufacturing (DDM), and it will add optimized electrical function in true three dimensions and any shape.

The authors describe the advantages of true 3D PCS:

Antennas can be printed on or within a structure, RF shielding can be printed in strategic locations of the electronic package, sensors can be printed and permeate throughout the structure, and all of these can be done using much less space and volume. Devices can be printed within devices or 3D shapes by changing materials, which eliminates the need for solder, nuts, bolts, and excess bulk wires.

The team envisions electronics “permeating throughout structures, providing sensing, controls, and smart features,” and devices that “feel, smell, see, hear, communicate, and actuate.”



About nScript

Founded in 2002 and headquartered in Orlando, Florida, nScript designs and manufactures award-winning, next-generation, high-precision Micro-Dispensing and Direct Digital Manufacturing equipment and solutions for industrial applications, with unmatched accuracy and flexibility. Serving the printed electronics, electronics packaging, solar cell metallization, communications, printed antenna, life science, chemical/pharmaceutical, defense, space, and 3D printing industries, our equipment and solutions are widely used by the military, academic and research institutes, government agencies and national labs, and private companies. nScript is a 2002 spin out from Sciperio Inc., a research and development think tank specializing in cross-disciplinary solutions. The nScript BAT Series Bioprinter, which won the R&D 100 award in 2003, will travel to the International Space Station in 2019, in a joint program with Techshot. nScript Cyberfacturing Center is our direct digital contract design and manufacturing service.