Rapid Fluidics
Shaping the Future of Microfluidics

nureo

CASE STUDY: REVOLUTIONIZING PNEUMATICS VIA AUTOMATED DESIGN AND ADDITIVE MANUFACTURING

Executive Summary

Rapid Fluidics, a UK-based microfluidic design and manufacturing services company focused on rapid production capabilities, recently partnered with nureo, a Swiss-based software company providing automated and generative 3D CAD design software for engineering applications.

Rapid Fluidics and nureo collaborated to value-engineer a pneumatic subsystem in a commercially available life sciences instrument that presented a significant manufacturing bottleneck for an innovative life sciences company.

This biotechnology company develops lab automation tools for genomic workflows in the life sciences. The key challenge was to design a highly complex fluid manifold that replaces a complex cluster of 30+ individual tubes.

The collaboration between Rapid Fluidics and nureo enabled the redesign of the tubing into a highly integrated compact part, which was successfully produced via additive manufacturing, assembled into the original system, and tested for its performance. The new manifold significantly reduces the number of components and overall assembly effort.

info@rapidfluidics.com

hello@nureo.ch

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The Challenge: A Tangled Assembly of Complex Tubing

Recently, a client that develops systems for automated sample preparation approached Rapid Fluidics with a manufacturing challenge. While their core system was production-ready, its pneumatic control module posed a significant manufacturing bottleneck. The traditional pneumatic layout required manual routing, cutting, and connection of 30+ individual tubes into the life science system.

This setup introduced significant challenges:

- **Production Inefficiency**: Technicians required approximately one hour to measure, cut, and manually assemble the tubing array for each instrument.
- **High Assembly Risk**: The dense cluster of nearly identical lines increased the likelihood of human assembly errors, such as plugging a tube into the wrong port.
- **Reliability Concerns**: Every tube connection point and fitting represented a potential failure mechanism or leak path over the life cycle of the diagnostic machine.

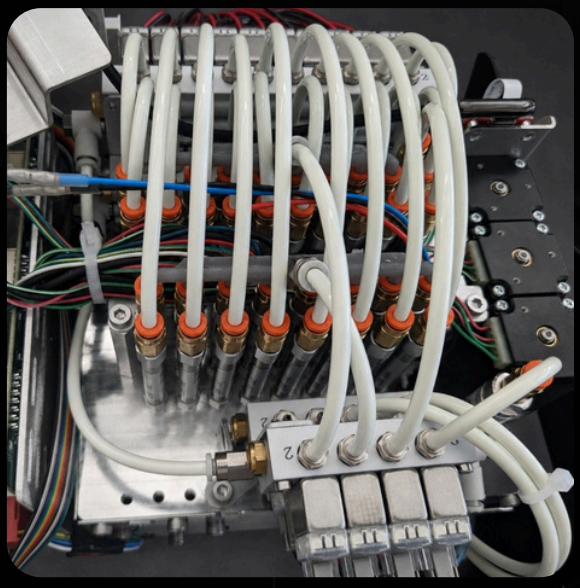

Fig. 1: Original pneumatic assembly with traditional tubing

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The Solution: Generative Design Meets Expert Additive Manufacturing

To overcome these limitations, a collaborative engineering project was launched between nureo and Rapid Fluidics, combining generative and automated 3D design with advanced manufacturing capabilities. The objective was to consolidate a high-maintenance tubing assembly into a single, integrated component.

Automated Re-Design of Fluid Manifold

Rather than tediously modeling all the flow channels manually, the team leveraged **nureo's generative 3D design software**. The software automatically generated the 3D design of the fluid manifold based on the following steps:

- The inlets and outlets were defined for the pneumatic valves and ports.
- The software automatically generated the 3D routing of the flow channels while considering different design goals and constraints (e.g., minimal channel length, smooth flow paths, collision avoidance between channels).
- The software then created the support structures required for additive manufacturing, generating the final 3D part geometry ready for production

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High-Precision Digital Additive Manufacturing
The resulting geometry was converted into a functional component using **Rapid Fluidics' manufacturing capabilities**.

- Rapid Fluidics utilized experience in additive manufacturing for material selection and the optimization of process parameters.
- The team deployed high-resolution 3D printing technology to manufacture the complex, interlocking internal pathways directly inside a compact structure.
- The new design consolidated the entire array of fittings and separate tubes into a single fluid manifold where valves click directly into position.

Fig. 2: New fluid manifold redesigned for additive manufacturing

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The Results and Benefits: Assembled in seconds. Monolithic reliability.

The new additively manufactured fluid manifold provided several benefits for the client:

- **Massive Time Reduction:** Assembly time dropped from approximately one hour to just a few seconds via a single "click-in" mechanism.
- **Foolproof Manufacturing**: Because the new fluid manifold is printed as a monolithic part, it acts as a mechanical puzzle piece that can only be installed in one orientation, reducing potential human assembly errors.
- **Improved Quality**: Each manifold is manufactured with the same defined geometry, eliminating the unit-to-unit variability caused by manually routing individual tubes. This ensures consistent system configuration across every instrument

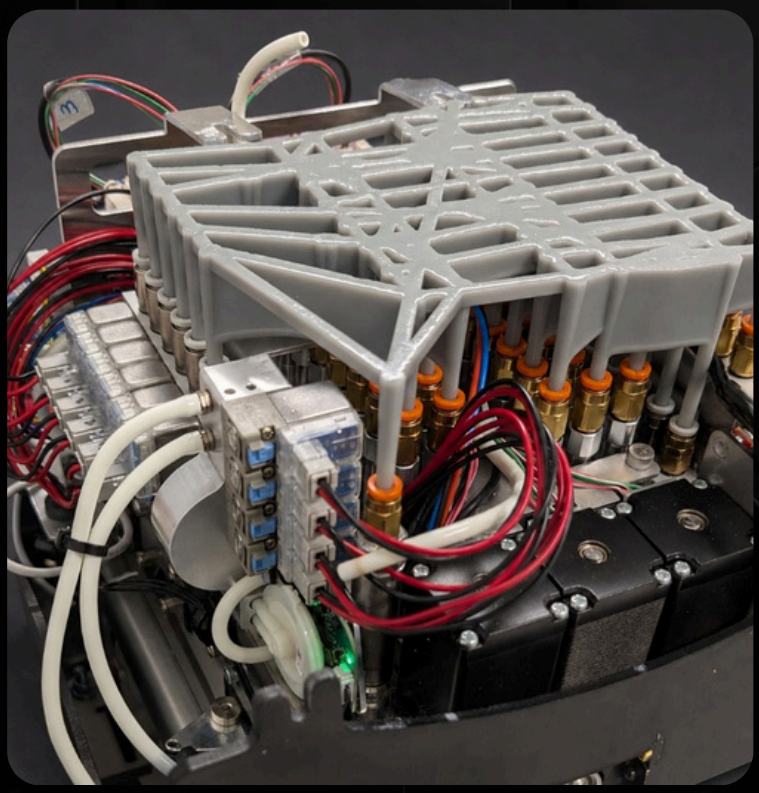

Fig. 3: Assembly with additively manufactured manifold

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Next Steps: Complete Monolithic Integration

The project successfully demonstrated the feasibility of replacing complex pneumatic tubing with highly integrated, additively manufactured manifolds.

The next phase of development aims to integrate further components of the pneumatic system (e.g., manifolds and valve interfaces) into a single, highly integrated, and monolithic manifold.

The next-generation manifold will further reduce system size, eliminate additional external interfaces, and lower manufacturing costs. This integration will bypass additional external connections, further reduce the physical size of the diagnostic system, and drop total component cost to achieve direct line-item cost parity with the current manufacturing approach.

"We considered machining and diffusion bonding, but it was no contest. Where weight and ability to iterate are concerns, additive manufacturing is the way to go. Rapid Fluidics and nureo were able to quickly design a strong proof of concept. We're excited to see where the collaboration goes next."
— Co-founder & CEO, Client Company

Rapid Fluidics Ltd.
info@rapidfluidics.com
www.rapidfluidics.com

nureo AG
hello@nureo.ch
www.nureo.ch