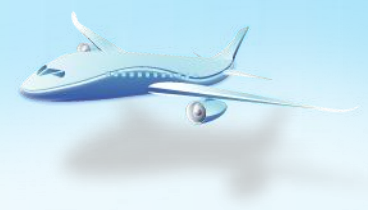


Modelling the Work of the Flightdeck

Amy Pritchett

Acknowledging
So Young Kim, Karen Feigh, Brian Sperling and Eric Johnson
(Georgia Tech),
Paul Schutte, Mike Feary and Steve Young (NASA)





Many Perspectives May Be Relevant

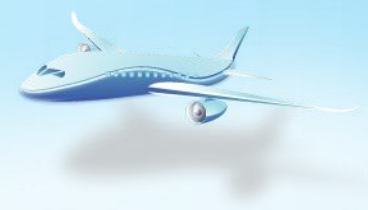
Automation Design, Human Factors, Team and Organization Design, Management Science, and Cognitive Systems Engineering

- + Technology-centered Perspective
 - How do we design automated technology?

- + Human-centered Perspective
 - How can technology best support human needs?

- + Team-oriented Perspective
 - How can effective teams be formed?

- + Work-oriented Perspective
 - How can the human-automated team improve mission performance?



Why Have More Team Members?

1. Divvy up the taskwork

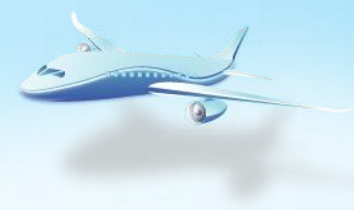
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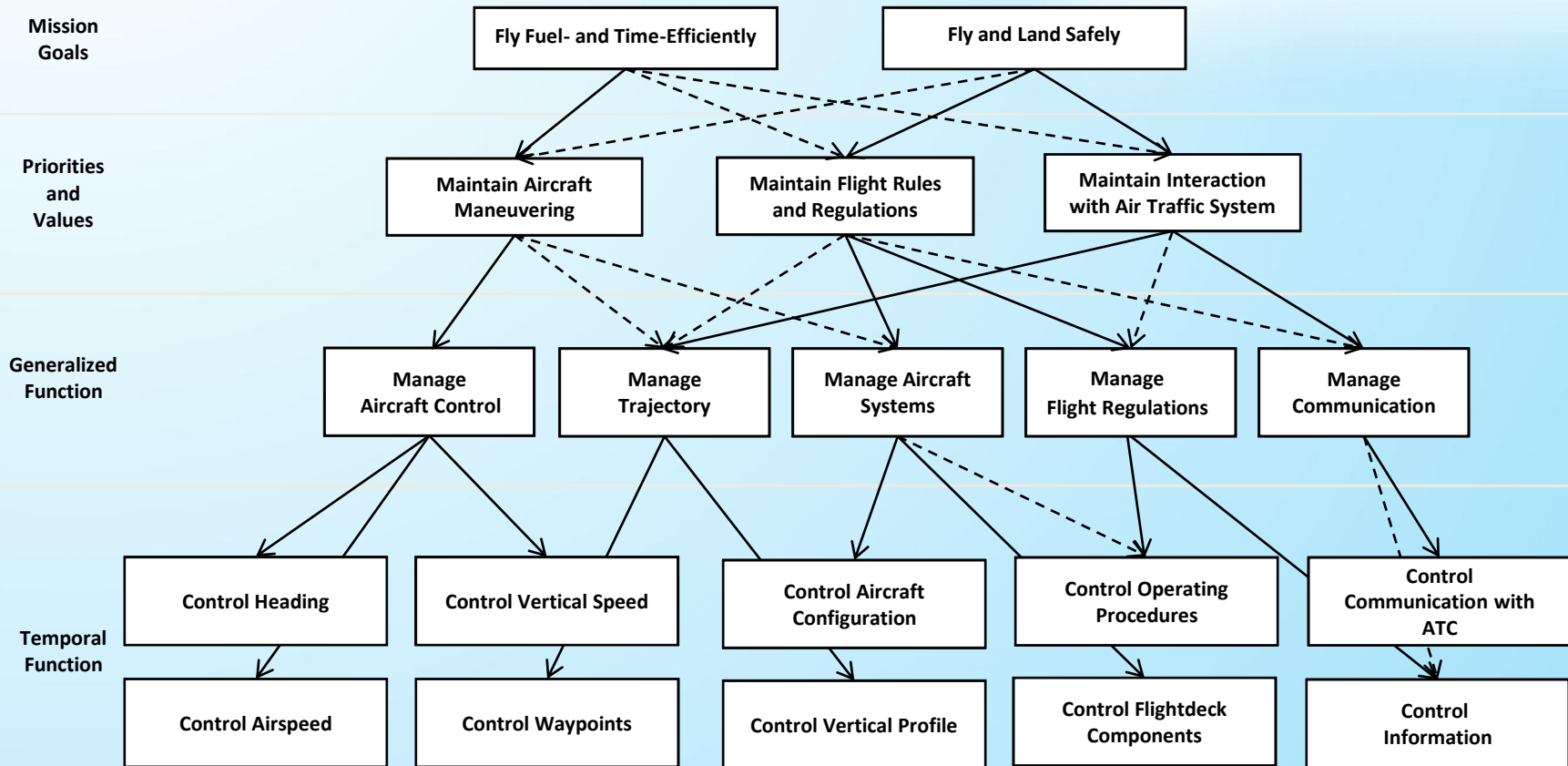
2. Redundancy on the taskwork

- + Team members will do the same things, for error checking

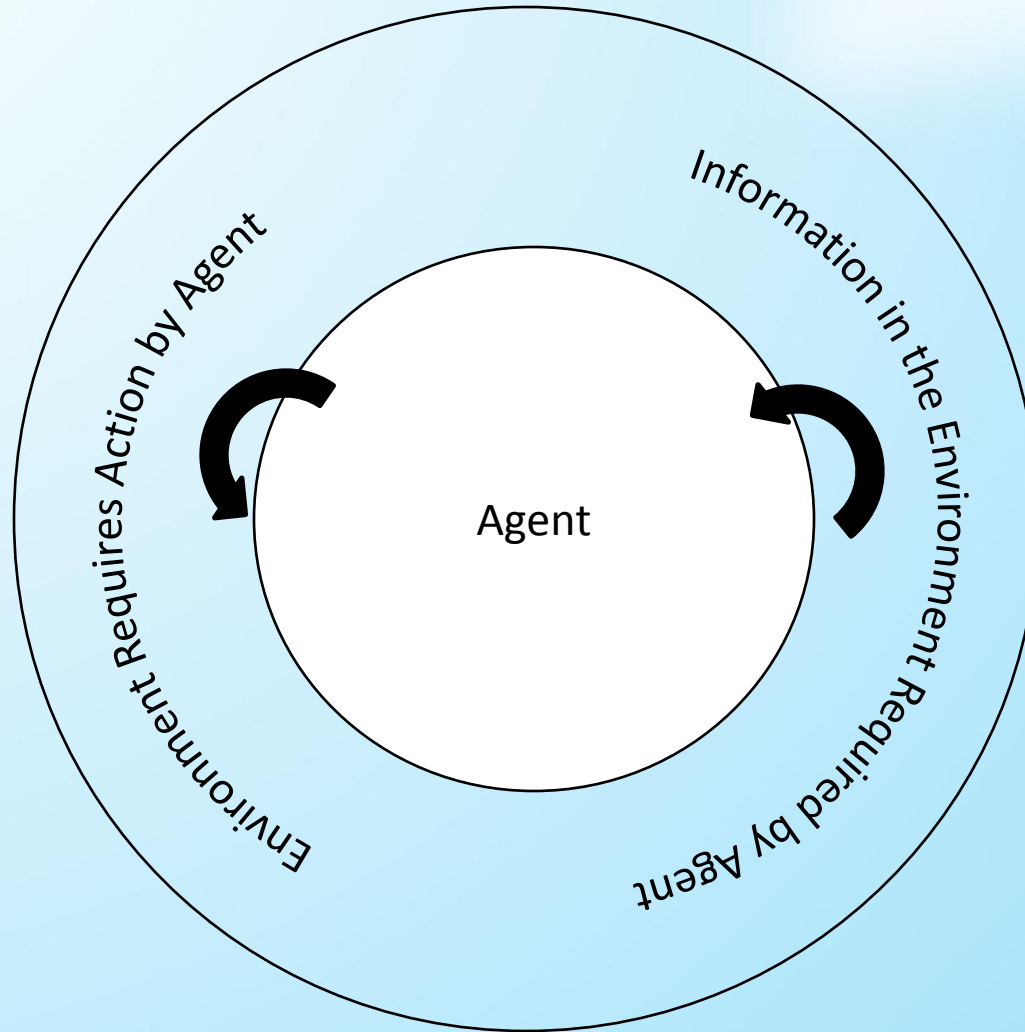
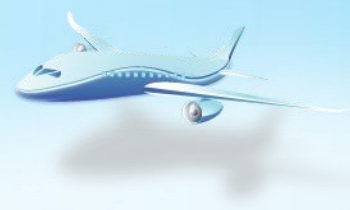
NOTE! Human team mates may make the same mistakes



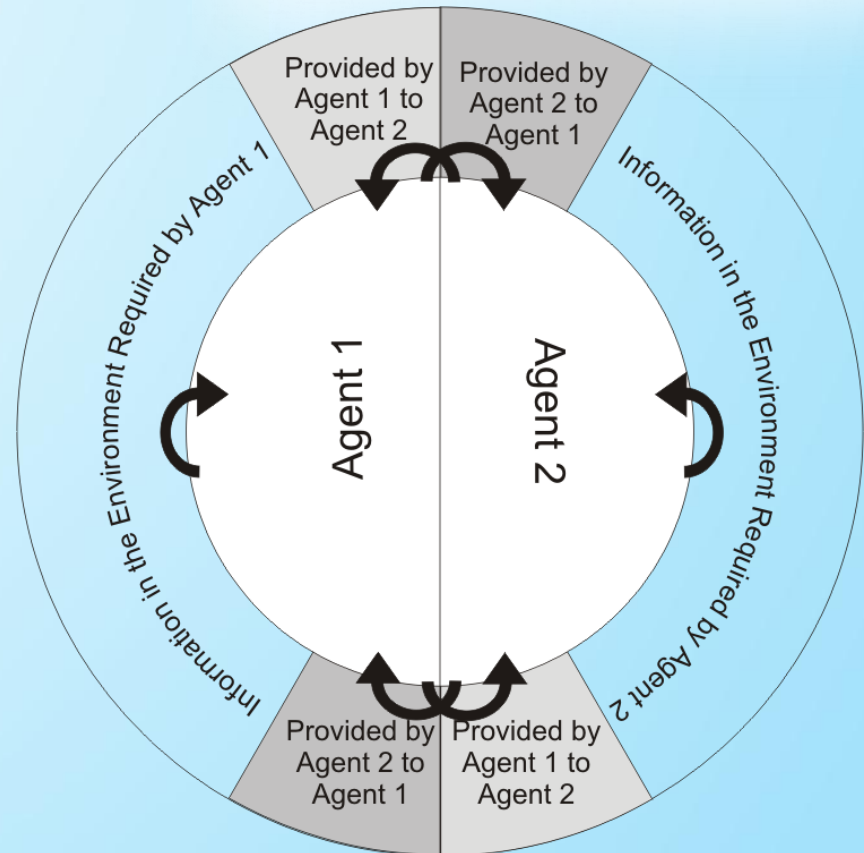
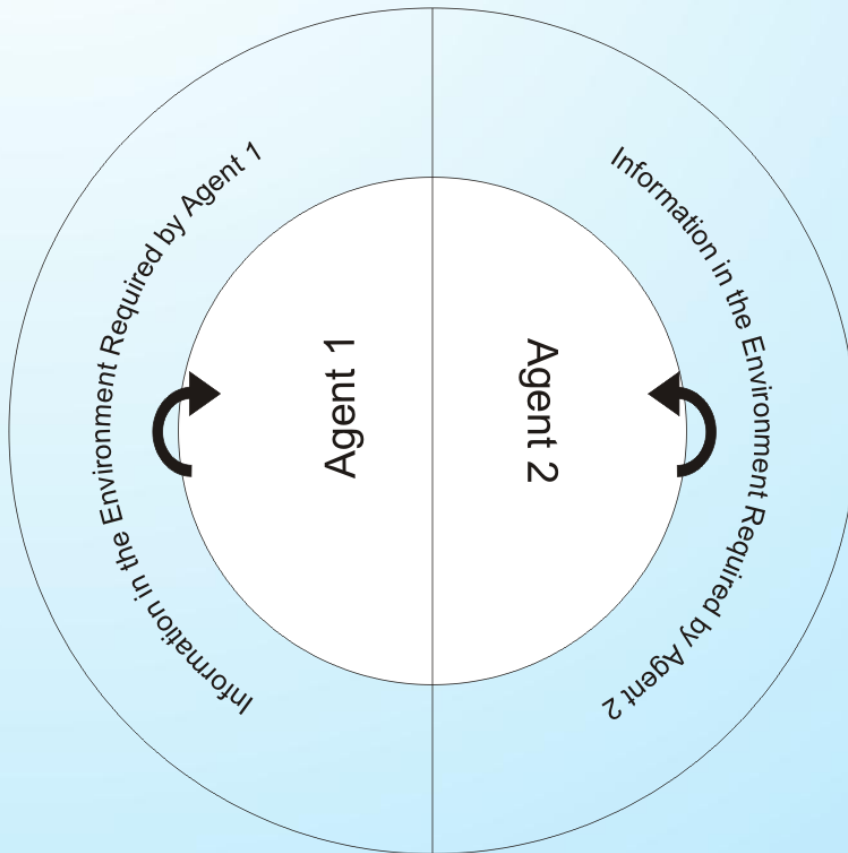
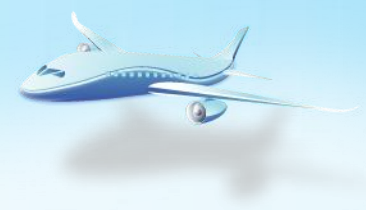
Aggregating Together the Arrival-Approach Model

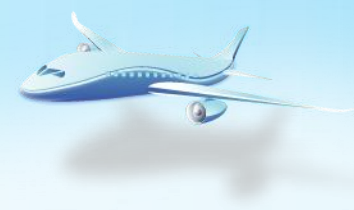


Modeling the Taskwork

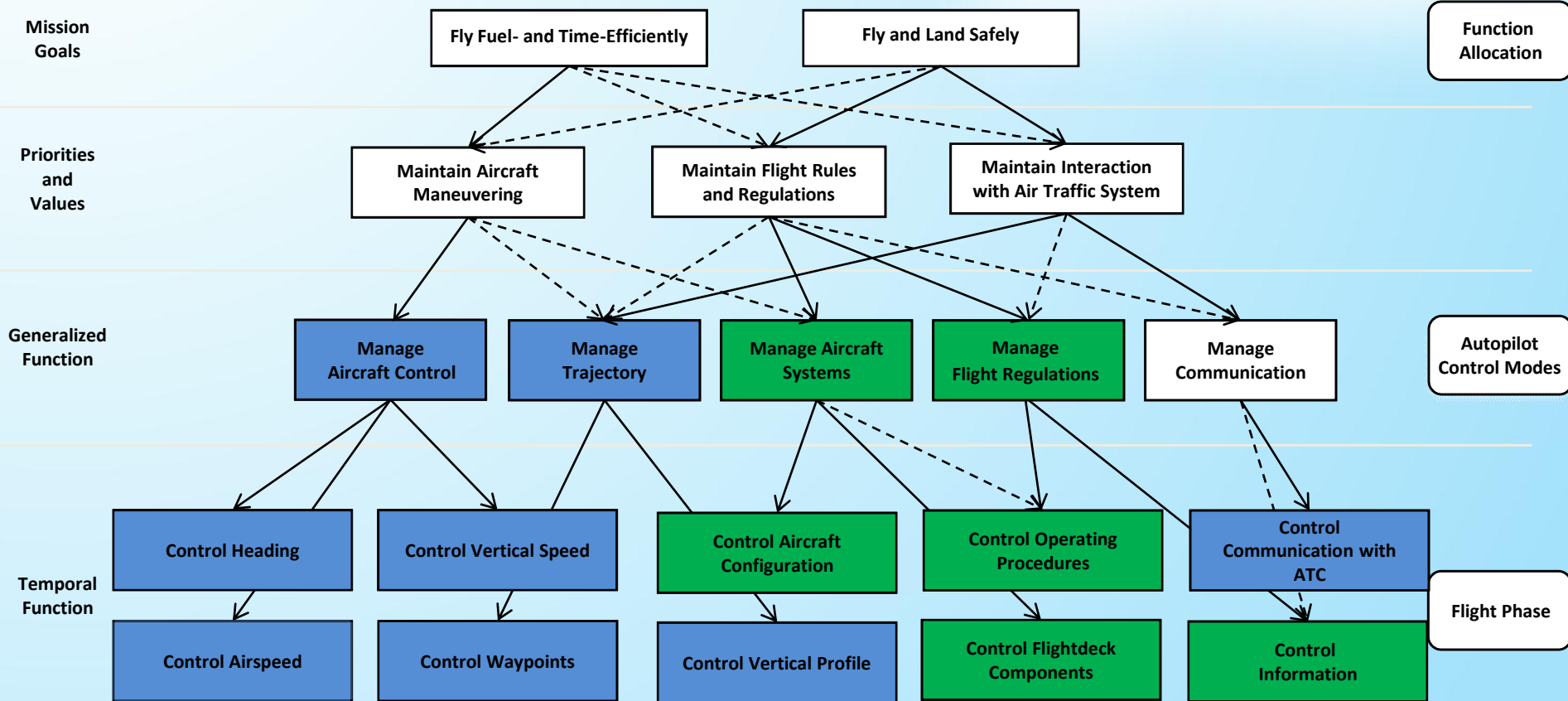


Extending the Modeling to Include Teamwork

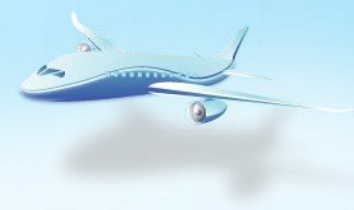




Assigning Functions Within FA1 'Full Automation'



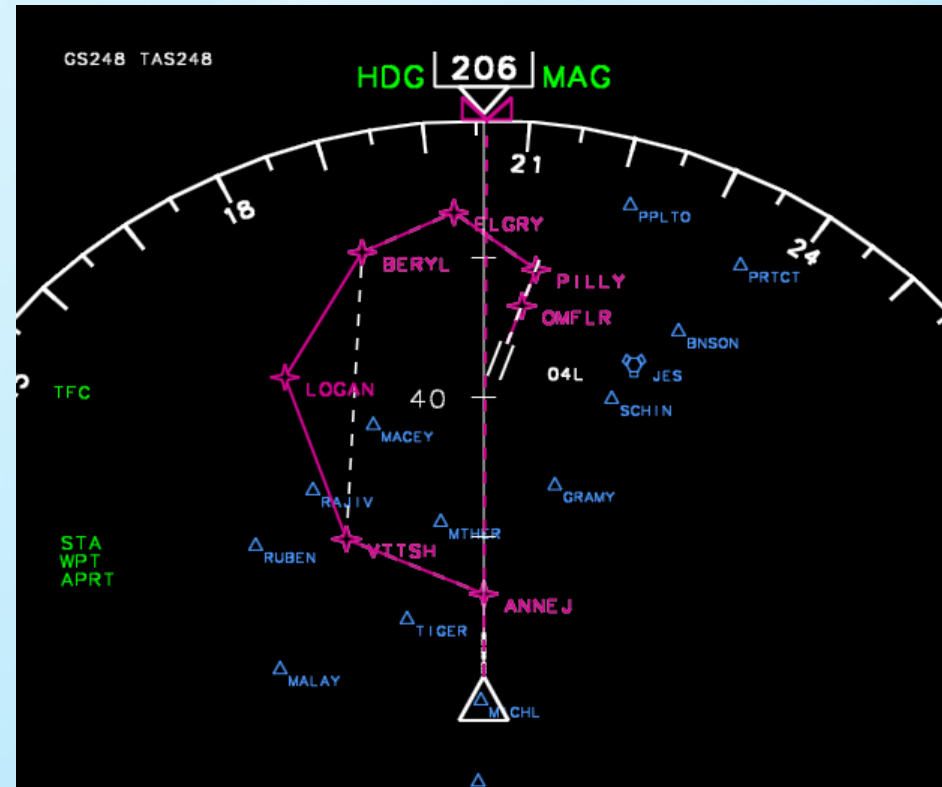
What the Pilot Sees With 'FA1: Full Automation'

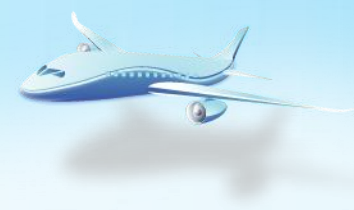


MOD	RTE	1	LEGS	1/2
206	12 NM		250/9000	
ANNE J				
139	19 NM		250/9000	
VTTSH				
209	41 NM		200/6000	
BERYL				
270	13 NM		190/5000	
ELGRY				
333	13 NM		180/4000	
PILLY				

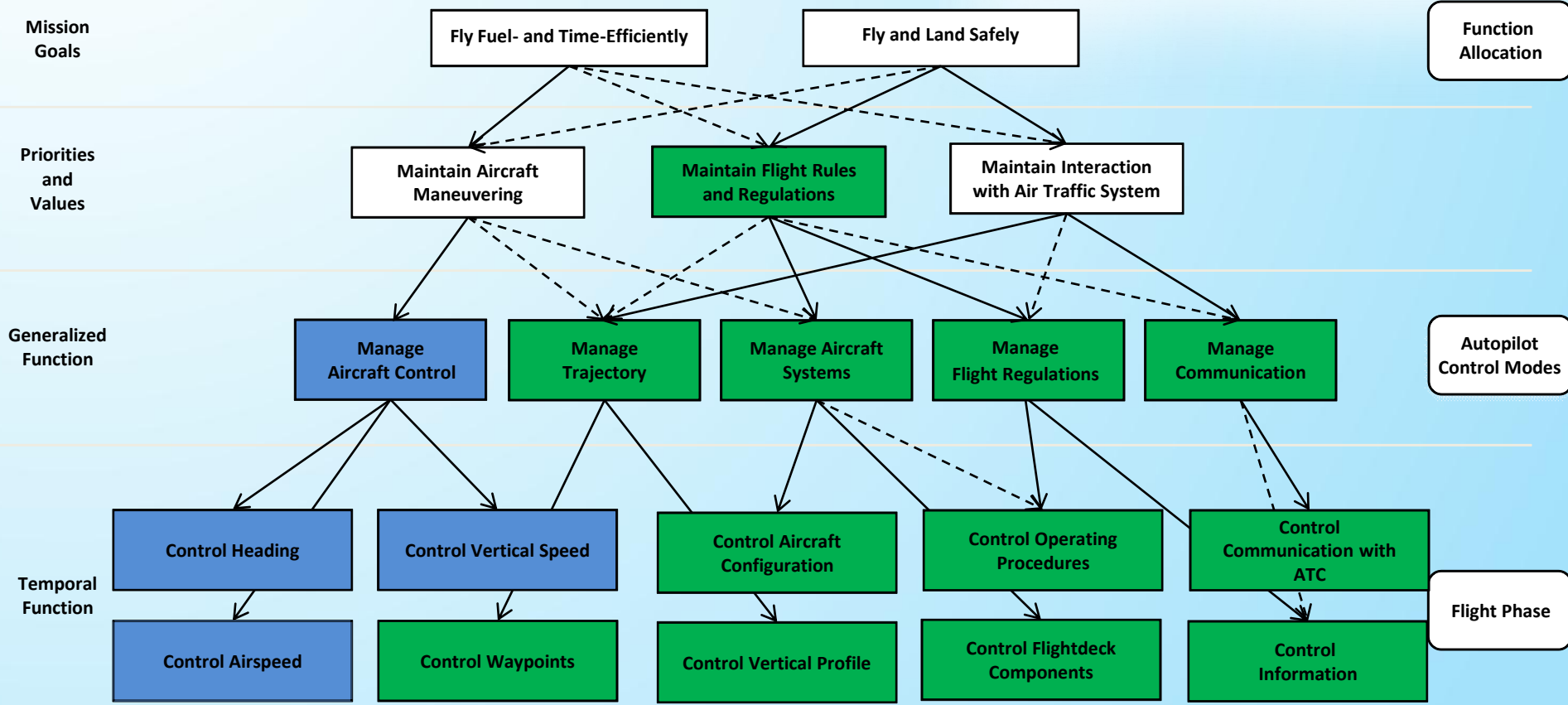
< ERASE

RTE					
LEGS					EXEC
AUTO PLAN	DIR INTC	A	B	C	D
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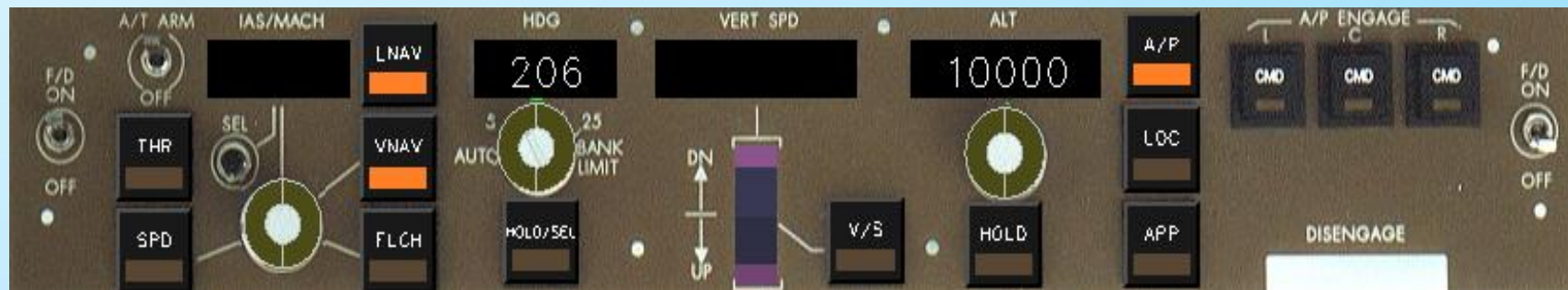
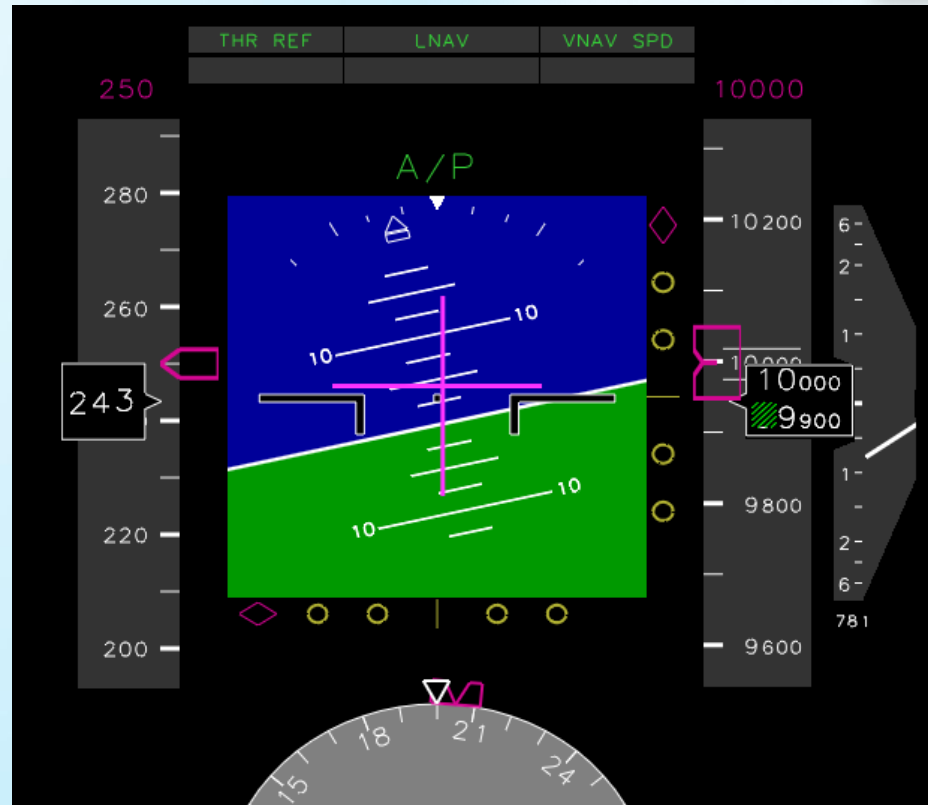




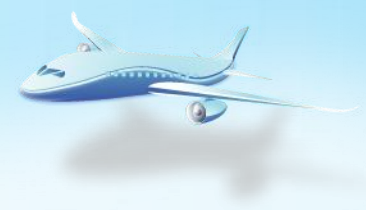
Assigning Functions Within FA4 'MCP'



What the Pilot Sees With FA4 'MCP'



Detailed Actions Required – Taskwork and Teamwork



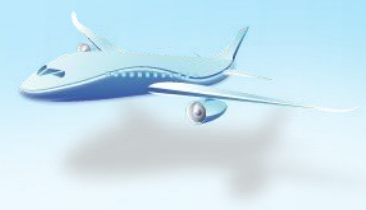
Full Automation (FA1)

Temporal Function	Pilot	Automation
Control Vertical Profile	Modify CDU Pages Reduce Airspeed for Late Descent Confirm Target Altitude Confirm Target Speed	Manage Waypoint Progress
Control Waypoints	Modify CDU Pages Monitor Waypoint Progress Confirm Active Waypoint Monitor Dist Active Waypoint	Calculate Dist Current Waypoint Evaluate Flight Phase Manage Waypoint Progress Direct To Waypoint
Control Communication With ATC	Respond Handoff Confirm Data Communication	Receive Altitude Clearance Receive ILS Clearance Receive Waypoint Clearance
Control Heading	Monitor Heading Trends	Update Lateral Control
Control Vertical Speed	Monitor Altitude Monitor Vertical Deviation	Adjust Speed Control Update Pitch Control Evaluate Vertical Mode Evaluate VNAV Mode Transition Evaluate Alt Restriction Mode Altitude Reminder
Control Airspeed	Monitor Descent Airspeed	Update Thrust Control Calculate Speed Deviation
Control Aircraft Configuration	Deploy Flap Deploy Gear Deploy Speed Brake Retract Speed Brake Confirm Configuration Change	
Control Aircraft Information	Verify TOD Location Verify Crossing Restriction	
Control Operating Procedures	Perform Approach Briefing Perform Approach Checklist Perform Landing Checklist	
Control Flight Deck Components	Turn off Altitude Alert Respond to Drag Required	

MCP (FA4)

Temporal Function	Pilot	Automation
Control Vertical Profile	Monitor Altitude Reduce Airspeed for Late Descent	
Control Waypoints	Manage Waypoint Progress Direct To Waypoint	Calculate Dist Current Waypoint Evaluate Flight Phase
Control Communication With ATC	Receive Altitude Clearance Receive ILS Clearance Receive Waypoint Clearance Respond Handoff Request Clearance	
Control Heading	Dial Heading Selector Push Heading Selector Monitor Heading Trends	Update Lateral Control
Control Vertical Speed	Dial Altitude Selector Dial VS Selector Push Alt Hold Switch Push FLCH Switch Push Vertical NAV Switch Push Vertical Speed Switch Monitor Green Arc	Update Pitch Control Evaluate Vertical Mode Evaluate Alt Restriction Mode Altitude Reminder
Control Airspeed	Dial Speed Selector Push Speed Switch Monitor Descent Airspeed	Update Thrust Control Calculate Speed Deviation
Control Aircraft Configuration	Deploy Flap Deploy Gear Deploy Speed Brake Retract Speed Brake Confirm Configuration Change	
Control Aircraft Information	Verify TOD Location Verify Crossing Restriction	
Control Operating Procedures	Perform Approach Briefing Perform Approach Checklist Perform Landing Checklist	
Control Flight deck Components	Turn off Altitude Alert Respond to Drag Required	

Building Blocks of a WMC Model: Actions and Resources



Temporal Action: **Control Airspeed**
Agent: Automation
Next update : +0.02 seconds
Duration: 0.01 seconds

Temporal Action: **Update AP Target Speed**
Agent: Pilot
Next update : +60 seconds or after ATC
Duration: 2.0 seconds

Sets

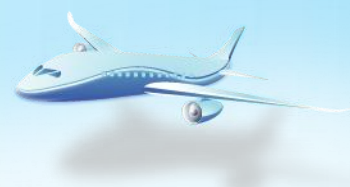
Gets

Gets

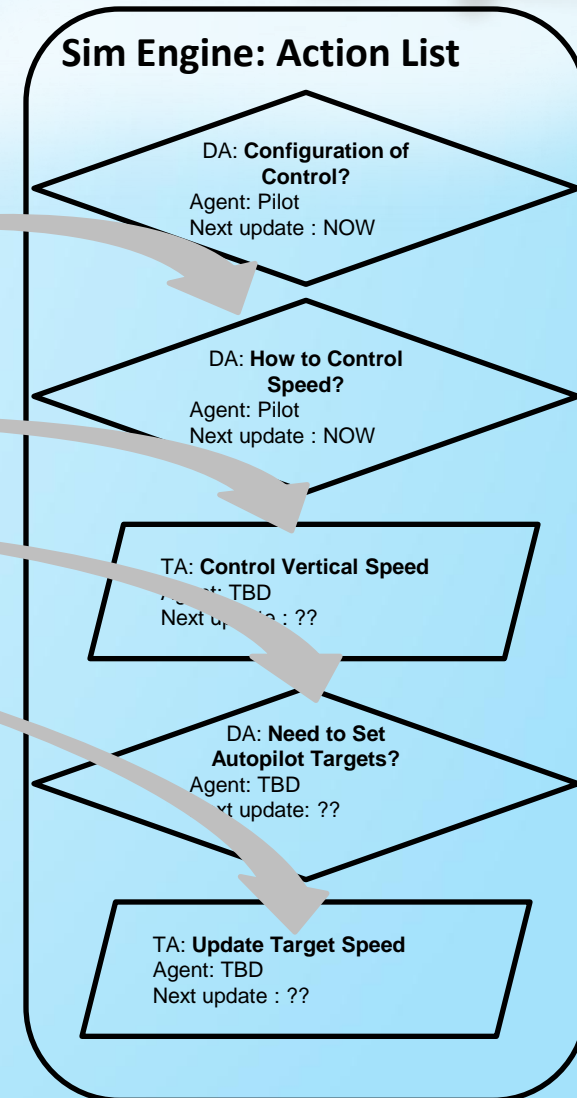
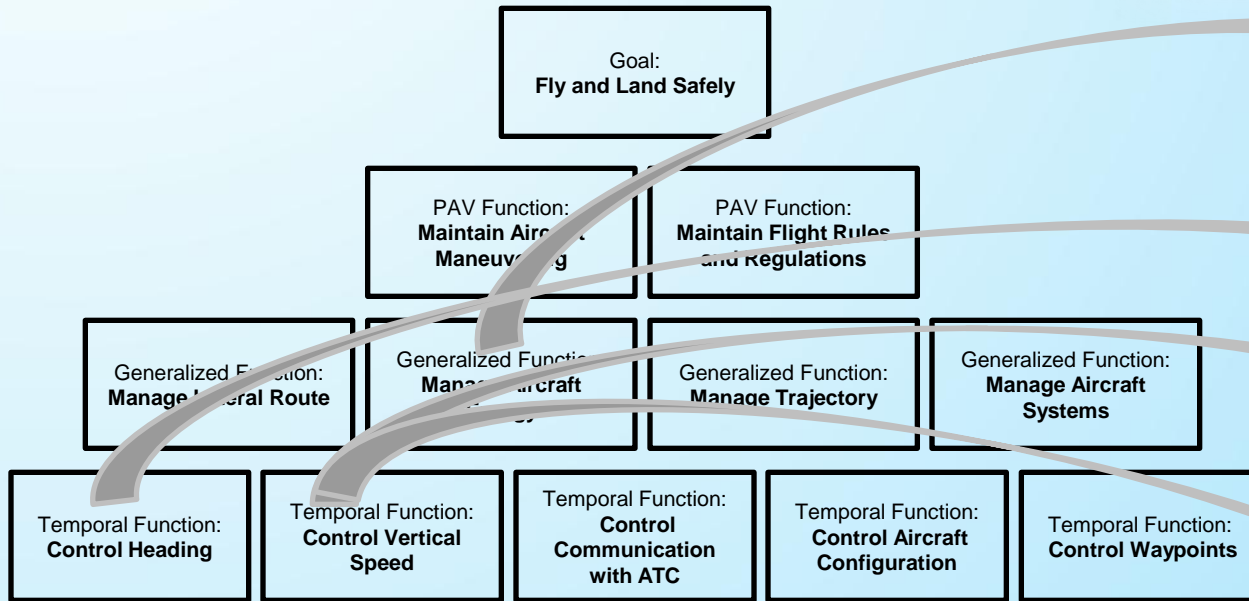
Sets

Resource: **Airspeed**
Value: 195 knots
Last update: 1:28:31.04

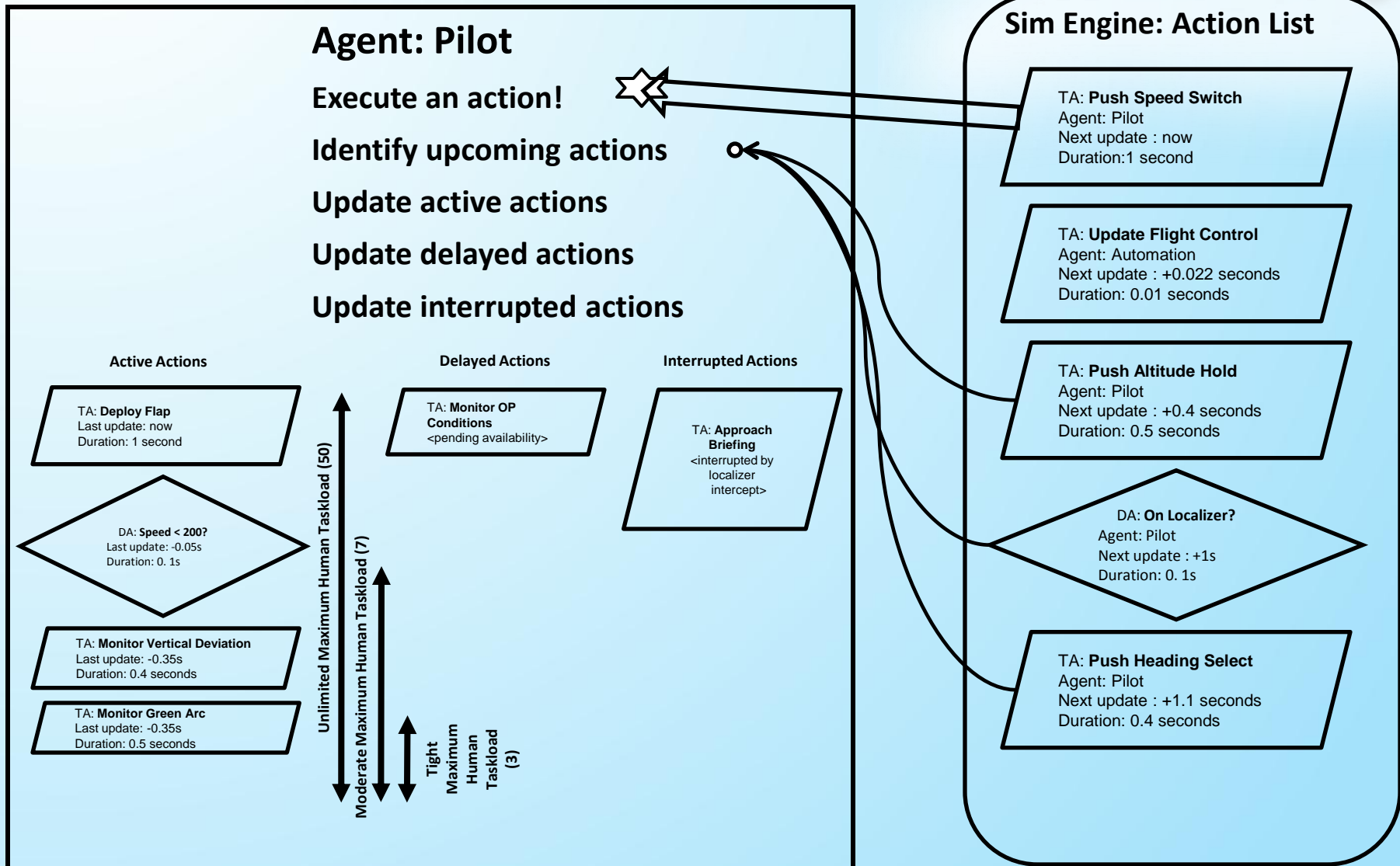
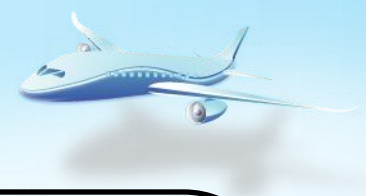
Resource: **Target Airspeed**
Value: 200 knots
Last update: 1:27:15.06



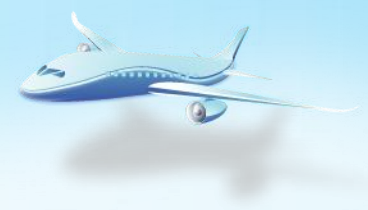
Simulating the Work Model: Step 1



Simulating the Work: Step 2

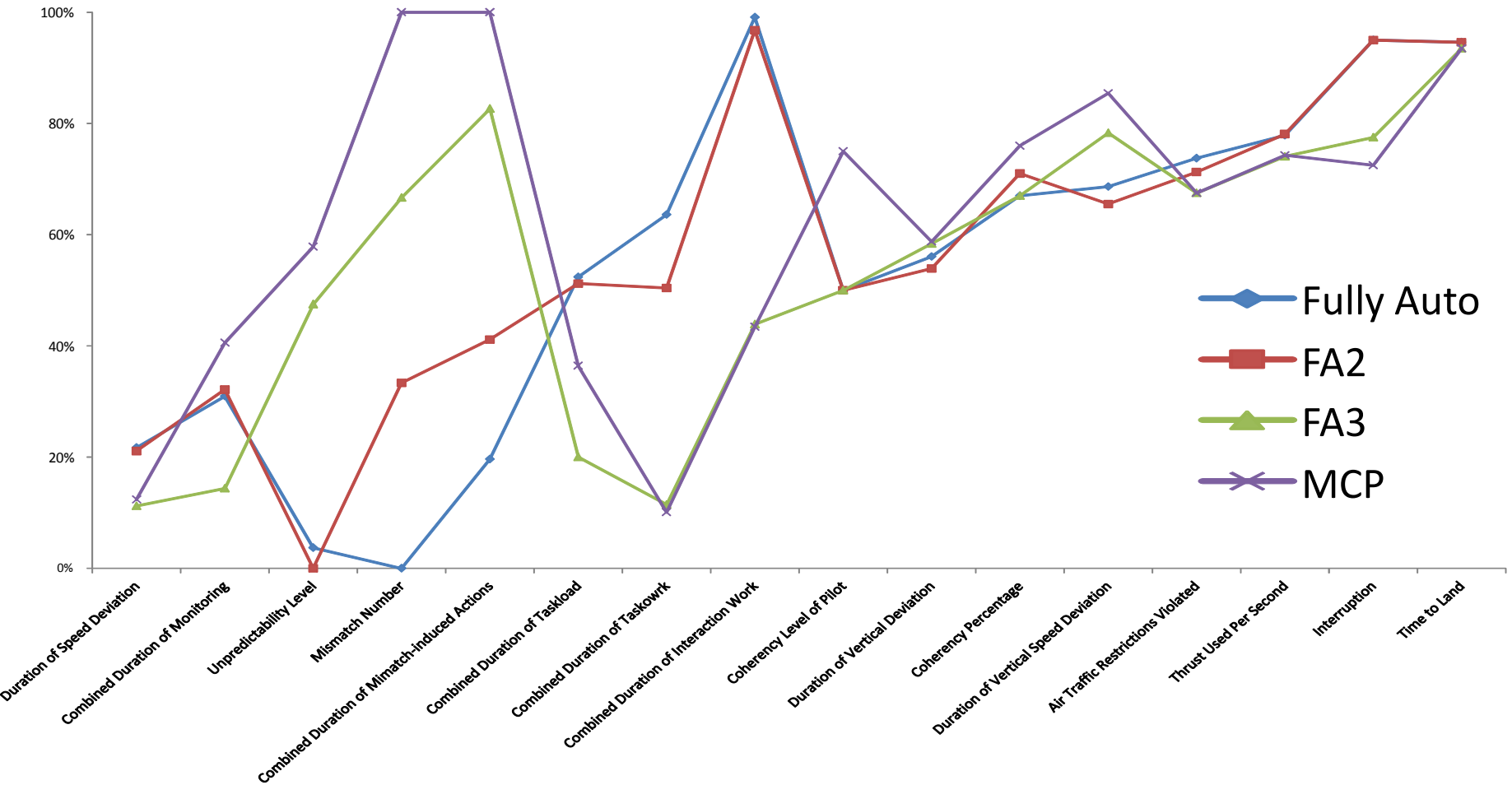
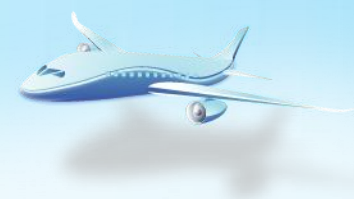


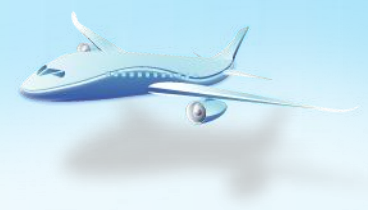
Metrics of Function Allocation



- 1) Workload
- 2) Mismatches Between Responsibility and Authority
- 3) Coherency of a Function Allocation
- 4) Interruptive Automation
- 5) Boundary Conditions
- 6) Effect of Human Adaptation to Context
- 7) Stability (Predictability) of the Humans' Work Environment
- 8) Mission Performance

Combined Patterns Across Metrics...





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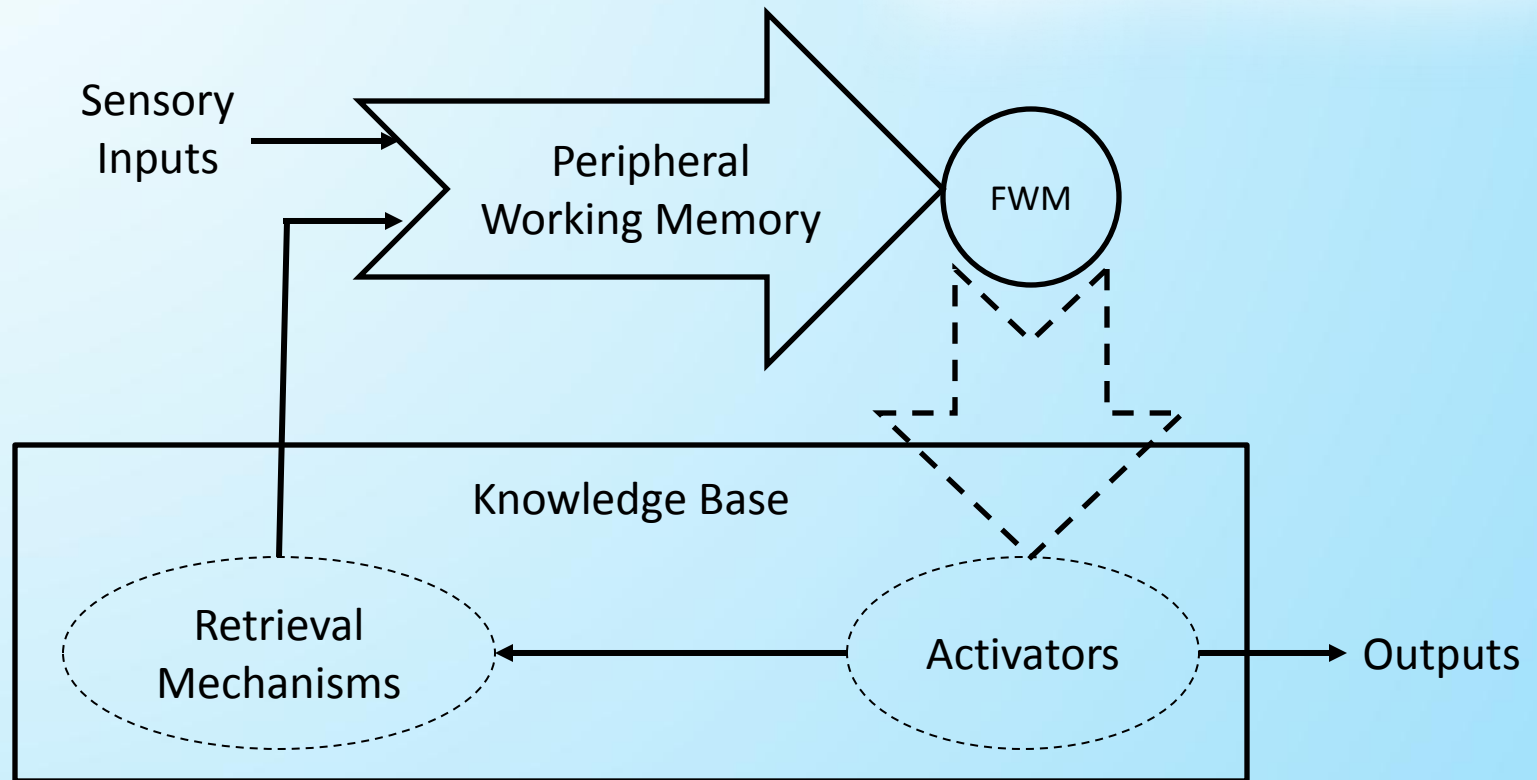
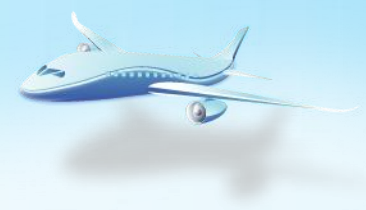
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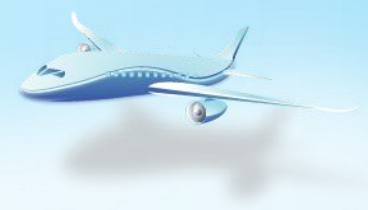
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NOTE! Human team mates may make the same mistakes

The Human as a Fallible Machine...



- + At what rate will human team members catch each others' slips?
- + At what rate will human team members catch each others' mistakes?



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Thank You

