





# **What we know about Human Factors that applies to Certifying and Operating UASs in the NAS**

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# Overview

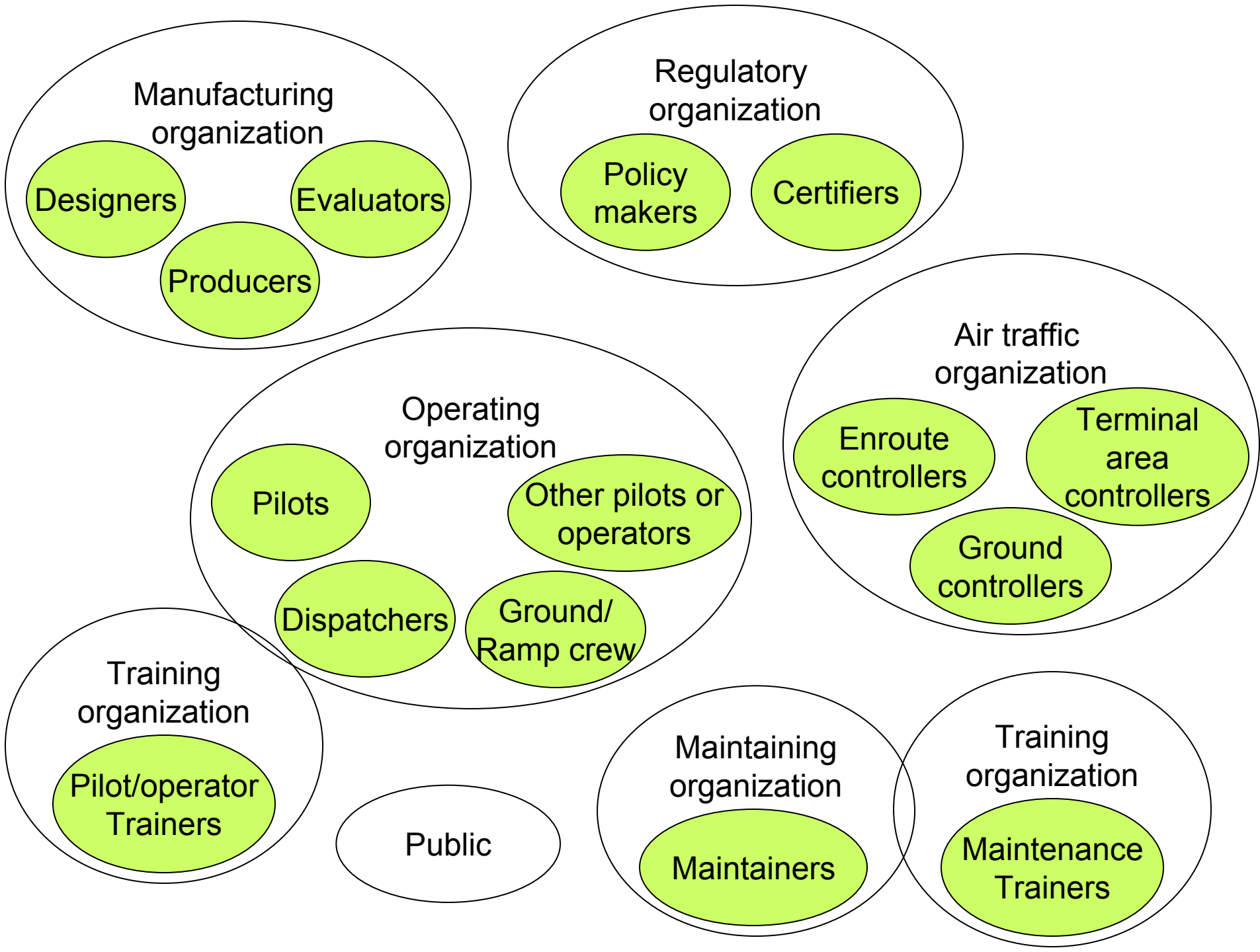
- What do we want to know?
- What do (don't) we know?



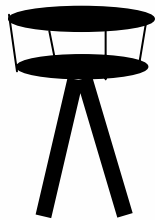
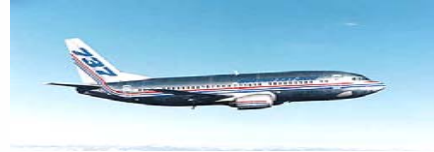
# What do we want to know?

- Minimum standards
- Equivalent level of safety





# Current system

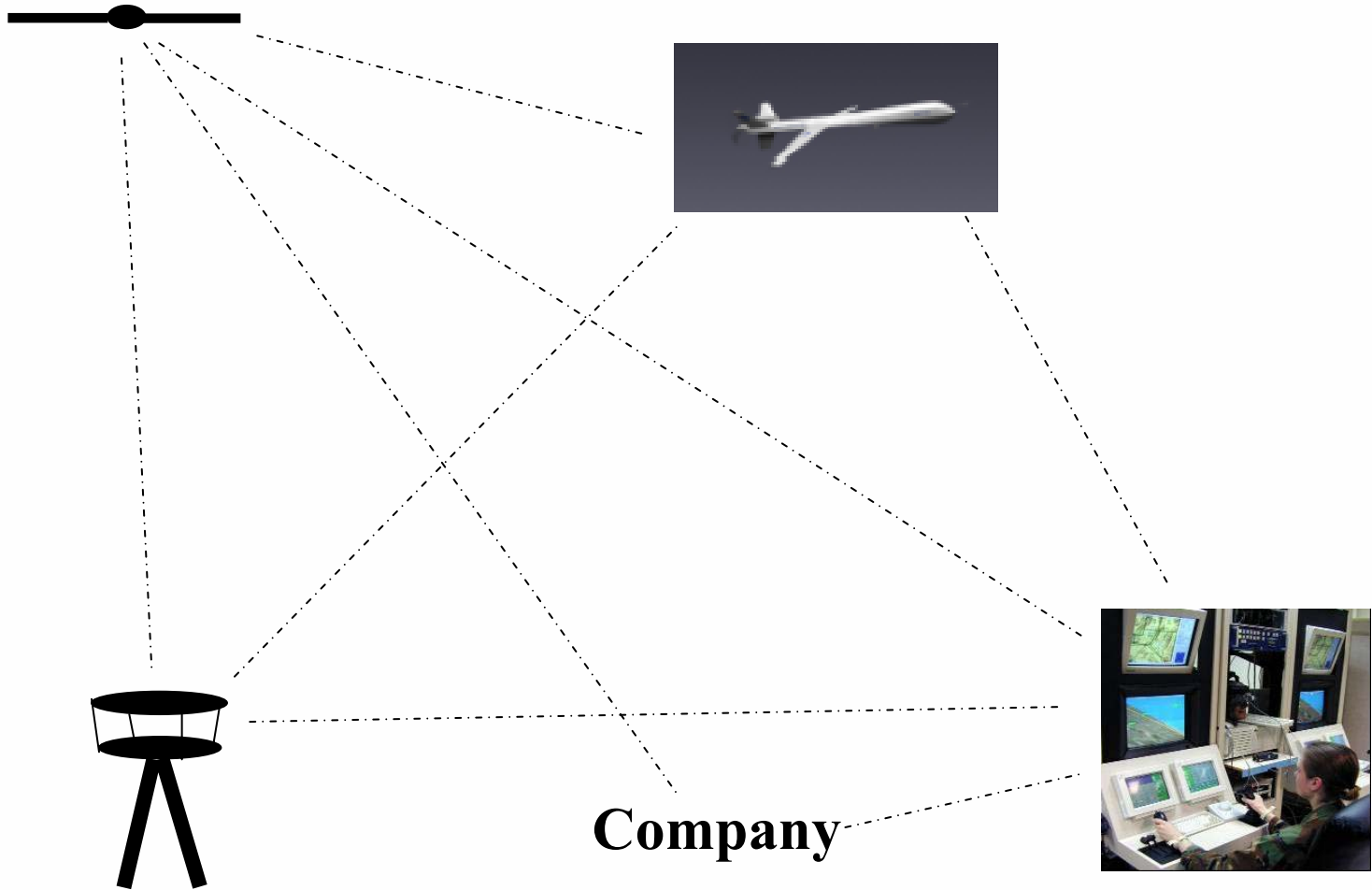


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# System including UAS



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# Some Differences

- Separation of pilot and airplane
- Intent of operations
- Size of vehicles can be much smaller
- Speed of operations can be much slower





# Certified elements

- Airplane
- Control station (with the airplane in manned aircraft)
- Modifications to airplane
- Modifications to control station
- Operations programs and procedures
- Pilot training
- Maintenance technician training/certification
- Maintenance program

# Aircraft Regulations



## CFR 14 Parts

- 21 General aircraft certification
- 23 Small airplanes
- 25 Transport airplanes
- 27 Small rotorcraft
- 29 Transport rotorcraft
- 33 Engines
- 35 Propellers

# Operator Regulations



## CFR 14 Parts

- 61 Certification: pilots, flight instructors, and ground instructors
- 63 Certification: flight crewmembers other than pilots
- 65 Certification: airmen other than flight crewmembers
- 67 Medical standards and certification
- 91 General operating and flight rules
- 93 Special air traffic rules
- 103 Ultralight vehicles

# Operations



## CFR 14 Parts

- 36 Noise standards
- 39 Airworthiness directives
- 43 Maintenance
- 119 Certification: air carriers and commercial operators
- 121 Operating requirements: domestic, flag, and supplemental operations
- 135 Operating requirements: commuter and on demand operations and rules governing persons on board such aircraft
- 137 Agricultural aircraft operations

# Training Organization Regulations



## CFR 14 Parts

- 141 Pilot schools
- 142 Training centers
- 145 Repair stations
- 147 Aviation maintenance technician schools

# How do we know what we want to know?



- Intended function (what)
- User population attributes (who)
- Environmental factors and envelope (where)
- Operational factors and envelope (how)
  
- Impact of differences

Intended function (what)



Tasks

Human factors considerations

User population attributes (who)

Environmental factors and envelope (where)

Operational factors and envelope (how)



Assumptions

# What do (don't) we know?

- Assumptions
- Tasks
- Human factors considerations
- Potential design solutions
  
- Impact of differences





# Assumptions we know

- Environment is same as for operation of manned aircraft
  - Weather
  - Traffic control system
  - Structure of airspace system

# Assumptions we need to know



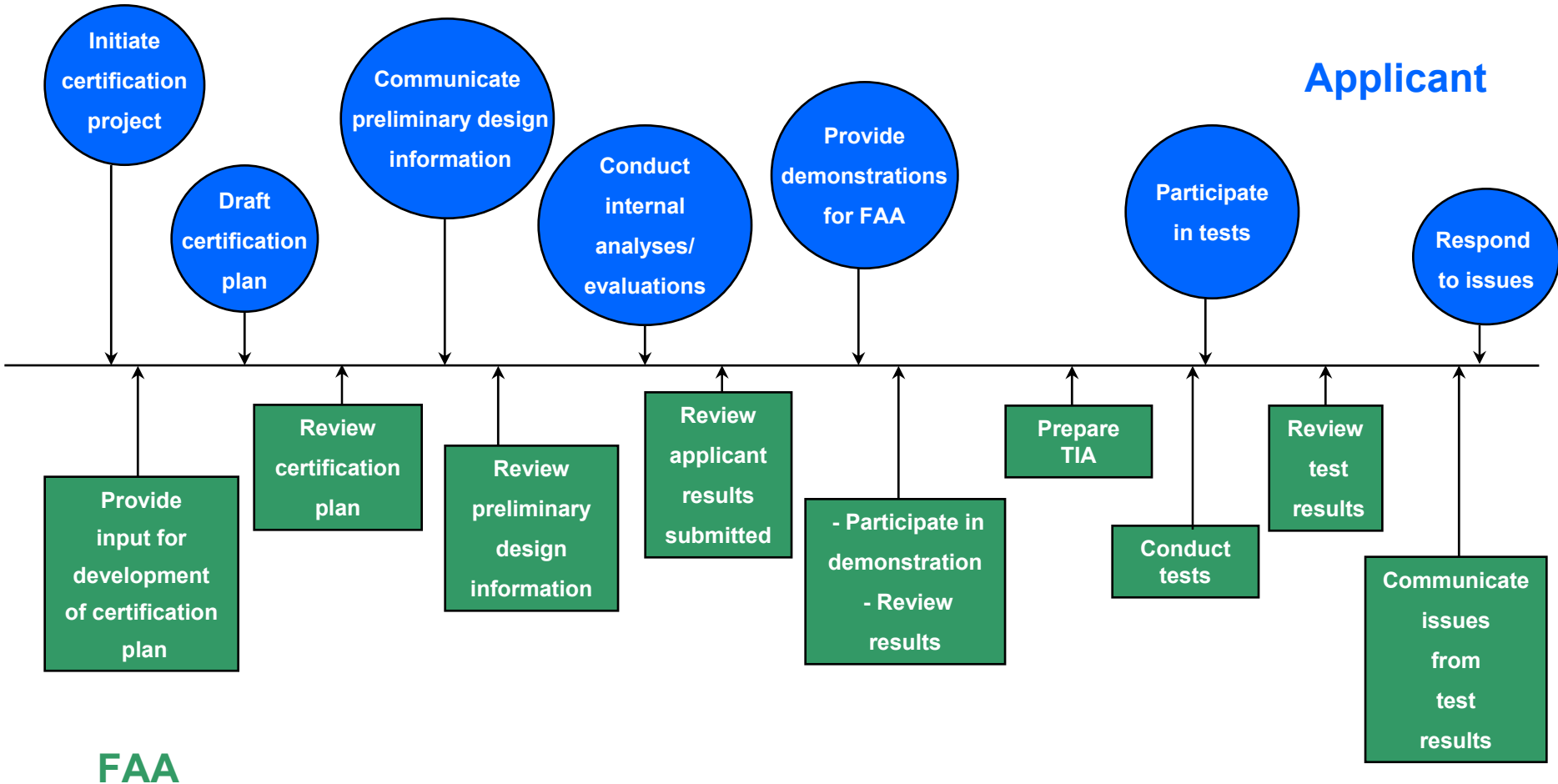
- Attributes of users
  - Minimum skill set
  - Minimum currency of training and experience
  - Low and high end physical attributes
  - Low and high end cognitive attributes
- Concept of operations
  - How will different parts of the system interact  
e.g. airplanes/control stations and ATC
  - Minimum requirements for performance in the system or parts of the system
  - Minimum performance requirements in the system  
e.g. places that are okay for takeoff and landing

# Processes we know

- Certification processes
- Current ROV operation processes
- Current NAS operation process
- Design processes
- Evaluation processes



# Airplane Certification Process



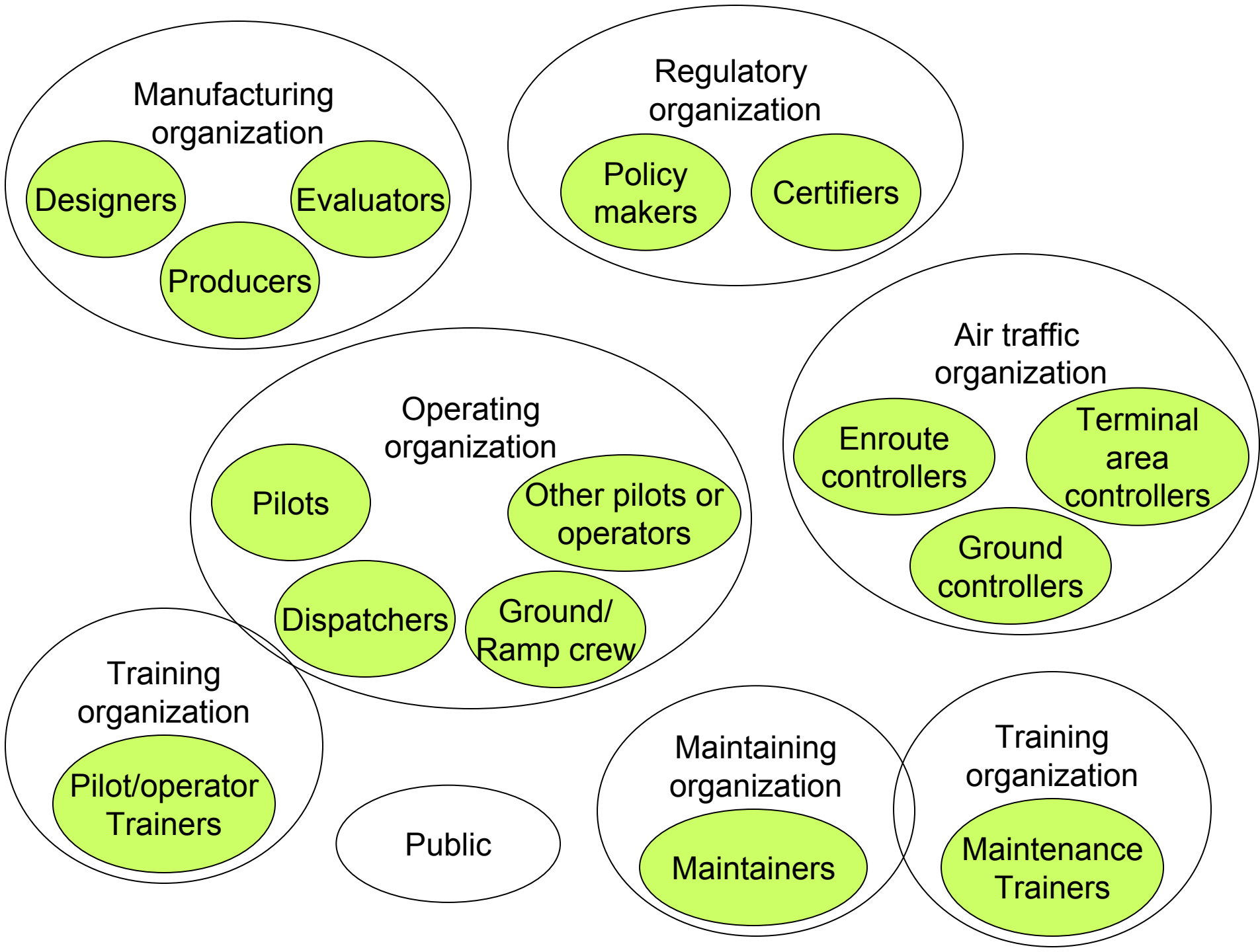
# Certification Processes

- Initiated by applicant
  - Manufacturer
  - Operator
  - Training organization
- FAA responds to information provided
- Compliance with regulations is determined
  - Minimum standards
- Most projects have unique aspects

# Tasks



Important to understand tasks for all users



# Human factors considerations

- Displays
- Controls
- Systems
- Other equipment
- Procedures



# Displays



## Display design is adequate

- Necessary information is presented
- Timing of information is appropriate
- Design is consistent with user expectations
- Information is visually accessible
- Information is understandable
- Crew action implications are appropriate
- Display appropriately attracts attention
- Display is usable with other displays and controls
- Display characteristics do not induce fatigue
- Skills requirements are not excessive
- Display is not objectionable

# Controls



## Control design is adequate

- Necessary controls are provided
- Control design prevents inadvertent operation
- Control is accessible (visually and physically)
- Control movement is unrestricted
- Strength requirements are not excessive
- Control design is consistent with user expectations
- Control function and method of operation are understandable
- Control operation does not require excessive attention
- Control is usable with related controls and displays
- Control characteristics do not induce fatigue
- Skill requirements are not excessive
- Control is not objectionable
- Control design minimizes potential for injury

# Systems



## System design is adequate

- Necessary systems are provided
- System logic prevents inadvertent operation
- System logic provides appropriate information to pilots
- Timing of system operations is appropriate
- User is provided necessary control over the system
- System logic and behavior are consistent with user expectations
- System logic and behavior are understandable
- System operation or monitoring does not require excessive attention
- System response to control input is appropriate
- System is usable with other systems
- Skill requirements are not excessive
- System design minimizes potential for injury
- System is not objectionable

# Other equipment



## Equipment design is adequate

- Necessary equipment is provided
- Equipment design prevents inadvertent operation
- Equipment is accessible (visually and physically)
- Strength requirements are not excessive
- Equipment design is consistent with user expectations
- Equipment function and method of operation are understandable
- Equipment operation is unrestricted
- Equipment operation does not require excessive attention
- Equipment is usable with other components
- Equipment operation does not induce fatigue
- Skill requirements are not excessive
- Equipment design is not objectionable
- Equipment design minimizes potential for injury

# Procedures



## **Task and Procedure design is adequate**

- Necessary procedures are provided
- Procedures do not require use of methods or devices that are unsafe or unreliable
- Procedures can be accomplished in the time available under all operating conditions
- Procedures are consistent with user expectations
- Procedures are understandable
- Procedures do not require excessive attention
- Procedures are usable with other procedures
- Procedures can be accomplished with necessary systems and equipment
- Procedures do not require excessive skill
- Completion of procedures does not induce fatigue
- Procedures are not objectionable

# Potential design solutions

- Systems currently in use by military
- A lot of work on other possible designs



# Impact of Differences



- Many tasks are different, but principles for using tasks are the same
- Technology is different and design strategies may be different, but principles are the same
- Assumptions may be different from those for manned aircraft
  - Pilot will always be there to take over
  - Automation can always be turned off
  - Pilot can react to environmental changes in real time
  - Pilots are involved in mission for full duration
    - e.g. Shift and duty issues
  - Minimum flight crew decisions
    - e.g. A pilot/monitor outside of the control station may be required

# Summary



There is a lot we know

There is more we don't know

But

- We know processes and approaches to develop the knowledge we need

*Let's all work together to help the FAA be an effective quarterback*