

LAI Joint Workshop

“Value Creation Through Integration”

**Lean
Aerospace
Initiative**



**Opportunities for
Lean Thinking in
Aircraft Flight
Testing & Evaluation**

January 31, 2002

Researcher: Carmen Carreras

Advisor: Prof. Earll M. Murman



- **Objective**
- **Key Questions**
- **Research Methodology**
- **5 Principles of Lean Thinking**
- **Next Steps**



**Determine whether Lean principles
can be applied to aircraft flight
testing and evaluation**



- **Where are the opportunities for the application of Lean principles to flight testing?**
- **What are the sources of preventable non-value added activities?**
- **What impact do these activities have on the program?**
- **What are the key enablers and barriers to a testing program with minimal delays?**



Research Methodology



Flutter

Loads

**Carrier
Suitability**

Performance

Aircraft Testing

**Weapons
Separation**

**Handling
Qualities**

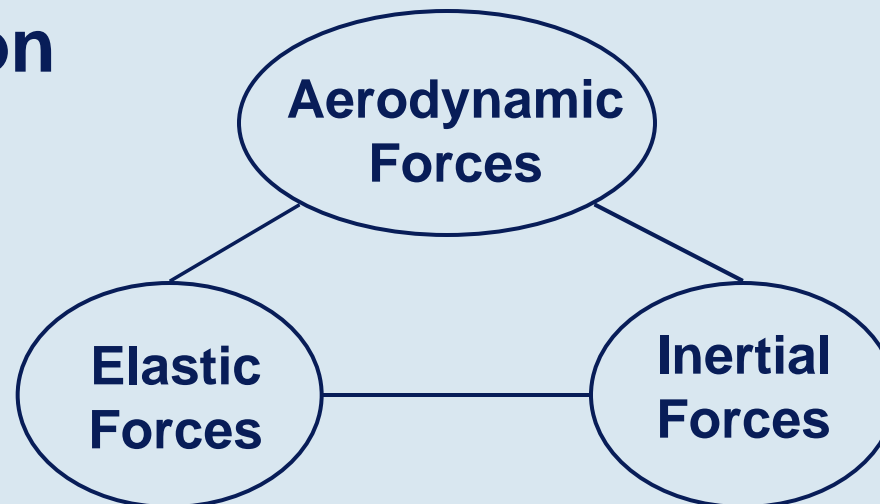
Signature

**Avionics &
Systems**

**Noise &
Vibration**

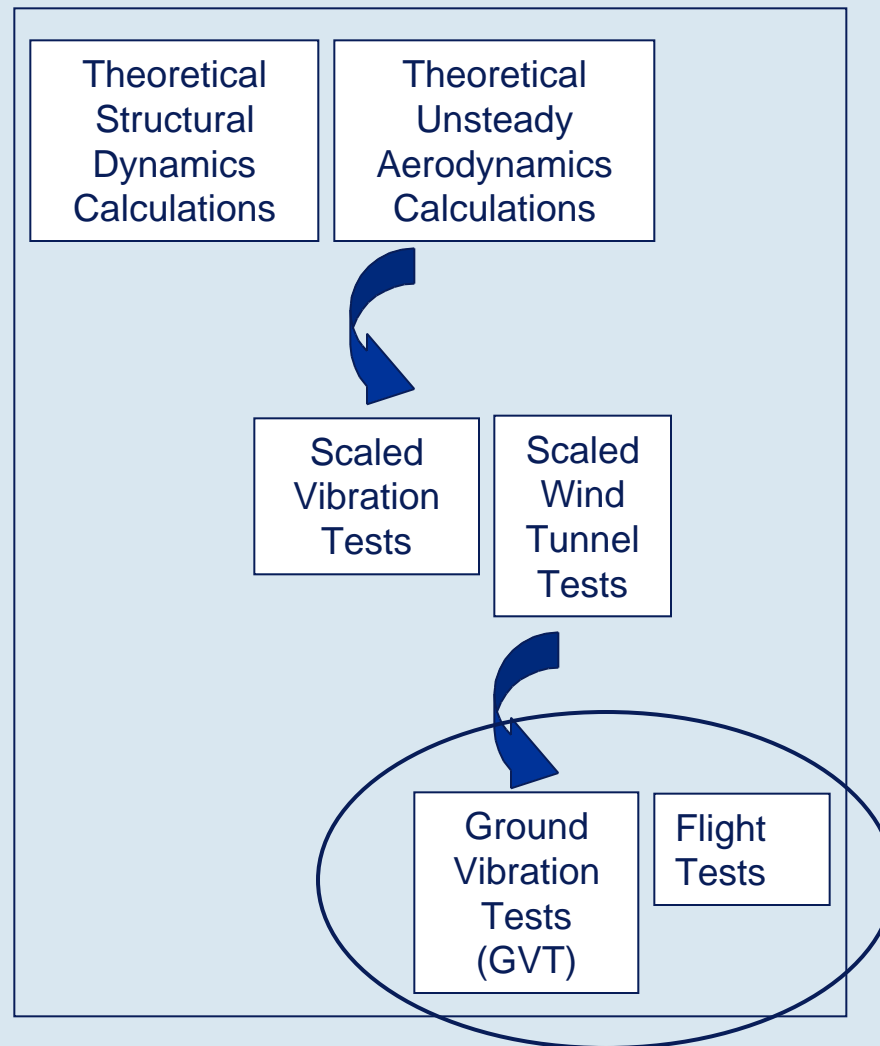


- **Flutter: A potentially destructive self-excited oscillation**



- **Prevention: Eliminate by design**
- **Test technique: Vibrate the aircraft and measure damping**

Flutter Testing Value Stream





C130J



737-NG



Horizon



F22



F/A-18E/F



T-6A





- **How does Lean thinking apply to the overall flight testing process?**
- **Data collected through interviews**
 - **What allowed the testing program to progress smoothly?**
 - **What were the major barriers/ sources of delays?**
 - **Where are the opportunities for process improvement in flight testing?**






Data used to map general value stream and identify opportunities

- **How does Lean thinking apply to the daily flight testing process?**
- **Data collected:**
 - **Daily flight logs/ test cards (~2 wks worth)**
 - **Daily FTE/ Ops summarizes of each flight**
- **Analyze daily flight logs and notes to identify sources and impact of delays during testing**

Data used to map detailed value stream and perform numerical analysis



Principles of Lean Thinking

-  Specify *value* by specific product
-  Identify the *value stream* for each product
-  Make value *flow* without interruptions
-  Let the customer *pull* value from the producer
-  Pursue *perfection*

Starting point for framework, adapted based upon the LAI book



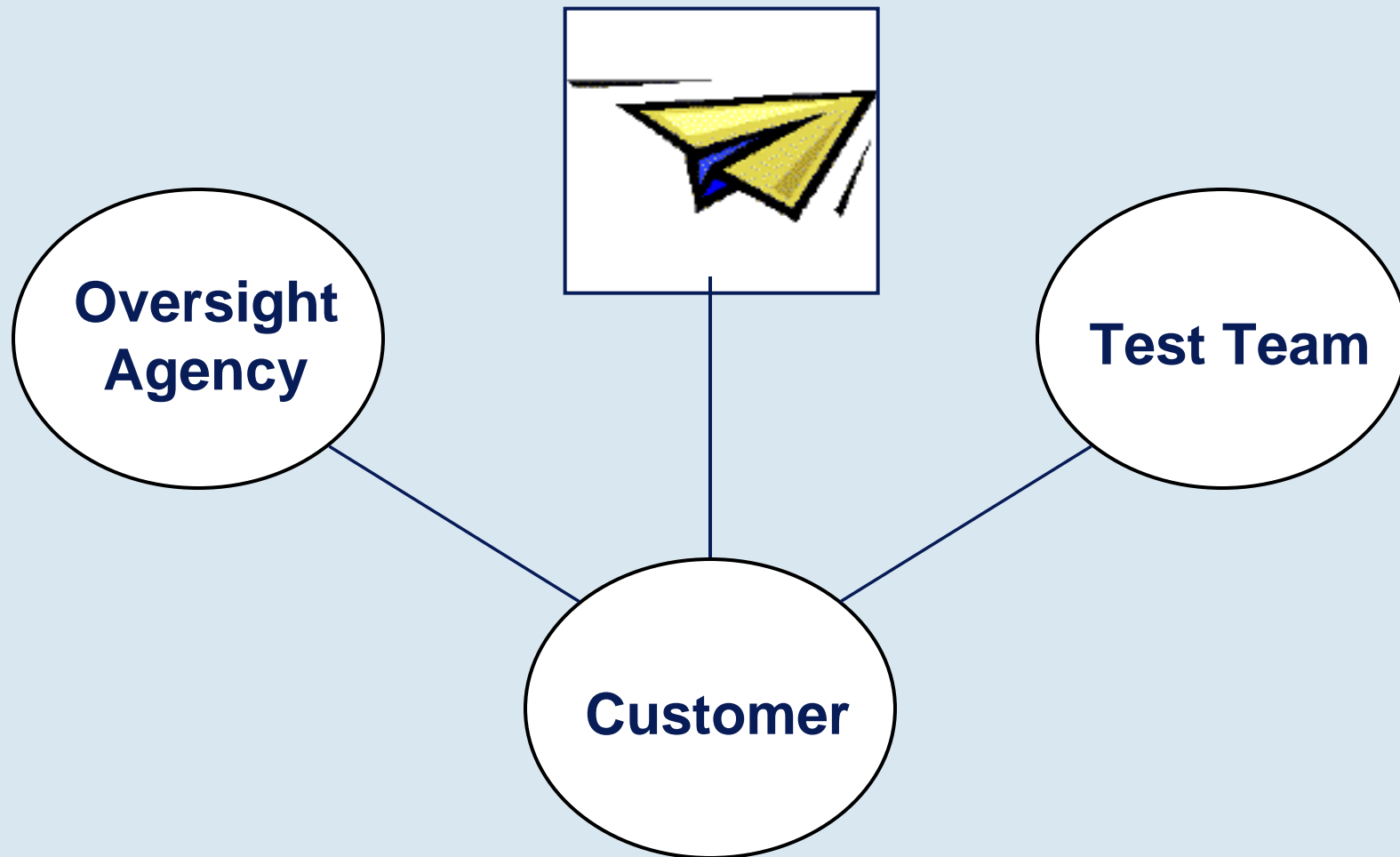
#1 Specify *value as* defined by the customer



**Delivery of the aircraft on *schedule*, with
full *confidence*, and within *budget*.**



Other Key Stakeholders



Conducting a test program with the minimal amount of risk to ensure full confidence in the aircraft

**Undertaking rewarding work, in a
stable environment with an aura of
respect**



#2 Identify the *value stream* ...

- Value-adding activities
- Type 1 waste: Non-value adding, but necessary activities
- Type 2 waste: Non-value adding, and unnecessary activities

... and eliminate Type 2 waste

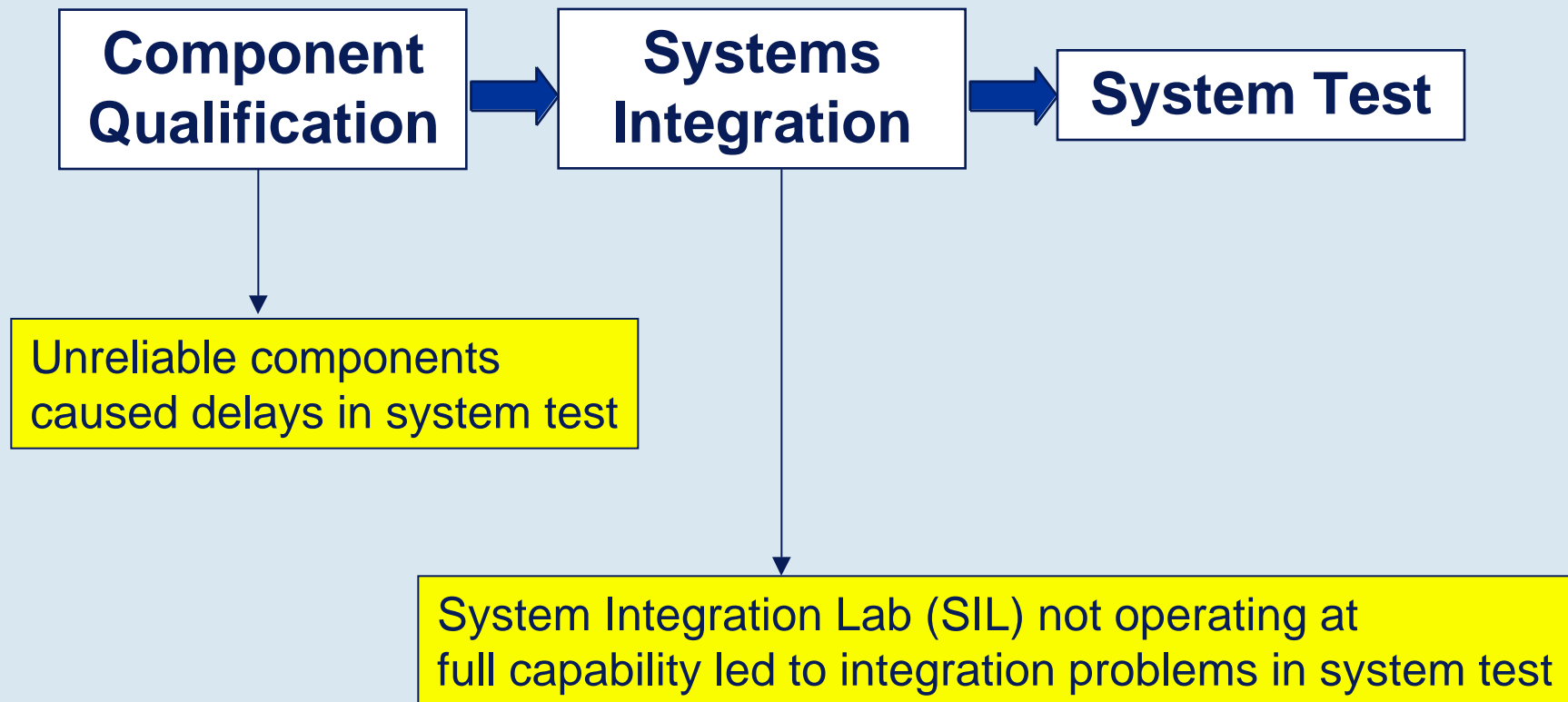


#3 Make value *flow* without interruptions

•*Testing Value Stream Definition*

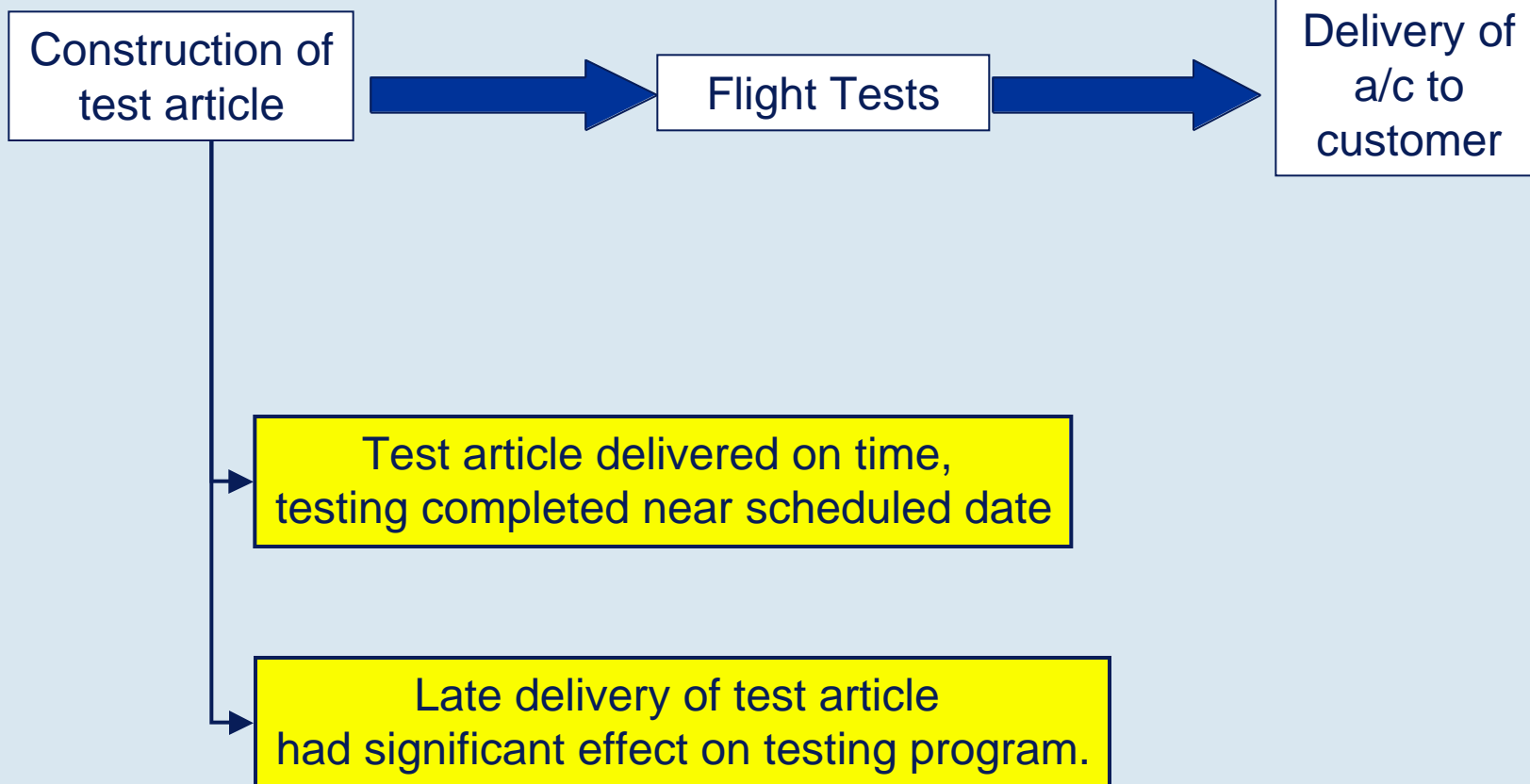
The test and evaluation “value stream” is the end-to-end set of all tests, modeling and simulations, and related processes and interactions, which are executed to reduce the risk of not achieving the end goal of delivering an aircraft to the customer which meets the end user’s expectations.

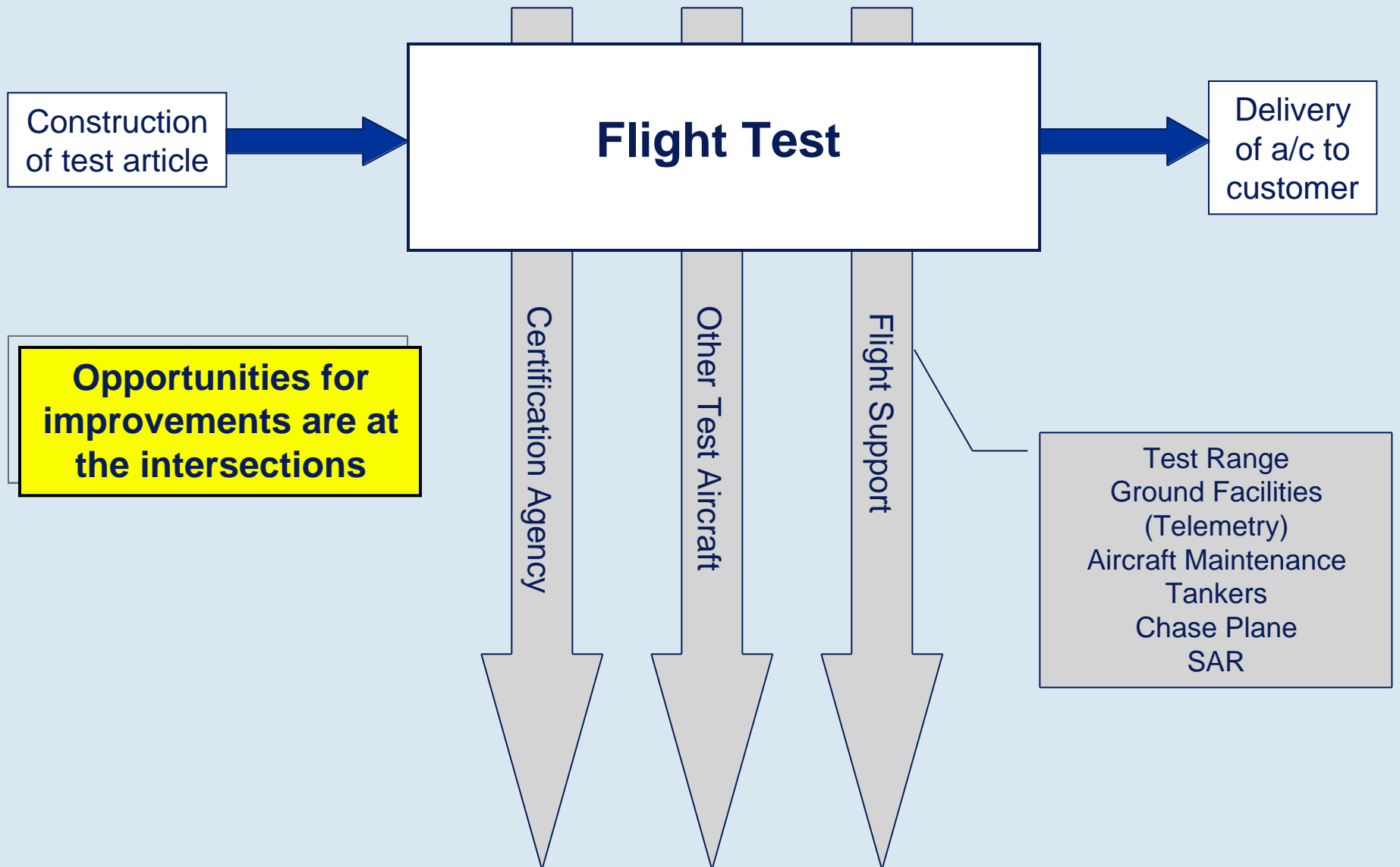
•*Generic Testing Value Stream*





•Flight Testing Value Stream







➤ **Certification Agency**

- **Obtaining signatures on paperwork in timely manner**
- **Waiting on availability of agency personnel for required briefings**

➤ **Other Test Aircraft**

- **Maintenance not having a/c ready in time because working on other a/c in the program**
- **Unable to perform ground test, because instrumentation being used by another a/c**



➤ **Flight Support**

➤ **Ground Facilities (Telemetry)**

- TM goes down for an hour, may miss flight window

➤ **Tankers**

- Unavailable tankers limit test efficiency
- Limited ceiling of tankers disrupts testing. Need to drop from test altitude to tanker altitude.

➤ **Chase Plane**

- Lose test time waiting for the chase to refuel
- Lose test days when chase needs unscheduled maintenance

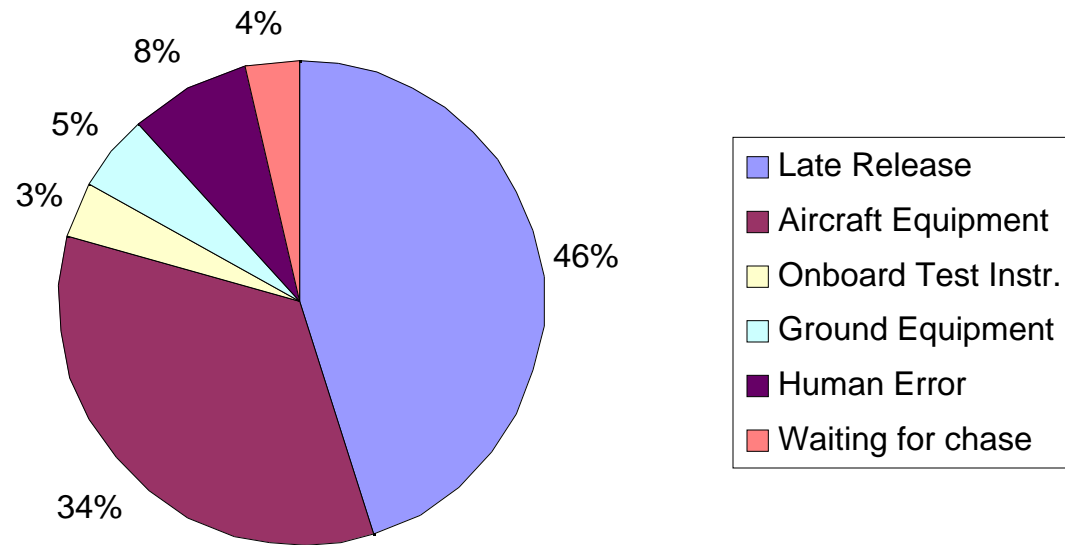
Typical Flight Testing Day



Opportunities for improvements are at the interfaces



Non-weather sources of delays



Biggest problem is late releases



#4 Let the customer *pull* value from the producer

**Research shows, principle #4 is not
applicable to flight testing**



#5 Pursue *perfection*

There is always room for improvement



- **Finish remaining 3 case studies**
- **Continue codifying enabling practices**
- **Continue data analysis**
- **Write Thesis**