

# Supporting Air Traffic Control Collaboration with a TableTop System

Stéphane  
Conversy

Hélène  
Gaspard-  
Boulinç

Stéphane  
Chatty

Stéphane  
Valès

Carole  
Dupré

Claire  
Ollagnon









# collaboration+flexibility=safety+efficiency

paper strips = communication medium

non-verbal communication = 50% of communication acts

physical distance = more demanding communication

multimodal communication (verbal+gesture) is richer

mutual awareness

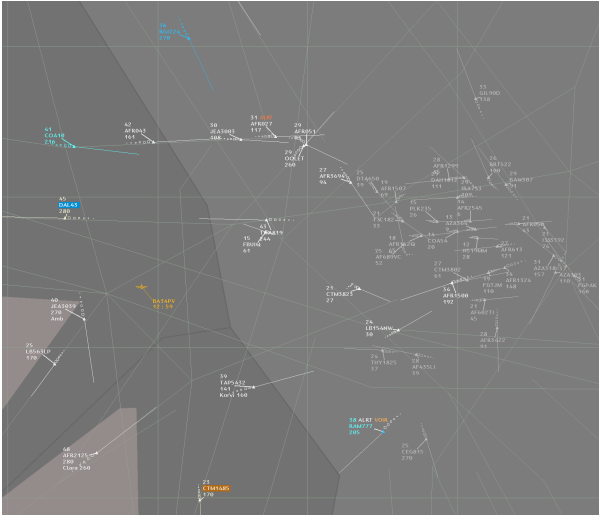
knowledge that one's collaborators know as much as oneself  
makes the interpretation of collaborators' intentions easier

cross-checking of actions done and to be done

2 users (dynamic support from planning controller),

3 users (instruction), 5+ users (storm)

# computer system unaware of clearances



# evolution of ATC systems



AFR1661	295	↘		ROLEX	TRO	SUSIN	SUSIN
LOWW LFPG RB		90	90	19:10	18	22	22
B73S 43 350							
AFR1661	295	↘		ROLEX	TRO	SUSIN	SUSIN
LOWW LFPG RB		90	90	19:10	18	22	22
B73S 43 350							
AFR1661	295	↘		ROLEX	TRO	SUSIN	SUSIN
LOWW LFPG RB		90	90	19:10	18	22	22
B73S 43 350							
AFR1661	295	↘		ROLEX	TRO	SUSIN	SUSIN
LOWW LFPG RB		90	90	19:10	18	22	22
B73S 43 350							

personalized radar image

actions on personal radar image

individual mouse

introduction of desktop technology weakens collaboration

# research questions

how to inform the system while fostering collaboration ?

how can tabletop systems improve collaboration compared to other digital systems?

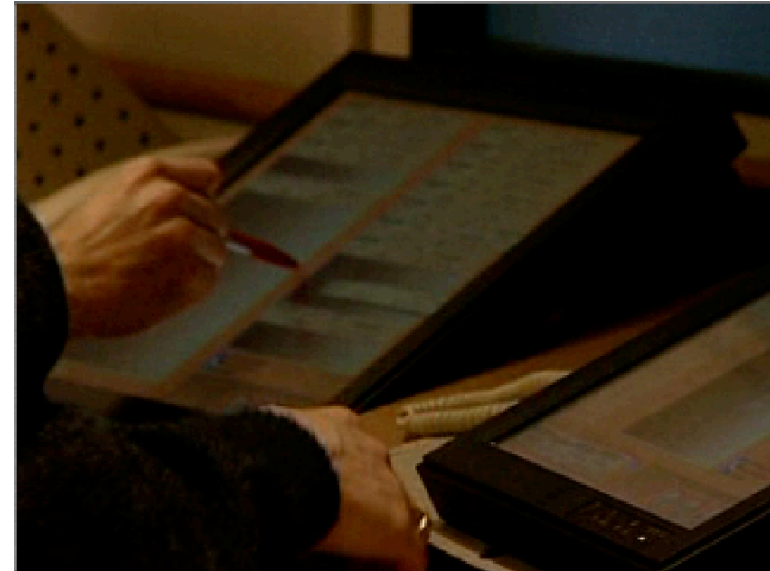
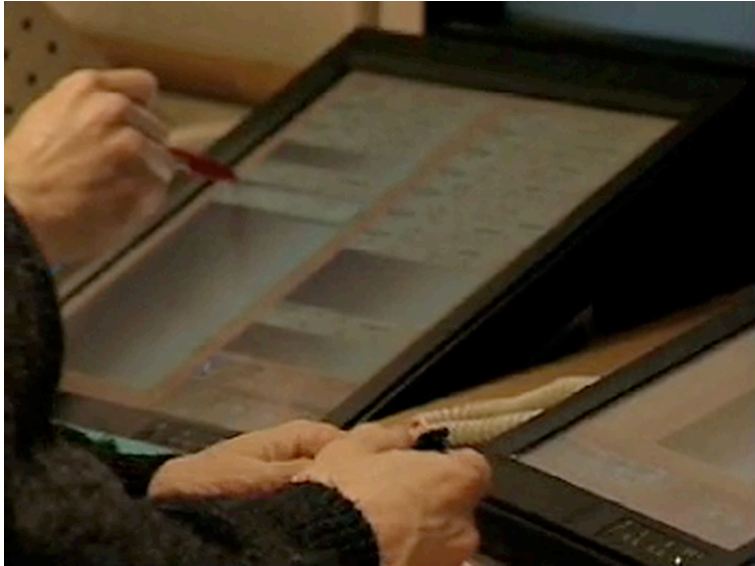
how do we maximize users' awareness of what teammates do?

how can we enable seamless dynamic task allocation?

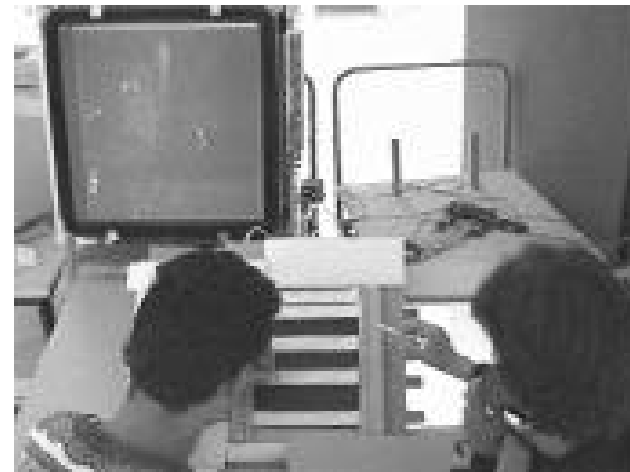
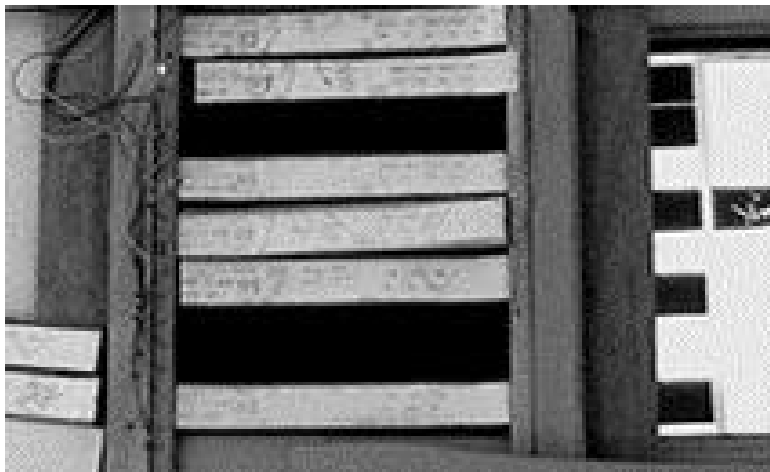
what set of guidelines should we follow to design effective collaborative tools on tabletop?



## related work



digistrip



chameleon (augmented paper strips)



# requirements

inform the system

more than two users

foster mutual awareness

foster communication and coordination

foster dynamic task allocation

# system design

horizontal shared, multi-touch surface

design principles:

- reify actions into objects

- enable partial accomplishment of actions

- provide feedback



**Post-it timeline**



**printer**

DLH43C LTP 1002  
EDDM LPPT 260

IWD527 LFSB GC  
A3

PRINT

**rotated strip**

CSA6721 LTP 1000  
LKPR LEMD A321 380

TAP558 LTP 0952  
EDDM LPPT A319 380

**trail**

EZS14J LTP 2952  
LFSB LEMG A319 342

**extrapolation tool**

EXTRAPOLATION

TAP558 EIN515

in 5'00'  
at 09°49'50

RESET

**TRAJECTORY EDITOR**

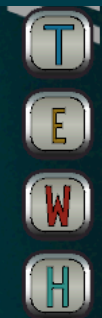
	FL	DIRECT	HEADING	TURN	SPEED
EIN515 LFML EIDW A320	260	/	0	/	460
EZS9PT LEMG LSGG A319	260	/	55	/	460
EZY5KK LEPA EGKK A319	410	/	0	/	460
CSA8114 LEBB LHBP B733	280	/	0	/	450
TAP558 LPPT EDDM A319	390	/	0	/	450

ABORT APPLY

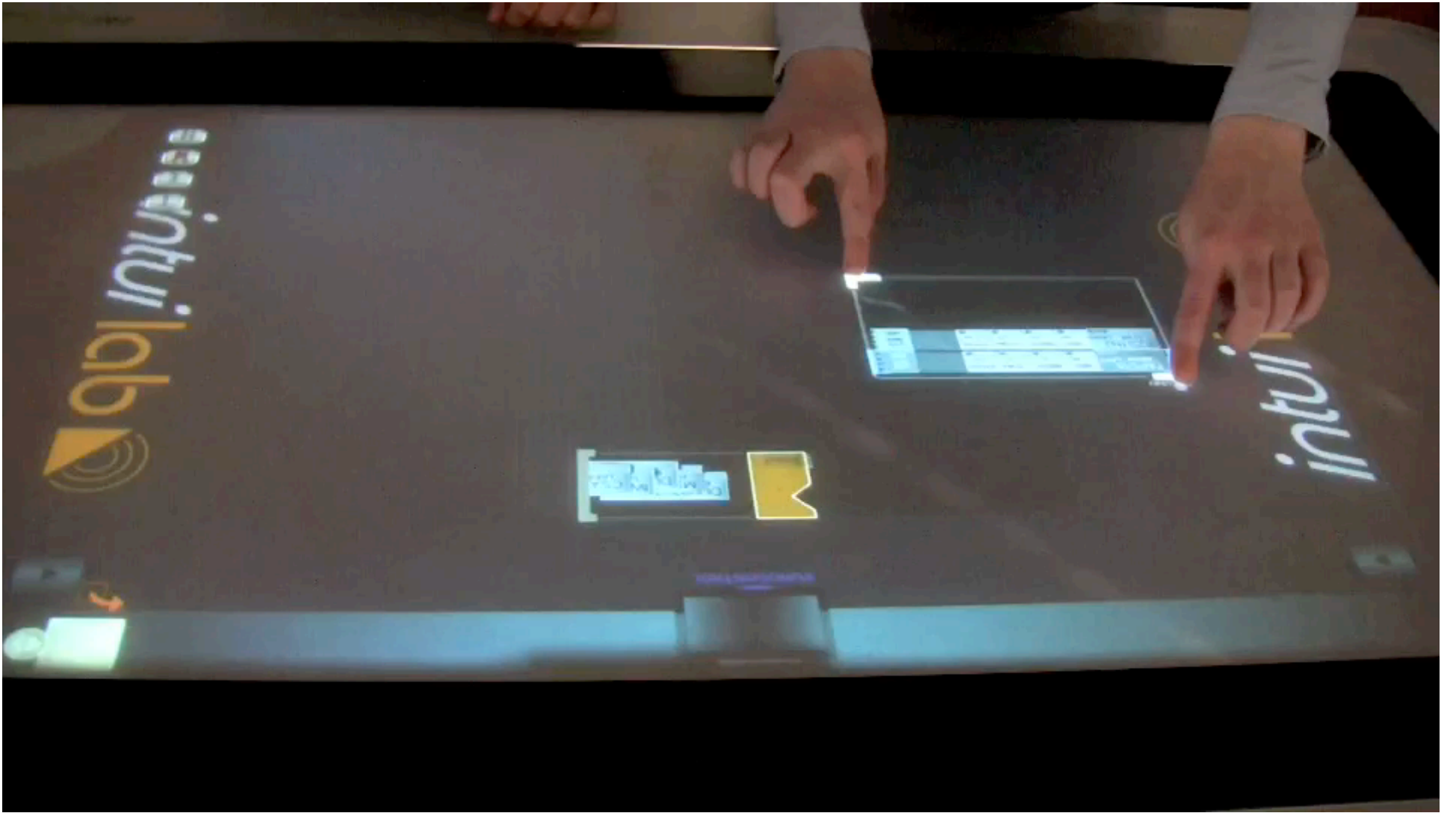
**COLUMN**

CSA8114 LHBP LEBB B733	MEN 43	MEZIN 50	LATAM 50	ETREK 53	LTP 0958 300
EZS9PT LSGG LEMG A319	AMIKO 45				LTP 0951 200
EZY5KK EGKK LEPA A319	MRM 41	MTL 51	ETREK 57		MADOT 1001 400

**column with extended strips**



**trajectory editor**







# preliminary evaluation

## exp 1: mutual awareness

proc: list of actions to perform in parallel, report other's actions at the end

res: failure

expla: still discovering interface, not a real scenario

concl: proximity not enough, engagement needed

## exp 2: communication

proc: must make focus with non verbal communication

res: used post-it, timelines and juxtaposition

res2: ATCo group: success, non-ATC group: failure

concl/expla: must share same level of skills

# preliminary evaluation

## exp 3: coordination with postit

proc: clearance + traj editor (tactical), notify with post-it  
(planning)

res: failure

concl/expla: timeline badly positionned

## exp 4: more than 2 users, dynamic task alloc

proc: regular traffic control with 2, then 3

res: success, effective use of the system, close collaboration,  
parallel task accomplishments

# discussion and conclusion

system usable (to a certain extent)... but needs more work

only partial evaluation

would be useful especially in storm situation

layed information (time-line, post-its) helps people figure out others' actions

... and instruction

time-line helps instructor understanding trainee strategy

real-time correction by instructor

# open questions

how to measure awareness, coordination, task allocation ?

co-evolution of the activity (less specialized individuals) ?

real context ?

a name ?