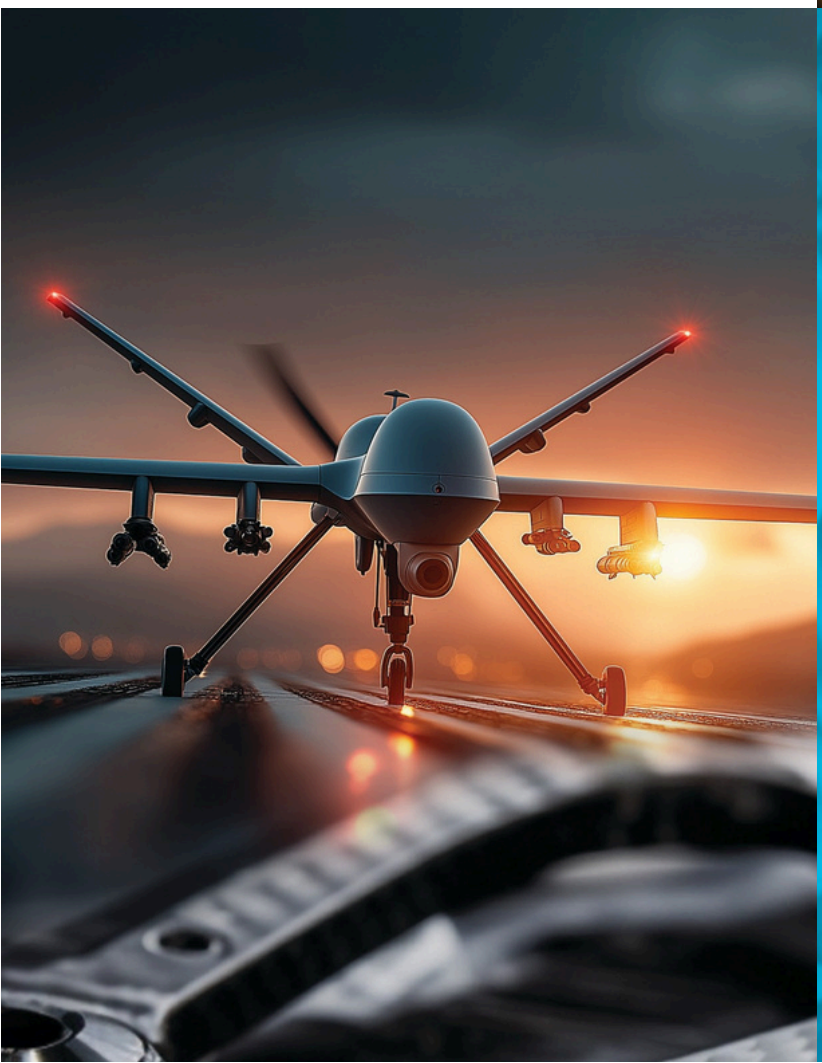
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SOLUTION GUIDE
DRONE & UAV



When Drone Production Stops Scaling

Why more printers aren't solving the problem and what to do next



When Drone Production Stops Scaling

A practical guide to identifying where your process is breaking down and how to correct it

This guide is based on observed production environments where additive manufacturing has successfully moved from prototyping into scaled production.



Output is maintained.
Effort increases.

At a certain stage, many UAV teams operate 10 or more desktop systems while overall output remains largely unchanged.

The system continues to deliver.
Airframes are produced, parts are completed, and deadlines are met.

What changes is the effort required to achieve it.

Printer count increases. Additional operators are introduced.
More process steps are added. Assembly and rework become part of the workflow.

Output is maintained. Efficiency is not.





Production is the constraint

Production is no longer defined by the ability to print parts. It is defined by how those parts are manufactured consistently, repeatably, and at scale. At this stage, performance alone is not the differentiator.

Speed, cost, and manufacturability become primary constraints.

Timing Matters

In many UAV programmes, early focus is placed on electronics, software, and payload capability.

Manufacturing decisions are often made later.

This creates a window where production approaches are selected quickly, often based on what is already in place rather than what will scale.

Where production starts to break down

As systems scale, three patterns consistently emerge:

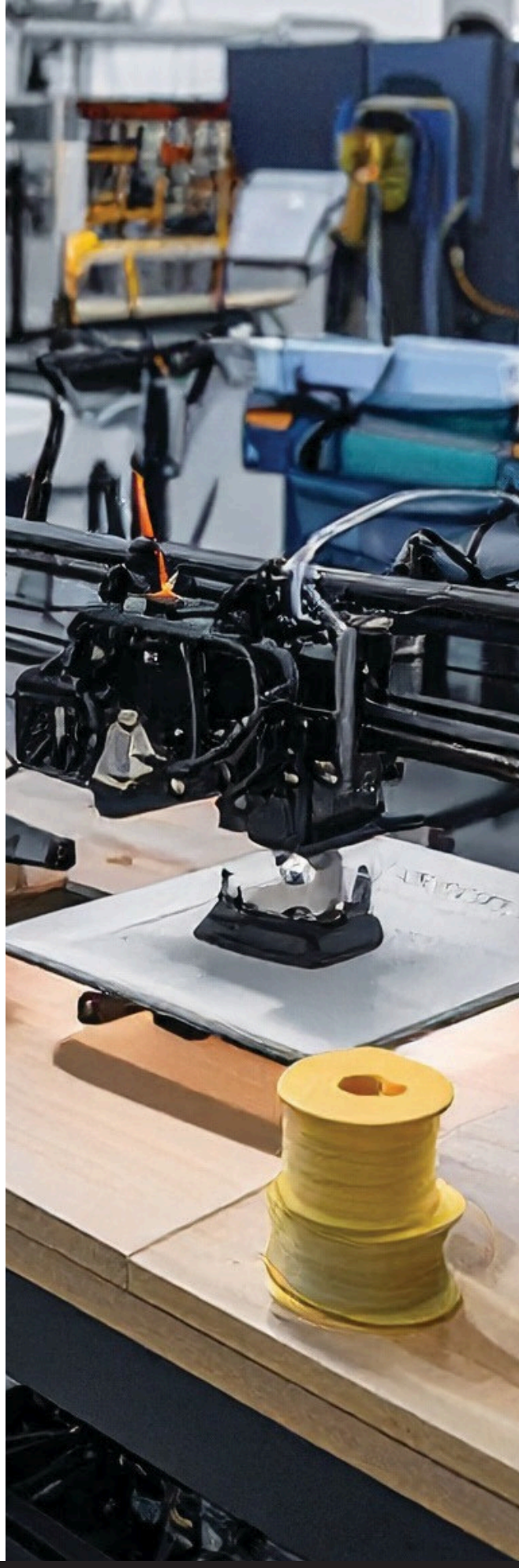
- **Work is distributed across multiple machines**
- **Assembly becomes standard, not exception**
- **Variability increases between builds**

Individually manageable. Collectively inefficient.

Print farms are not production systems

Scaling desktop systems often leads to the creation of print farms. These increase capacity, but do not simplify production.

They introduce coordination overhead, variability, and labour dependency.



UAV structure production

A UAV manufacturer produced a full aircraft structure using a distributed desktop setup.
In some cases, a single structure required 12 to 16 desktop systems operating in parallel.
The process worked. It delivered output.

It also required continuous monitoring, coordination, and post-processing.
The same structure was evaluated using an industrial system.
It was produced in a single, consolidated build.

No segmentation. No bonding. No alignment steps.

Measure	Desktop / FFF setup	Industrial FDM setup	Why It Matters
Build count	6 builds	1 build	Less scheduling, handling, queue management
Total build time	~136 hrs	~66 hrs	Around 50% less build time
Structure approach	Multiple components	Single consolidated structure	Less bonding, alignment, assembly and rework
Operating model	Distributed across machines	Controlled in one system	Fewer variables to manage
Key takeaway	Output possible	Output scalable	Same aircraft, different production model

- **6 builds to 1 build**
- **136 hours to 66 hours, around a 51 percent reduction**
- **Multiple components to a single structure**



Throughput and scale are not equivalent

Desktop systems can deliver throughput at small scale.
At production scale, the issue is how that throughput is achieved.

In benchmark testing, industrial FDM systems deposited up to five times the material volume in roughly two thirds of the time.

This reflects system design. Continuous operation, controlled conditions, and consistent material behaviour.



Material consistency and process control

Desktop workflows typically rely on a mix of materials such as PLA, PETG and lightweight variants, often across multiple machines. This works in development.

At production scale, it introduces variability. Industrial FDM systems operate within controlled environments using validated toolpaths and consistent material profiles.

Requirements such as EMI shielding, ESD protection, thermal resistance, and repeatable mechanical performance become increasingly difficult to manage in uncontrolled desktop environments.

This also enables the use of engineering-grade materials designed for production environments, including ESD-safe, high-temperature, and structurally stable thermoplastics.

> Production challenges are often environmental and operational before they are mechanical.

In UAV applications, this becomes increasingly important as systems move from development into operational and environmental requirements. This enables predictable mechanical performance and repeatable output.

What desktop environments struggle to control

As additive manufacturing moves from prototyping into production, environmental and material control become increasingly important.

Production systems are designed to support:

- **Moisture control**
- **Repeatable material behaviour**
- **ESD-safe and shielding- capable materials**
- **Engineering-grade consistency**
- **Qualification-ready workflows**
- **Thermal stability**
- **Controlled build environments**

These factors become increasingly difficult to manage across distributed desktop print farms operating in uncontrolled conditions.



Cost is not the same
as cost per part

Material cost is often the first comparison made between desktop and industrial systems.
In some cases, desktop builds may cost tens of dollars, while industrial builds may appear to cost several hundred.

This comparison excludes:

- **Assembly time**
- **Labour cost**
- **Rework and failed builds**
- **Throughput limitations**
- **Environmental variability**

At production scale, cost is determined by total process efficiency, not material cost alone.



Assembly is
the hidden constraint

At small scale, assembly is manageable.

At production scale, it becomes a limiting factor.

Bonding, alignment and finishing introduce labour dependency and variability.

In some cases, each bonded section requires manual handling and alignment.

Multiplied across assemblies, this becomes a significant constraint on throughput.

> Part consolidation does not just reduce parts. It removes labour.



Production includes more than printing

At scale, production includes:

- **Part consolidation and design optimisation**
- **Assembly and finishing**
- **Process validation**
- **Repeatable workflows**

Printing is one part of the system.

What part consolidation actually changes

- **Fewer builds**
- **Reduced BOM complexity**
- **Elimination of non-printed structural components**
- **Reduced touch labour**
- **Reduced assembly and bonding**
- **Fewer alignment and fit issues**
- **Lightweighting opportunities**
- **Faster production throughput**
- **More repeatable structures**



Production systems, not printer fleets

The objective is not to improve printing.

It is to establish a production system.

One that reduces variability, removes unnecessary steps and scales without increasing operational complexity.

Qualification and compliance

For UAV and defence applications, qualification is often assumed to be a constraint.

In practice, production-grade additive systems are already deployed within NDAA-aligned manufacturing environments.

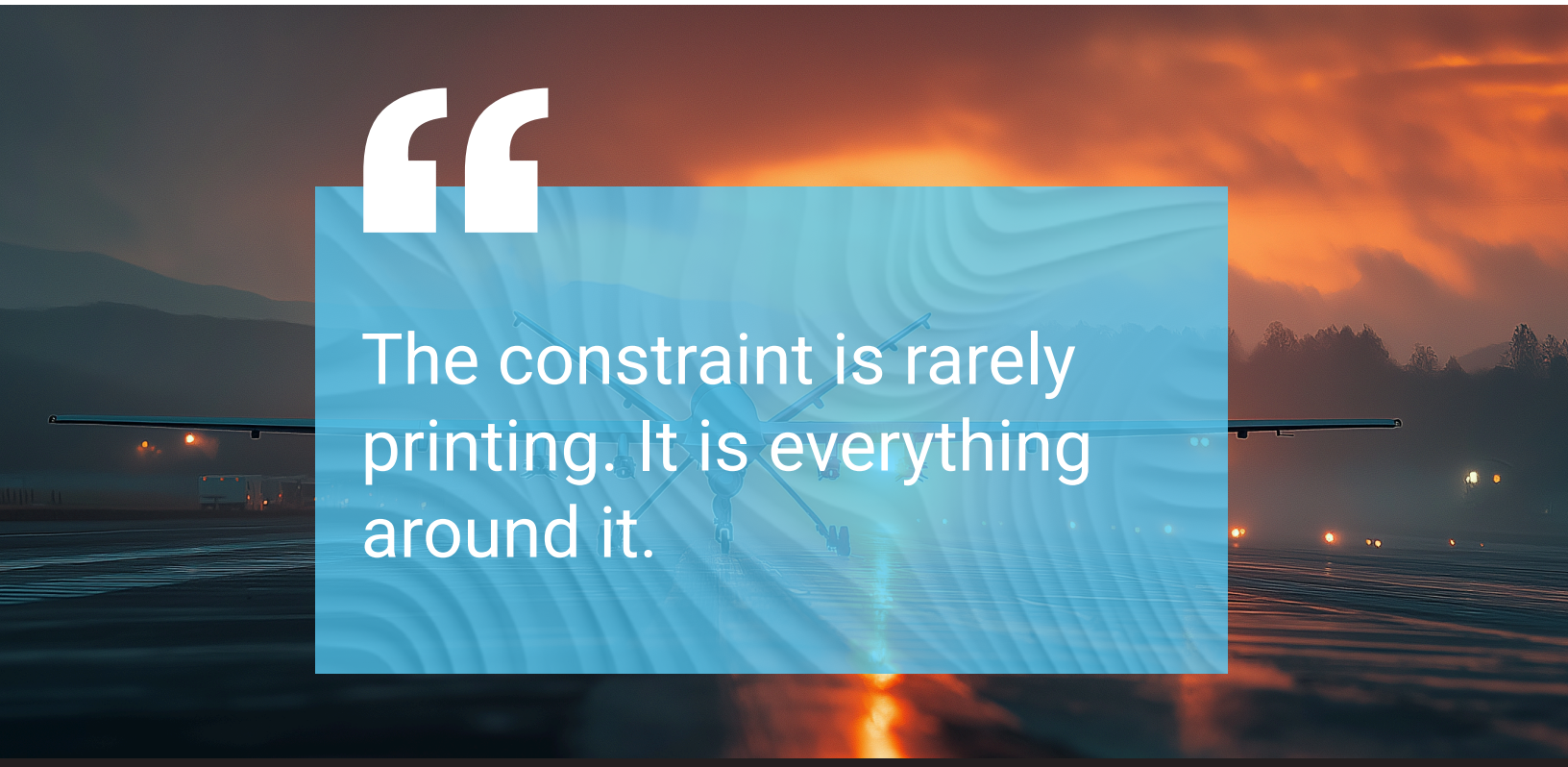
Material traceability, process control and repeatability are built into the system. Qualification is not the limiting factor.

How to correct it

When production becomes effort dependent rather than process driven, the objective is not to add capacity.

It is to simplify how parts are produced.

1	2	3	4	5
Start with one part or structure	**Evaluate consolidation**	**Measure total production effort**	**Validate performance and repeatability**	**Scale from a single validated use case**
Identify a component that is: • Produced across multiple builds • Requires assembly or bonding Subject to rework or inconsistency	Can it be produced: • In a single build • Using a consistent material • Within a controlled environment	Look beyond print time: • Number of machines • Handling and assembly • Rework and iteration • Operator involvement	Look beyond print time: • Number of machines • Handling and assembly • Rework and iteration • Operator involvement	Once proven, apply the same approach across similar parts and workflows.



> The constraint is rarely printing. It is everything around it.

You are ready to transition if:

- You are running 8 or more printers
- Assembly is standard, not exception
- Rework is expected, not occasional
- Output does not increase when you add machines
- More effort is required to maintain the same throughput

This is a transition, not a replacement

Desktop systems remain appropriate for:

- Concept development
- Early-stage validation
- Early-stage validation

Make it practical

The most effective way to assess this is through direct evaluation.
Qualification is not the limiting factor.

Next Step

If you have a part that currently requires multiple builds or assembly, it can be evaluated to show what it would look like as a single consolidated structure.

This will demonstrate:

- **What changes in process**
- **What changes in performance and consistency**
- **What production looks like at scale**

Printing is one part of the system.



Conclusion

Desktop additive manufacturing enables rapid development.
Its limitations emerge at production scale, not because of capability, but because of operating model.



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