Week 4: Second Wave HCI (Part 2)
“Mess” is the message, groups and contexts

Chunk 1: Distributed Cognition

What is Distributed Cognition

An example of a DC analysis

A blueprint of DC analysis

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What is Distributed Cognition?

Computation is made simple when it is distributed between internal and external representations

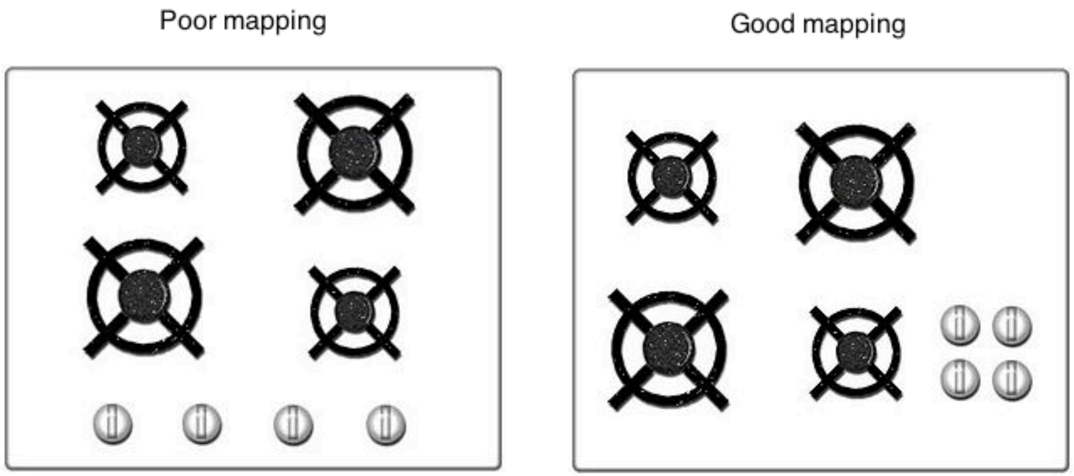
X	0	X
	X	
0		

4	3	8
9	5	1
2	7	6

4	3	8
	5	
2		6

What is Distributed Cognition?

Computation is made simple when it is distributed between internal and external representations



What is Distributed Cognition?

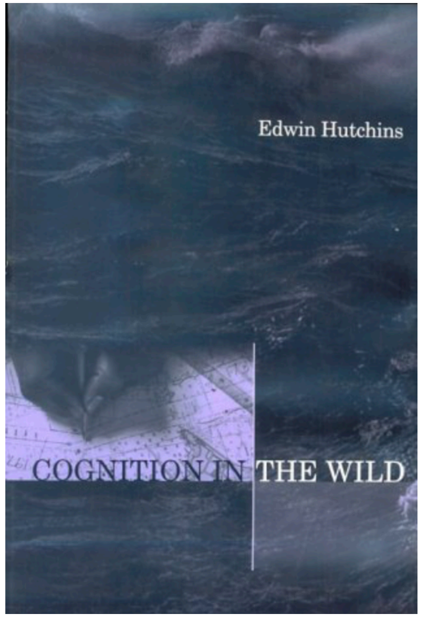
Remember the 90s…

What is Distributed Cognition?

Developed by cognitive anthropologist Edwin Hutchins in the 1990s

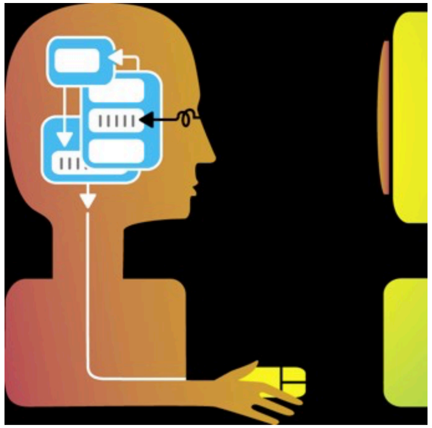
Seminal work: Cognition in the Wild (1995)

"Systems larger than an individual have cognitive properties in their own right that cannot be reduced to the cognitive properties of individual persons" (Hutchins, 1995)



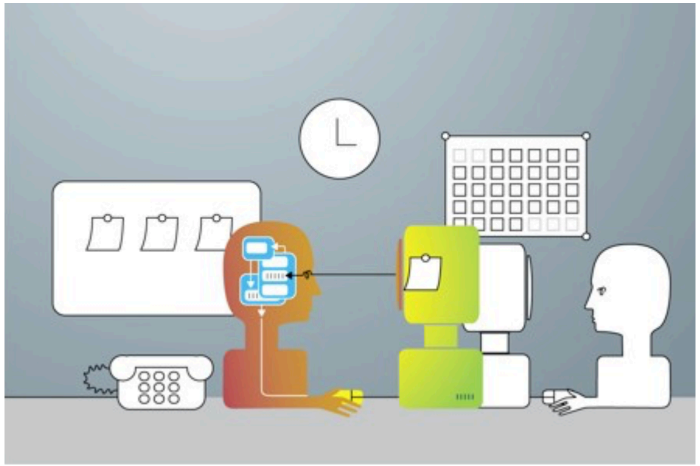
What is Distributed Cognition?

Moving from modelling an individual's cognition/internal representations with external representations (computer interface)



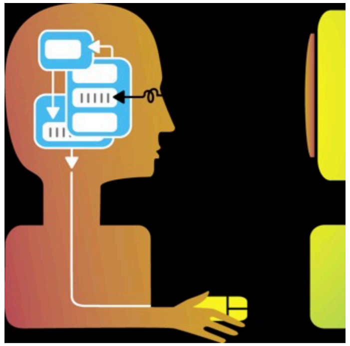
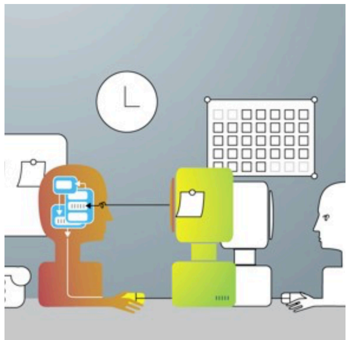
One person, one computer

Towards taking into account a person's context, with other people around, other interfaces, other source of information storage and processing



In context

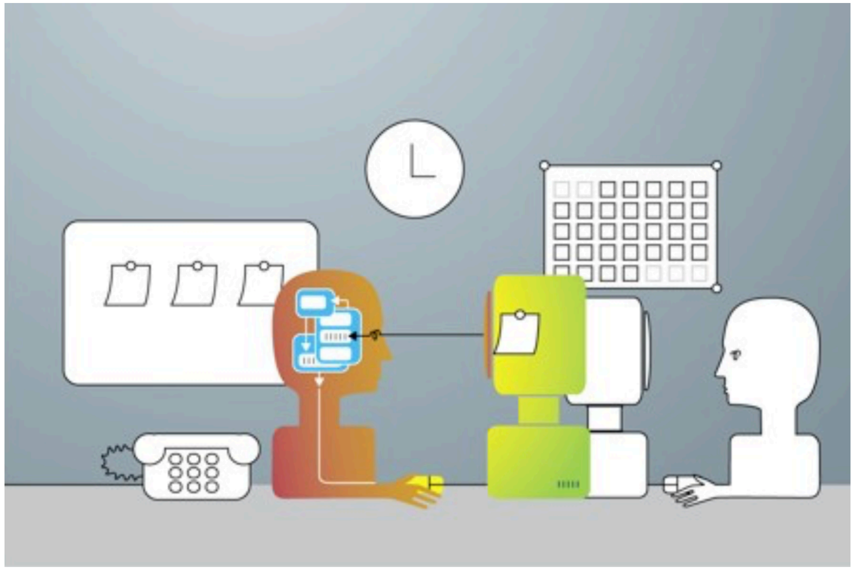
What is Distributed Cognition?

	Model	Unit of analysis	Focus	Methods
Cognitive Science 	Computational model of cognition	Individual	Internal representations	Experiments, modelling of cognitive processes
Distributed Cognition 	Computational model of cognition	People + technology + people	External representations, Physical and social interactions	Direct observation

What is Distributed Cognition?

Problem solving = Not just a single person and a computer; there other people around, other representations/interfaces, other means for storing and retrieving information, other ways of doing computation..

DC Goal = to identify and explain extra tools, resources and social relations that people draw on to carry out their work



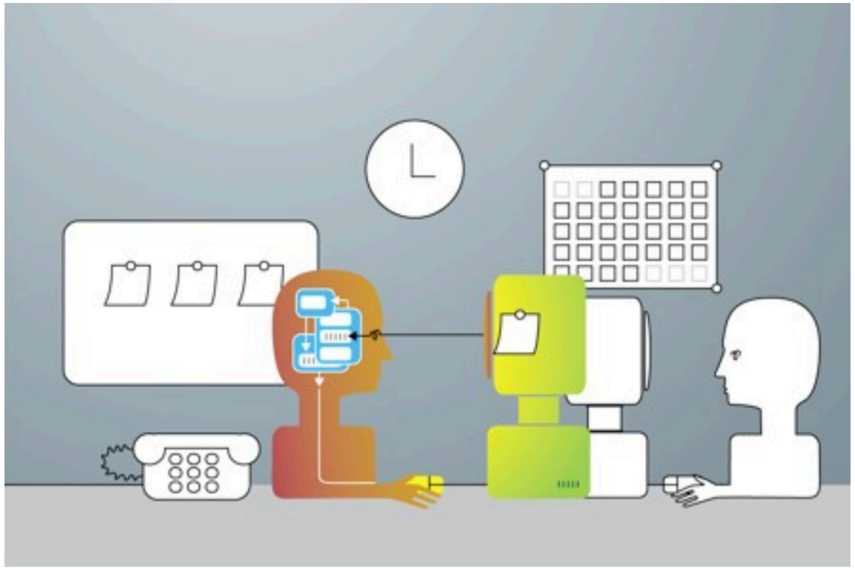
What is Distributed Cognition?

Three distinguishing features of DC

1. Expands the unit of analysis
From individual cognition to whole system computation

2. Expands the range of mechanisms that constitute cognitive processes
From internal mental processes to external representation, physical and social interaction

3. Viewing physical artefacts and social organisation not just for communication and coordination, but problem solving as a single intelligent unit: *“the system performs the task, not the individual”*



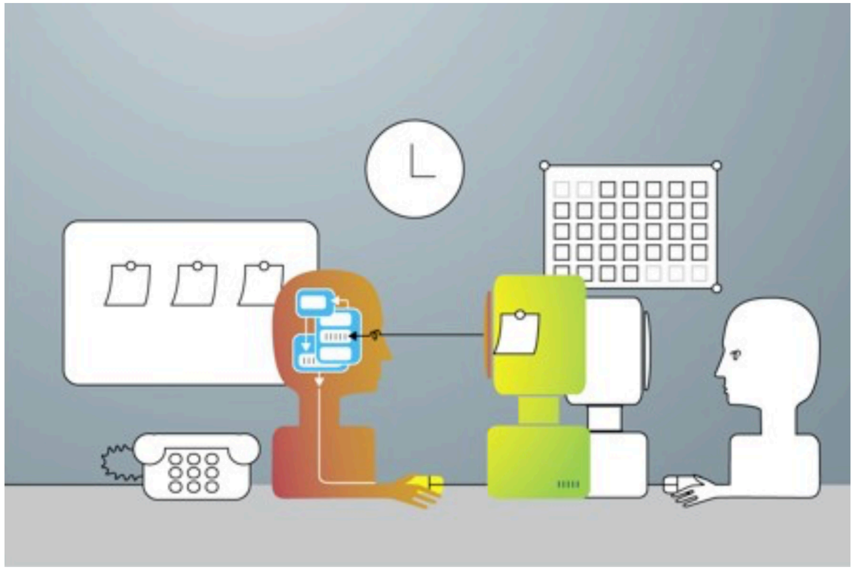
What is Distributed Cognition?

Three kinds of “distributed”

1. Between internal and external representation

2. Across members of a social group

3. Across time: results of earlier events can transfer the nature of later events



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Example: How to land a place (Hutchins, 1995)

“How a cockpit remembers it speed”

Ethnographic investigation

- As pilot and observer
- 6 years > 100 flights

Scope

- unit of analysis: the whole cockpit
- Computations for landing
- Individuals: crew
- System: crew, plane, dials, books, procedures, utterances, etc.

Example: How to land a place (Hutchins, 1995)

Procedural description

- Get the right landing speed
- Coordinate speed with wing configuration (Slats/Flaps)
- Table: all possible speeds for all possible weights and wind configurations

TABLE 1
The FLAP/SLAT CONFIGURATION MIN MAN AND REFERENCE SPEED Table
as it Appears in the MD-80 Operating Manual

	GROSS WEIGHT X 1000 POUNDS																			
	86	90	94	98	102	106	110	114	118	122	126	130	134	138	142	146	150	154	158	160
0/RET Min Man	190	194	199	203	207	211	215	219	223	227	230	234	237	241	244	248	251	255	258	260
0/EXT Min Man	148	152	155	159	162	165	168	171	174	177	180	183	186	188	191	194	197	199	202	203
11/EXT Min Man	130	133	136	139	142	145	147	150	153	155	158	160	163	165	167	169	172	174	176	177
15/EXT Min Man	128	131	134	136	139	142	144	147	149	152	154	157	159	162	164	166	169	171	173	174
28/EXT Min Man	119	122	124	127	130	132	135	137	139	142	144	146	149	151	153	155	157	159	161	162
40/EXT Min Man	115	118	120	123	125	128	130	132	135	137	139	141	144	146	148	150	152	154	156	157
28/EXT Vref	111	114	116	118	121	123	125	128	130	132	134	136	138	140	142	144	146	148	150	151
40/EXT Vref	107	110	112	114	117	119	121	123	126	128	130	132	134	136	138	139	141	143	145	146

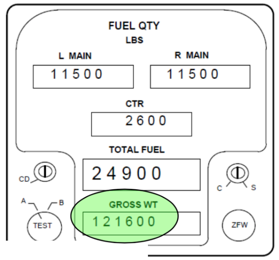
Example: How to land a place (Hutchins, 1995)

Procedural description

30 mins before landing

- PNF prepares landing data: computes wing configuration & speed for projected landing weight

- Procedural Steps
  1. determine weight
  2. select speed card
  3. post card prominently



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MANEUVERING
FLAPS/SLATS SPEED

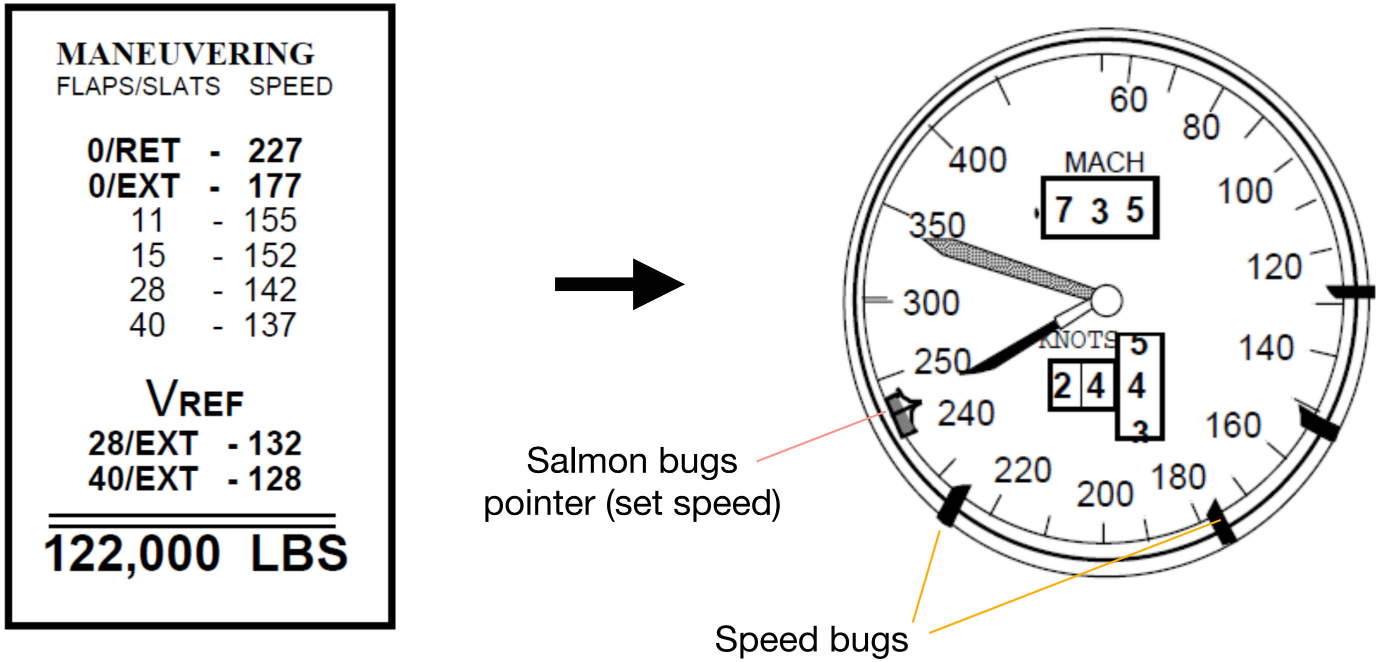
0/RET - 227
0/EXT - 177
11 - 155
15 - 152
28 - 142
40 - 137

VREF
28/EXT - 132
40/EXT - 128

122,000 LBS

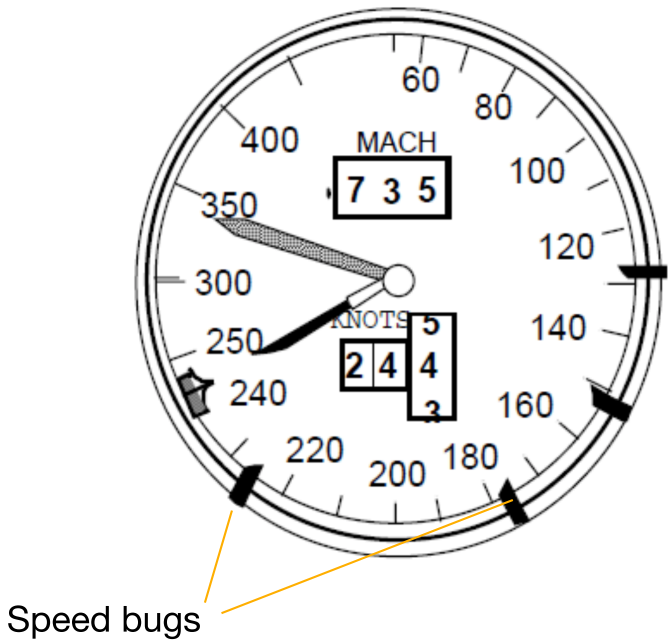
Example: How to land a place (Hutchins, 1995)

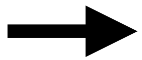
Set **speed bugs** according to speed card

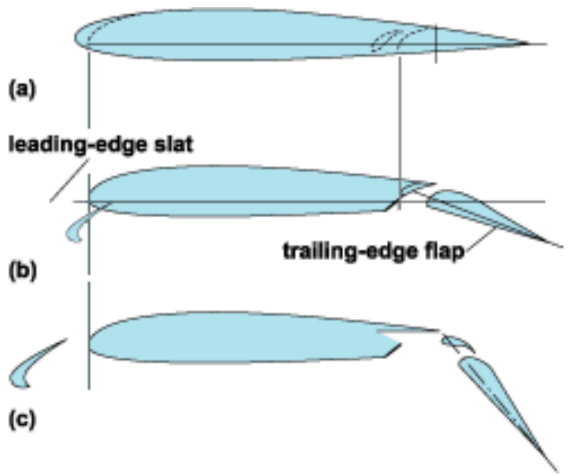


Example: How to land a place (Hutchins, 1995)

As speed comes down, change wing configuration according to speed bug indicators





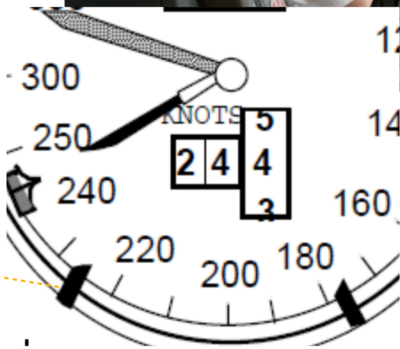


Example: How to land a place (Hutchins, 1995)

Final approach: a lot of talking

- Sharing information and information second by second
- Cross checking speed bugs, configuration
- 1000ft final wing configuration
- 500ft PNF calls out altitude, airspeed, decent rate
- Report if speed is below or above desired approach speed
  - Must be +/- 5 knots

Width of speed bug!



Example: How to land a place (Hutchins, 1995)

Sounds complicated! …But let's look at the tasks:

- Select card
- Read values
  - Helps make key values salient
- Set speed bug
  - Remember speed, match to scale, move bug
- Monitor proximity of speed needle and speed bugs
  - Represent wing configurations/speeds as regions
- Monitor proximity of speed needle and speed bugs
  - Width of bugs correspond to error margins
- Listen to values

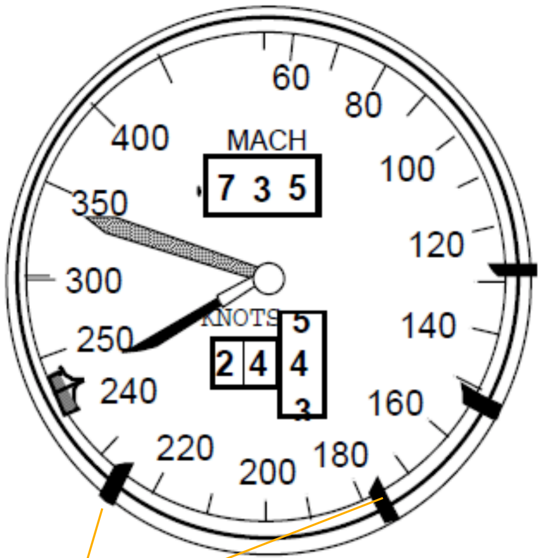
External representations

External representations help!

- Computational offloading
- Re-representation
- Changing the nature of the task

E.g. instead of remembering the list of speeds, doing addition and subtractions then match wing configuration: keep track of needle location in defined areas within the width of a marker!

Not just a memory aid -> the whole system remembers!



Speed bugs

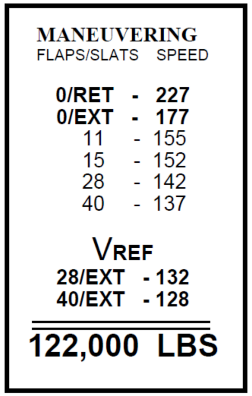
A distributed cognition analysis

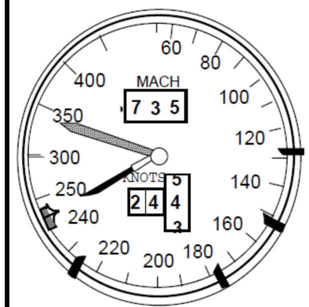
Provides a cognitive description of the whole system:

Computational problem: coordinate airspeed and wing configuration

Computational characteristics:

- Speed cards = non-volatile long term memory
- Computing speed from weight is embedded into the physical structure of the cards
- Prominent placement of card provides *redundant* storage
  - Route for information to PF and a resource for cross-checking
- Speed bug provide 'medium term' *malleable* memory
- PNF creates multiple representations of speeds
  - cards, verbal utterance, and speed bug
- Temporary verbal representations help synchronise actions





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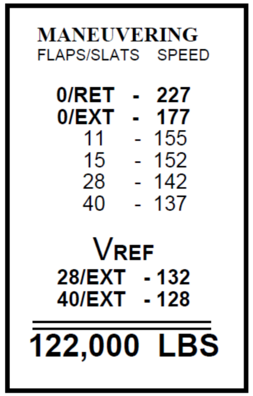
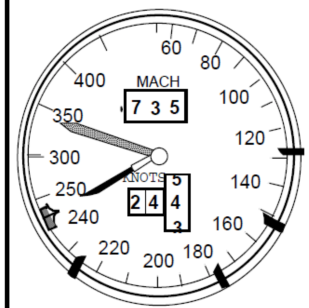
A Blueprint of a DC Analysis

Coming up with a cognitive description of how a whole system works:

- What information is relevant?
- Where the is it located?
- Where computation that relies on it happens?
- How does the information flows from one part of the system to another?





What is Distributed Cognition?

Three key questions:

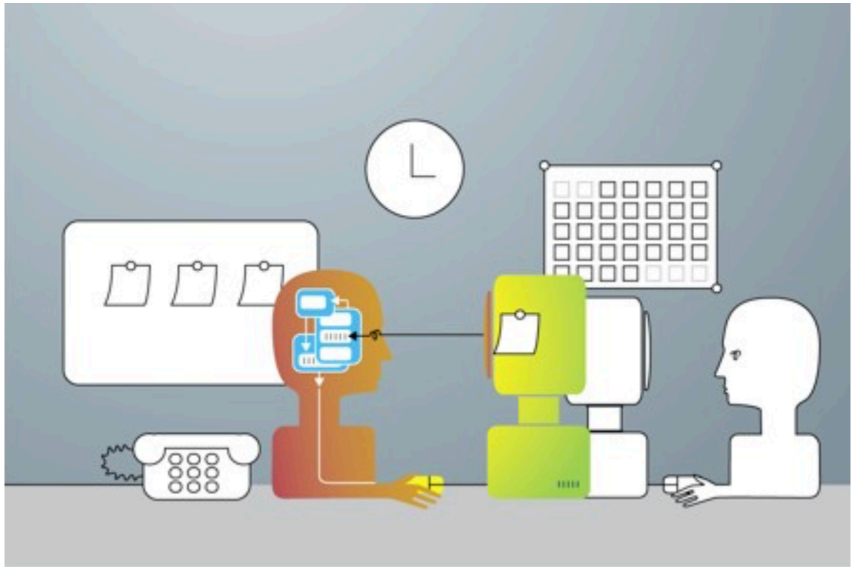
1. Where is the knowledge/memory?

2. Where is the computation/processing?

3. Where is the information flow?

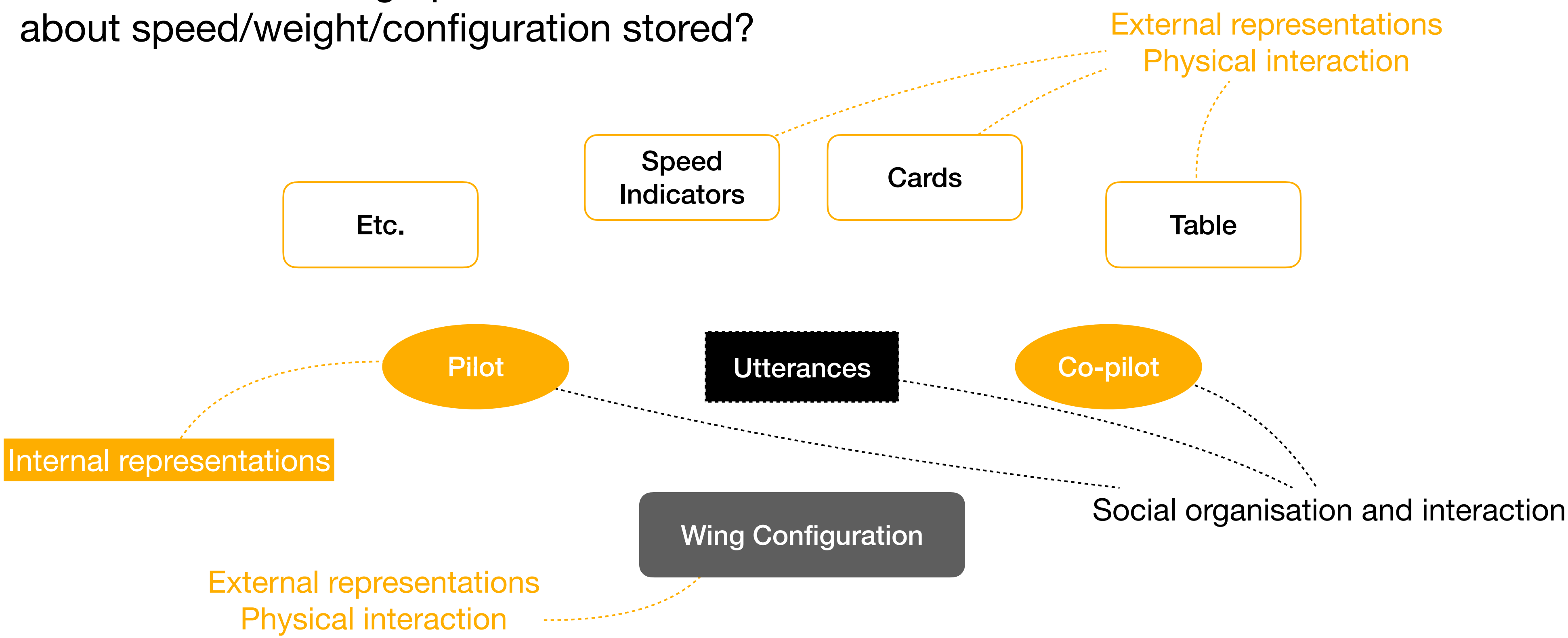
As applied to the whole unit of analysis that is:
people, artefacts, physical and social interactions

Use of observation to answer these questions



Memory Resources

We can draw it as a graph: Where is the information about speed/weight/configuration stored?



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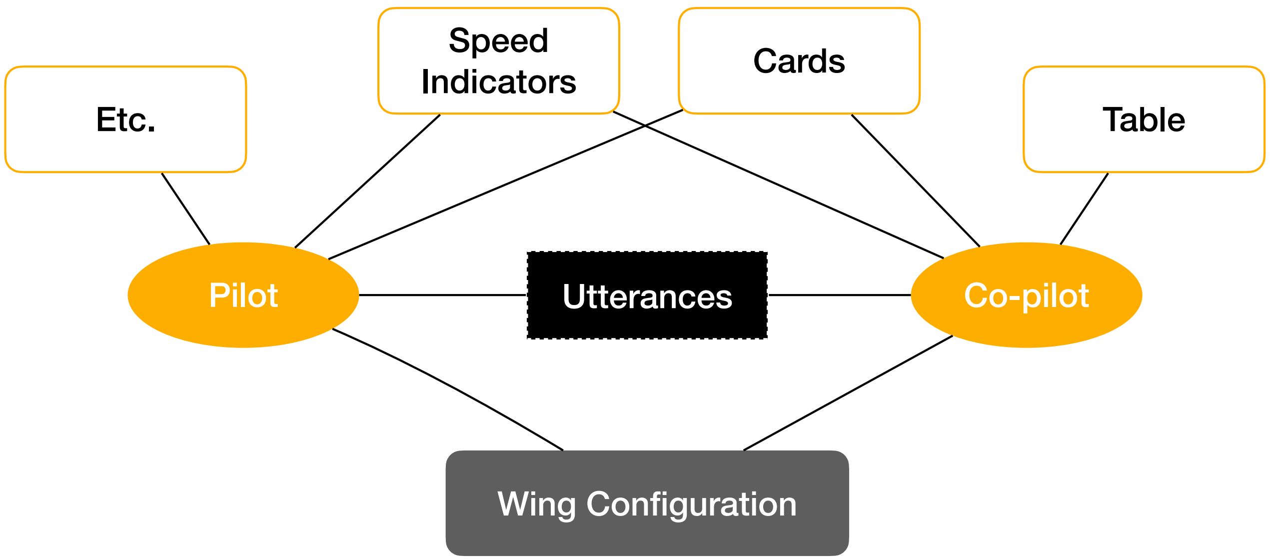
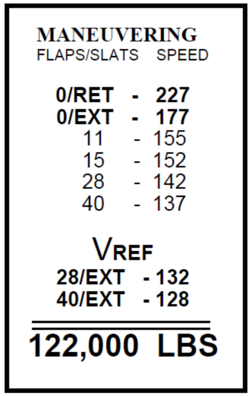
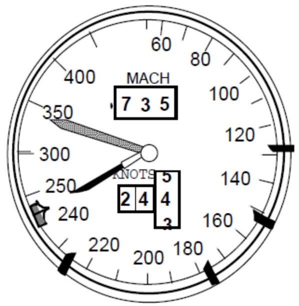


Information Flow

Which information and how does it flow from one part of the system to another

- Airspeed indicated by indicator needle
- Needle approaches a marker —> PF calls out the wing setting
  - PNF verifies the airspeed is appropriate
- PNF adjust the marker on flap handle
  - PF maintains controls of throttle
- Flap handler alters wing configuration
- Wing configuration alters indicated airspeed
- Configuration cross-checked with card and speed bug, weight
- PNF uses bugs to track deviation from target speed





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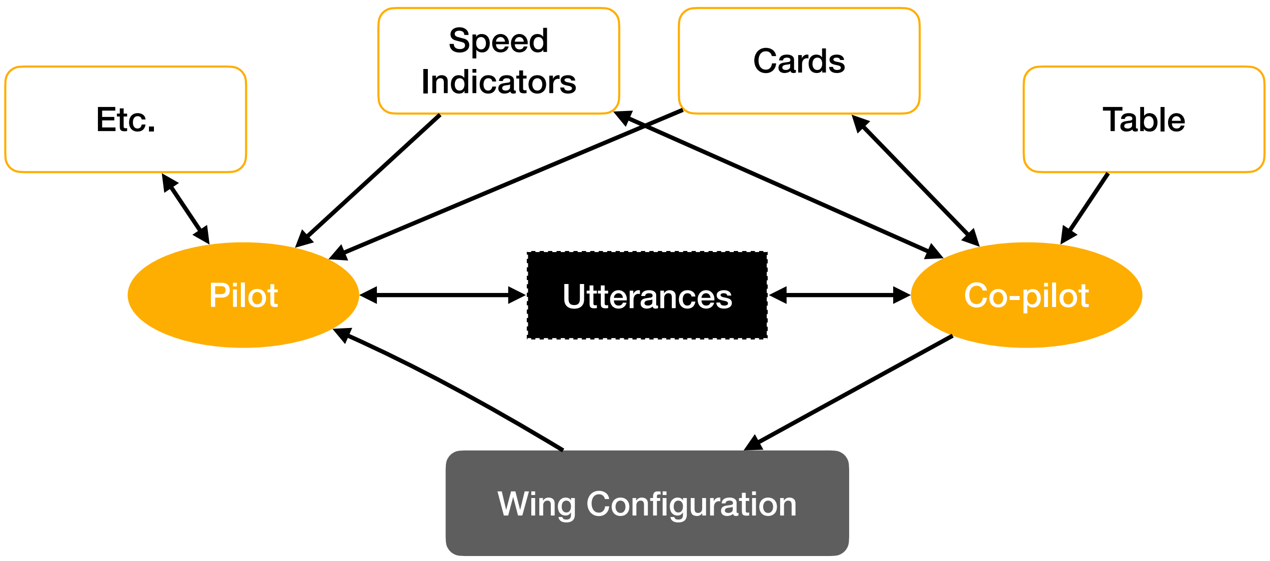

Information Processing

PNF selects card from table
- convert weight into dataset
- Extract relevant dataset

PNF Set bugs
- convert speed, Conf settings

PNF monitor bugs & airspeed needle
- convert posions into instruction/utterance

PF performs instructions
- converts data in flat/speed settings

Speaking/listening

MANEUVERING

FLAPS/SLATS		SPEED
0/RET	**-**	**227**
0/EXT	**-**	**177**
11	-	155
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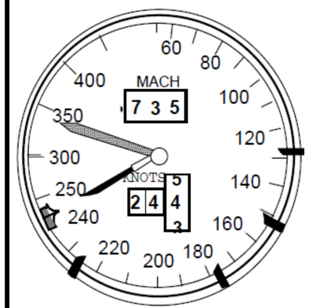
122,000 LBS



In Summary

Distributed Cognition considers problem solving as distributed between

- Representations
- People
- Time

Not just the sum of individuals activities

The whole distributed system represents and transforms information

Conceptual tasks are converted into perceptual tasks

Model a distributed cognitive system in terms of:

- information flow,
- memory load, and
- processing requirements

Next…

Week 4: Second Wave HCI Part 2
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Chunk 2: Activity Theory