Evaluation of Usability and Workload with Paper Strips as Compared to Virtual Flight Strips Used for Ramp Operations

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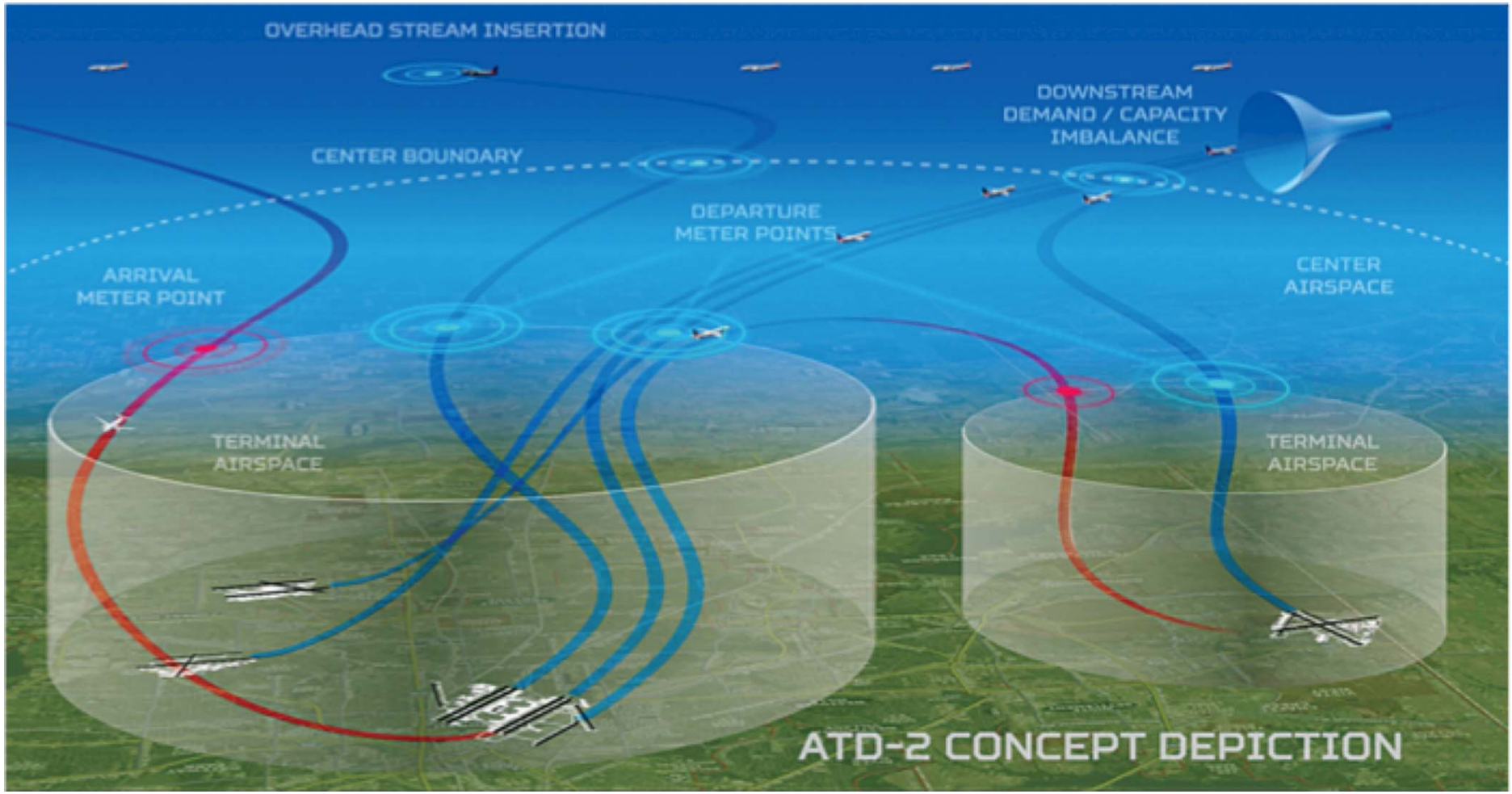
AHFE July 23 2018

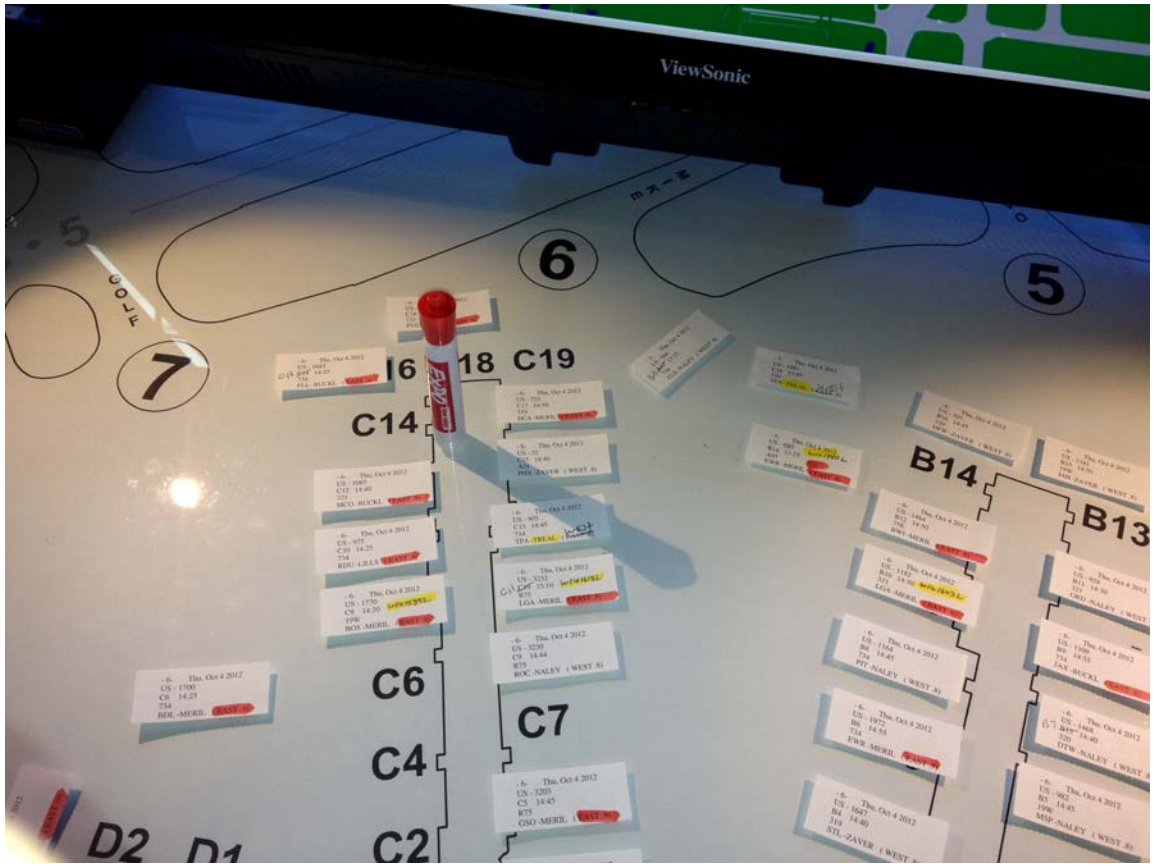
What is ATD2?

Airspace Technology Demonstration (ATD) 2

Integrated Arrival Departure Surface traffic management developed at NASA.
We are currently fielding the surface tool with AAL at CLT



Paper Strips and Paper Map
at Charlotte Douglas International Airport



Paper strips and paper map limitations include

- Lack of digital updates to flight data
- Lack of Traffic Management Initiative data

-4- Thu, May 29 2014
ASH9632
E25 S12 13:55
CRJ9
SAV -BUCKL (EAST .9)

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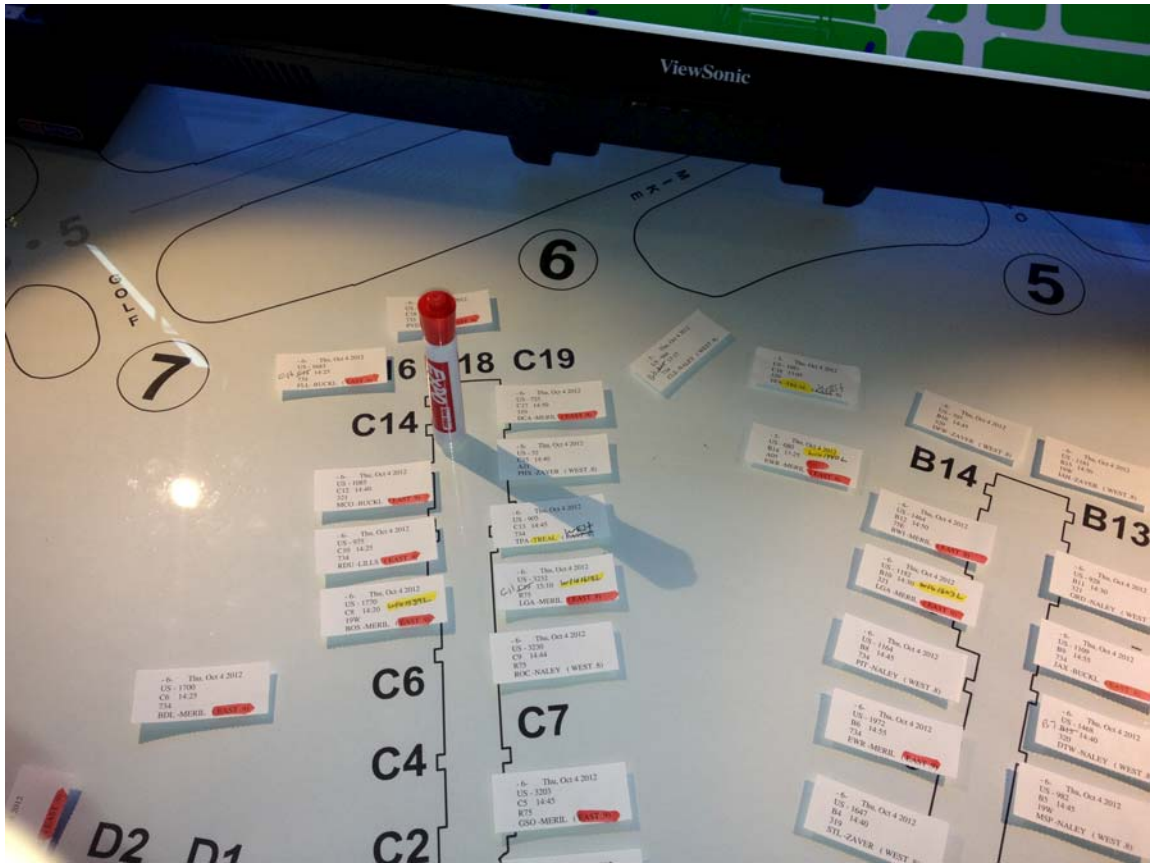

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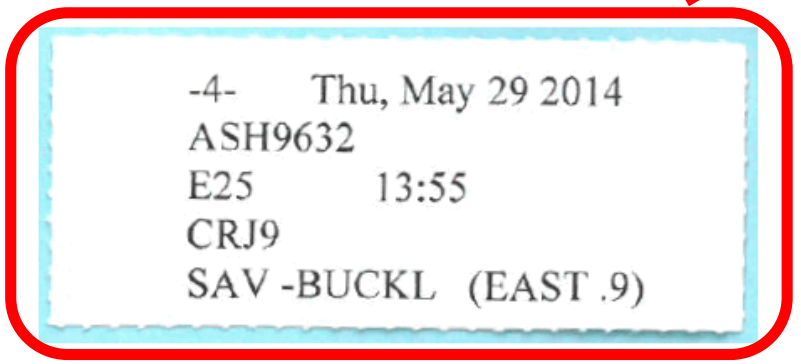

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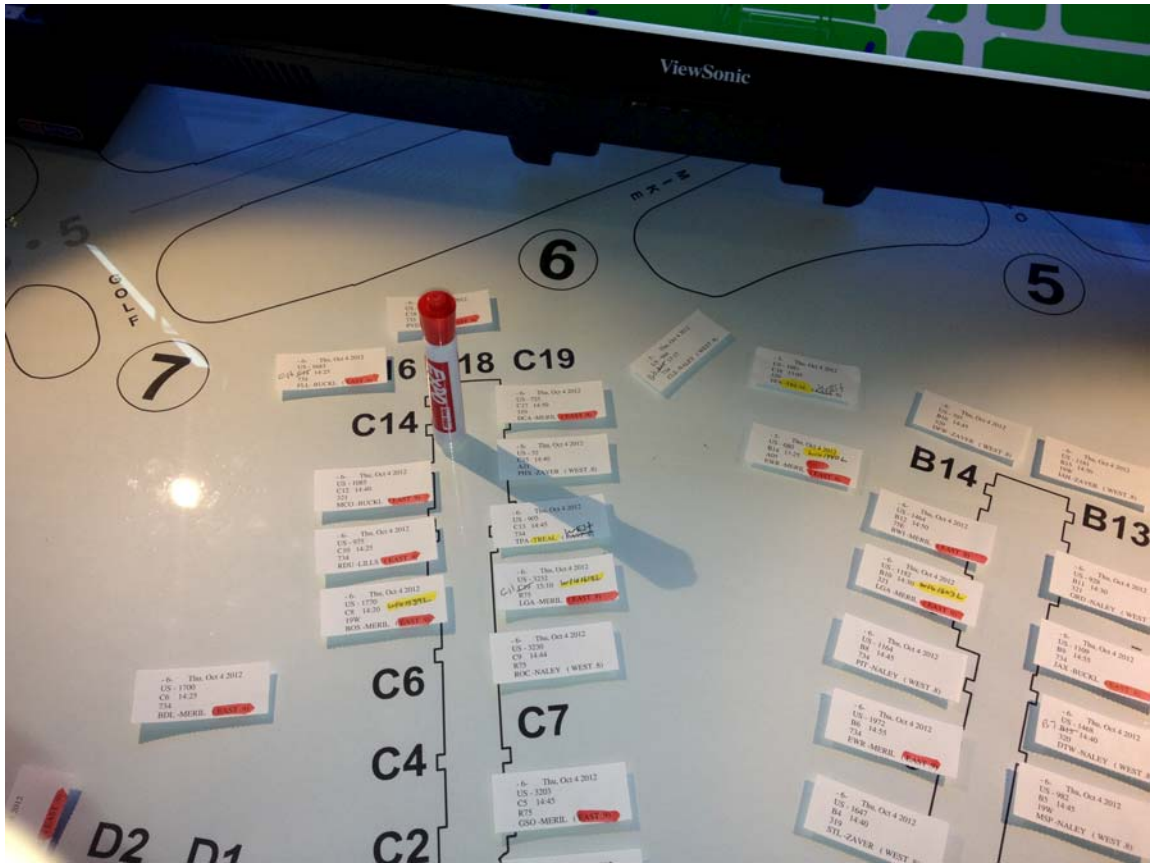

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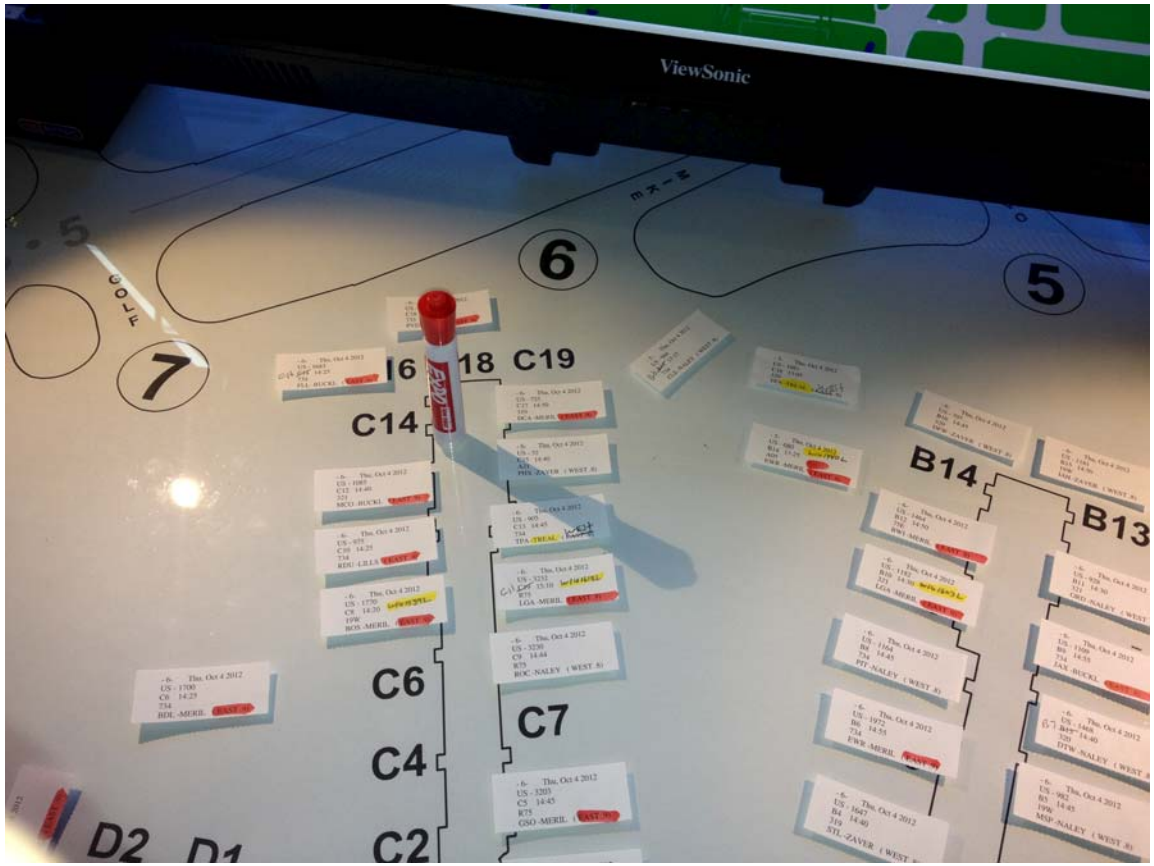

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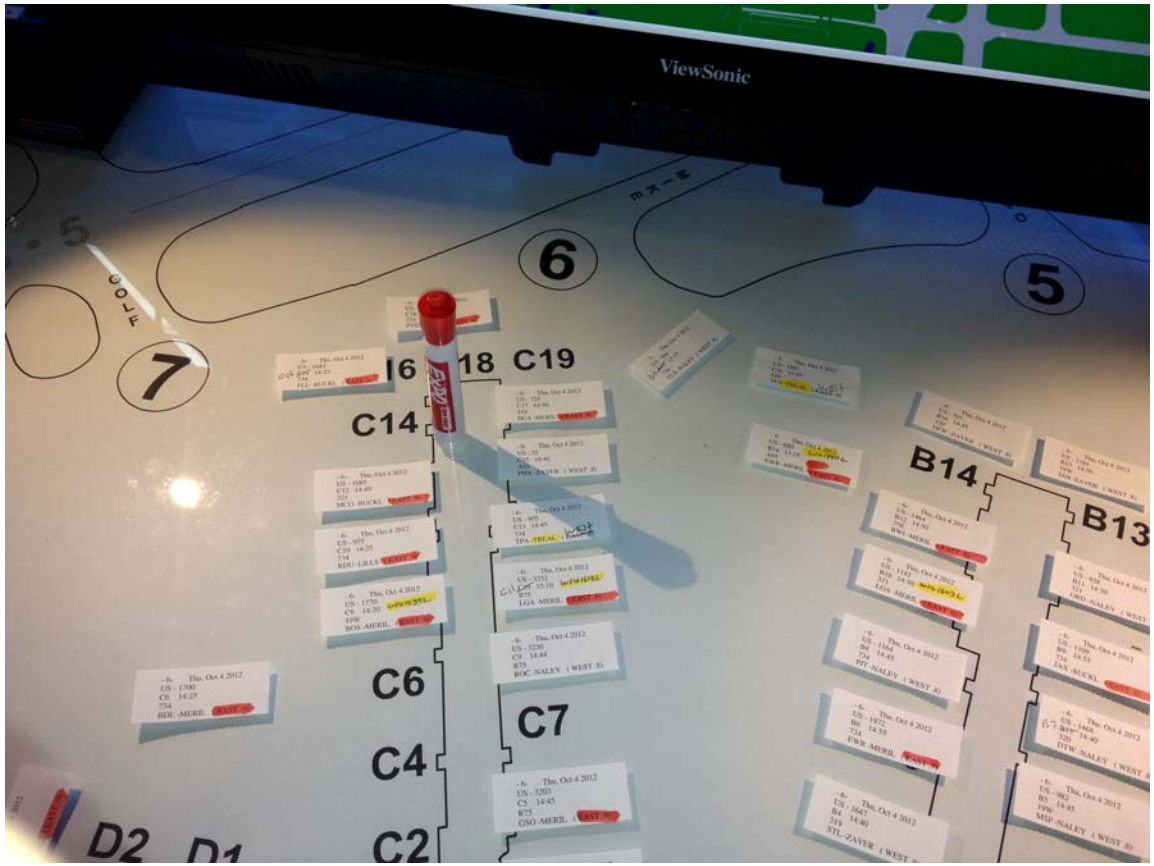

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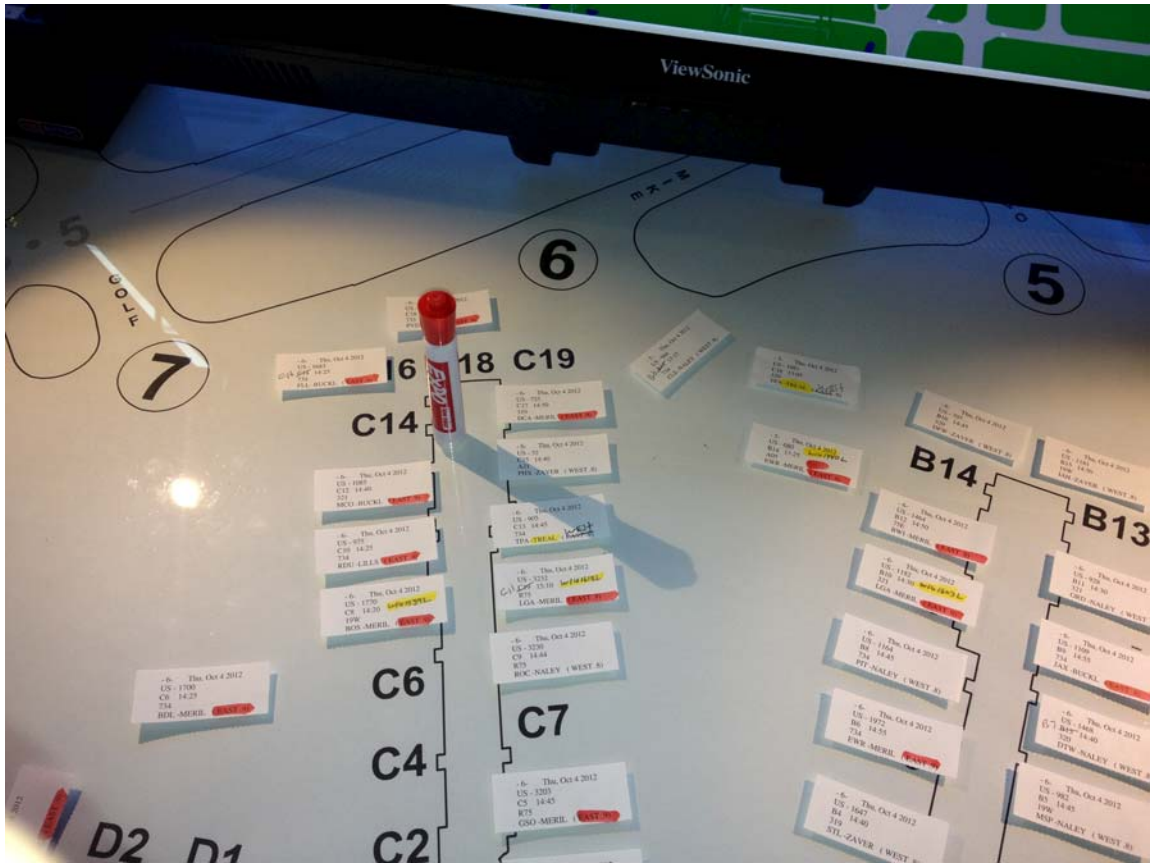

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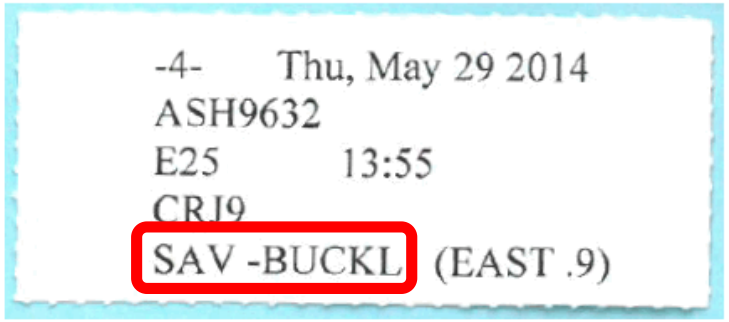

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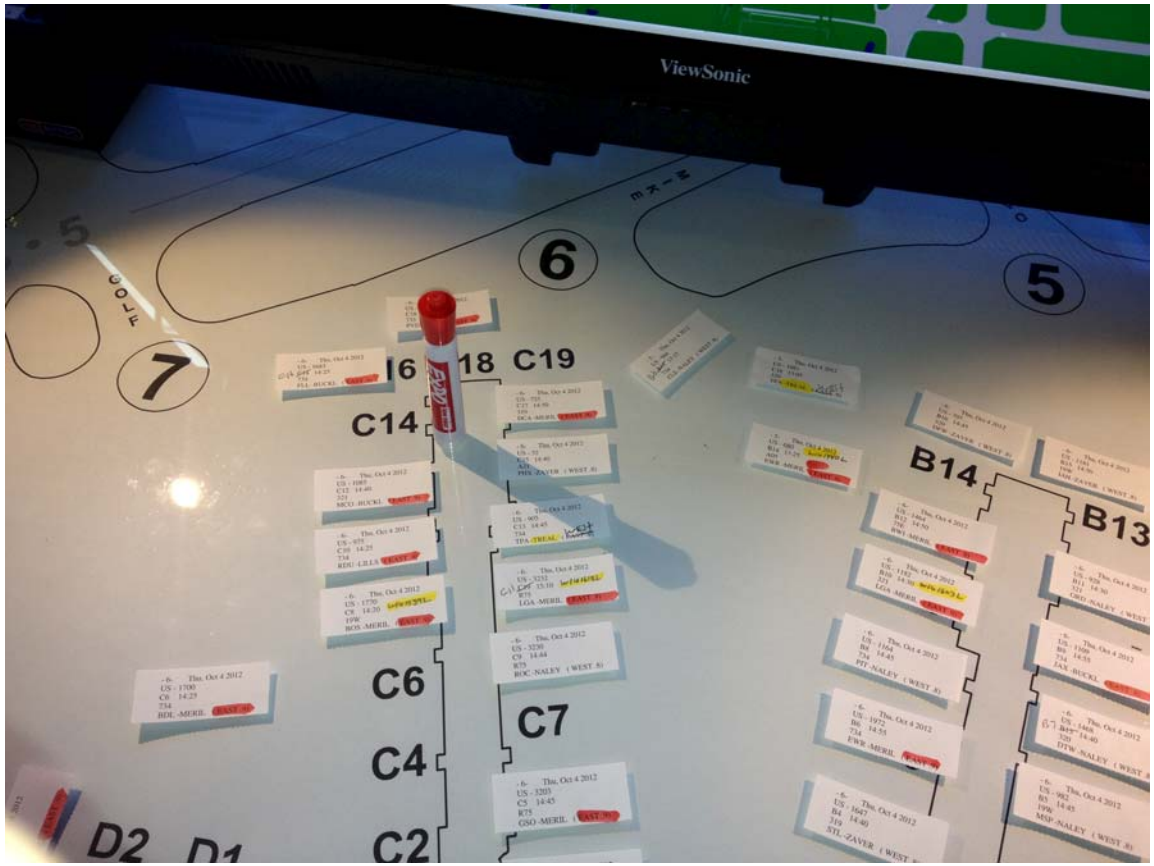

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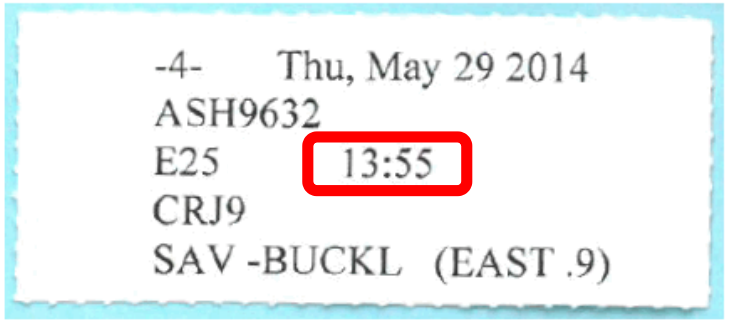

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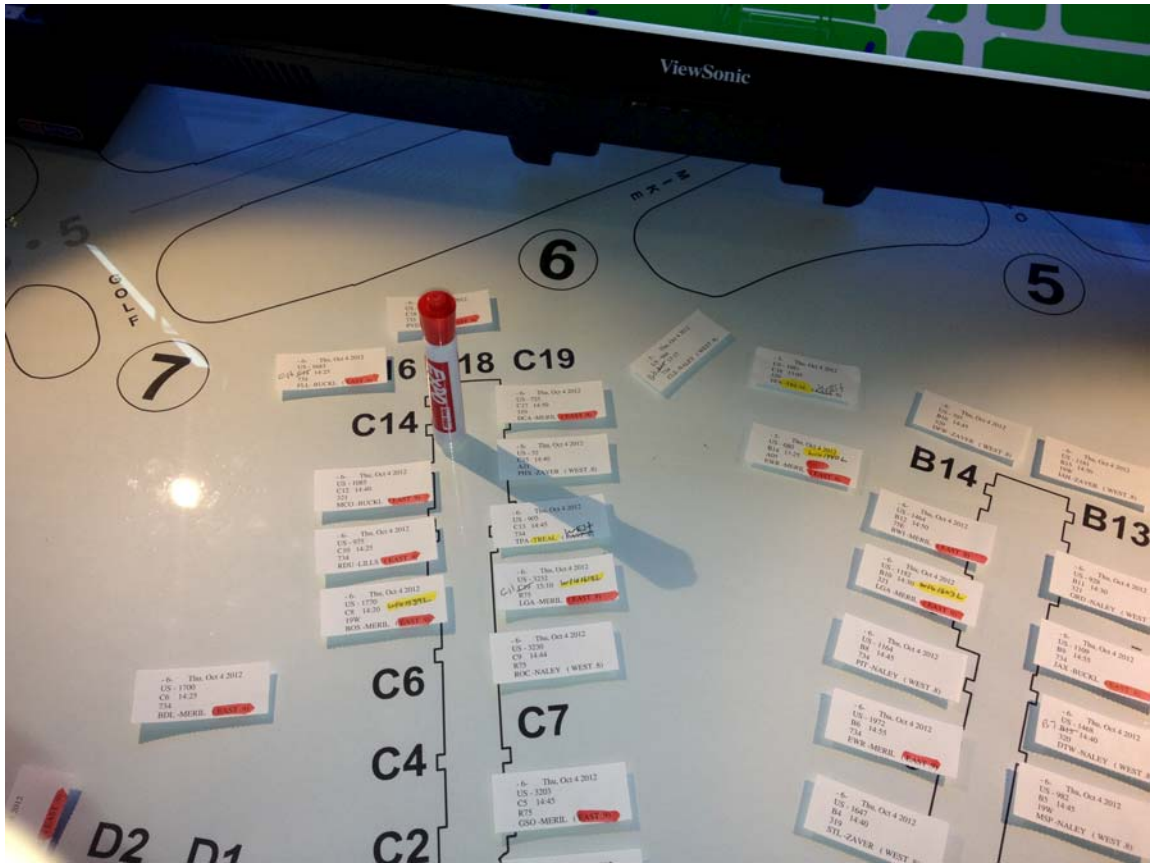

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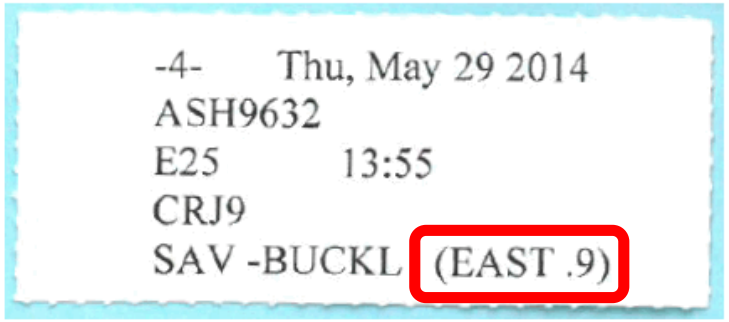


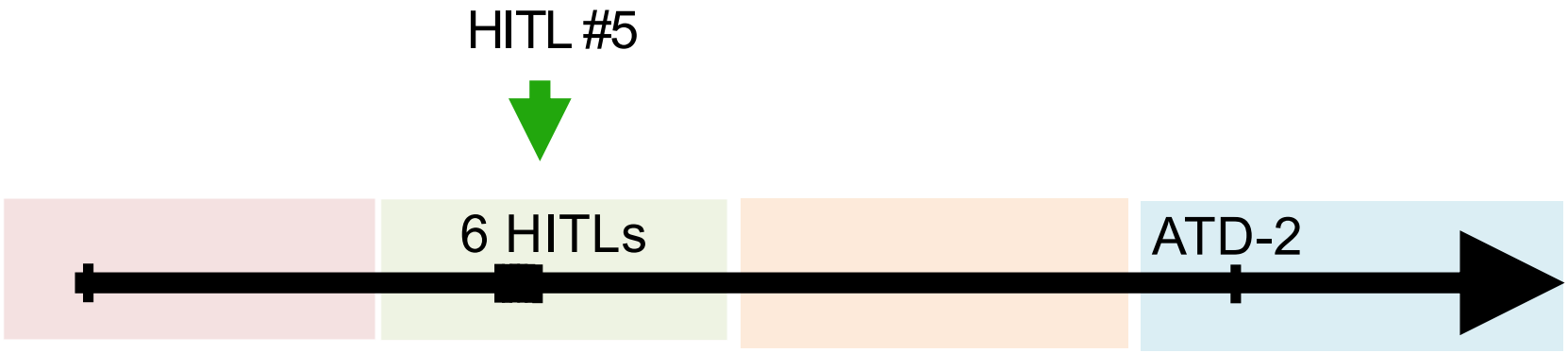
Virtual Flight Strips
Ramp Traffic Console (RTC)

- Interactive moving map
- Digitally updated flight data
- Provide Traffic Management Initiative data
- Decision Support - metering pushback from the gate

Outline

- Background
- **Evolution of Ramp Traffic Console and ATD2**
- Objective of current study
- Ramp Traffic Console features
- Design of experiment
- Method
- Results
- Discussion
- Future Work

Evolution of ATD2
(Airspace Technology Demonstration 2)



Ramp Traffic Console designed along with a new departure metering decision support tool

Evaluation and Design Evolution

Integration of Ramp Traffic Console with other tools used by the Air Traffic Control Tower and Center controllers

Current day field testing activities

Outline

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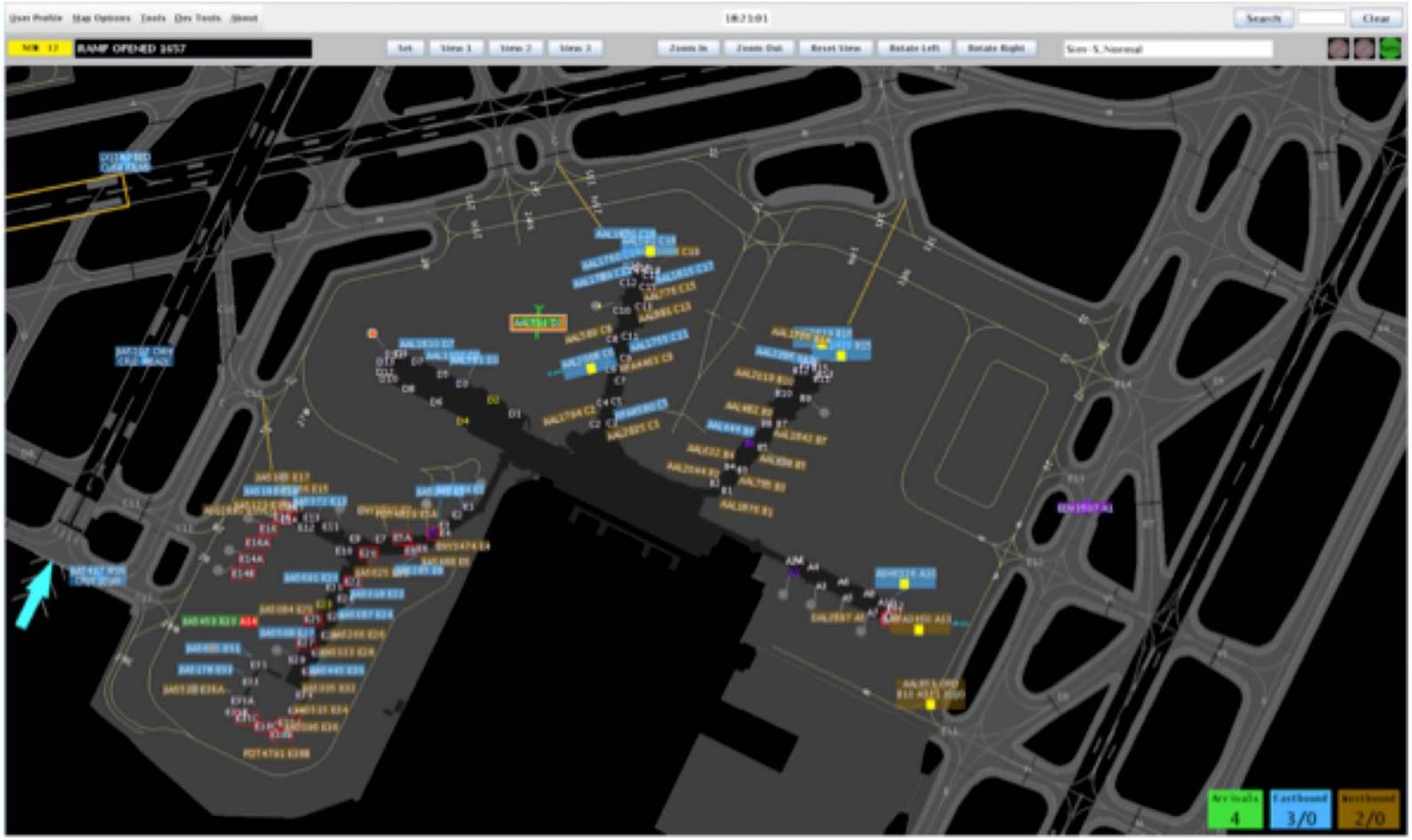
HITL 5 Objective

- Human in the Loop (HITL) #5 simulation experiment was conducted to evaluate usability and workload ratings of ramp controllers with the using paper strips as compared to virtual flight strips

- During the HITL, post run and post study questionnaires were administered to assess ramp controller workload and usability ratings while using either Ramp Traffic Console or paper

Current state of development of Ramp Traffic Console (RTC)



Design of Experiment

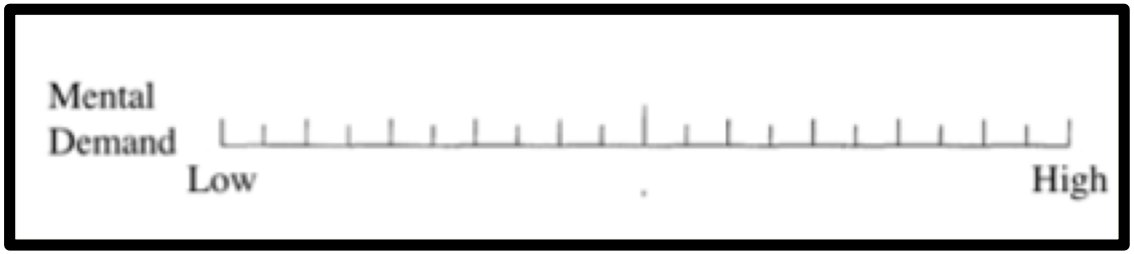
- Eight 90-minute data collection runs over three days
  - Four runs with Paper
  - Four runs with virtual strips
- Four ramp controller participants rotated through four sector positions
- Post-run and post-study questionnaires were administered to assess workload and usability
- Two-way repeated measures analysis of variance to determine effect of flight strip type on participant workload and usability

Method
Workload

Post Run workload questions

- Four aspects of workload were assessed from NASA Task Load Index
  - mental demand
  - physical
  - temporal
  - frustration
- Response on a 10 point scale:

Example question:
"Please rate your workload during the last run"



Method
Usability-ISO definition

- **Effectiveness**: Asked Seven "Traffic Management Performance" questions

  Eg: I maintained sufficient separation among planes.

  (Always) 1 2 3 4 5 6 7 (Never)

- **Efficiency**: Six "Resources and Efficiency" questions

  Eg: The actions required the minimum number of steps.

  (Always)1 2 3 4 5 6 7(Never)

- **Satisfaction**: Eighteen Post study "Preference" questions

  Eg: Rate your preference for tracking aircraft status.

  (Prefer paper) 1 2 3 4 5 6 7 (Prefer RTC)

Results Summary

- Workload results:

Lower mean workload for virtual strips

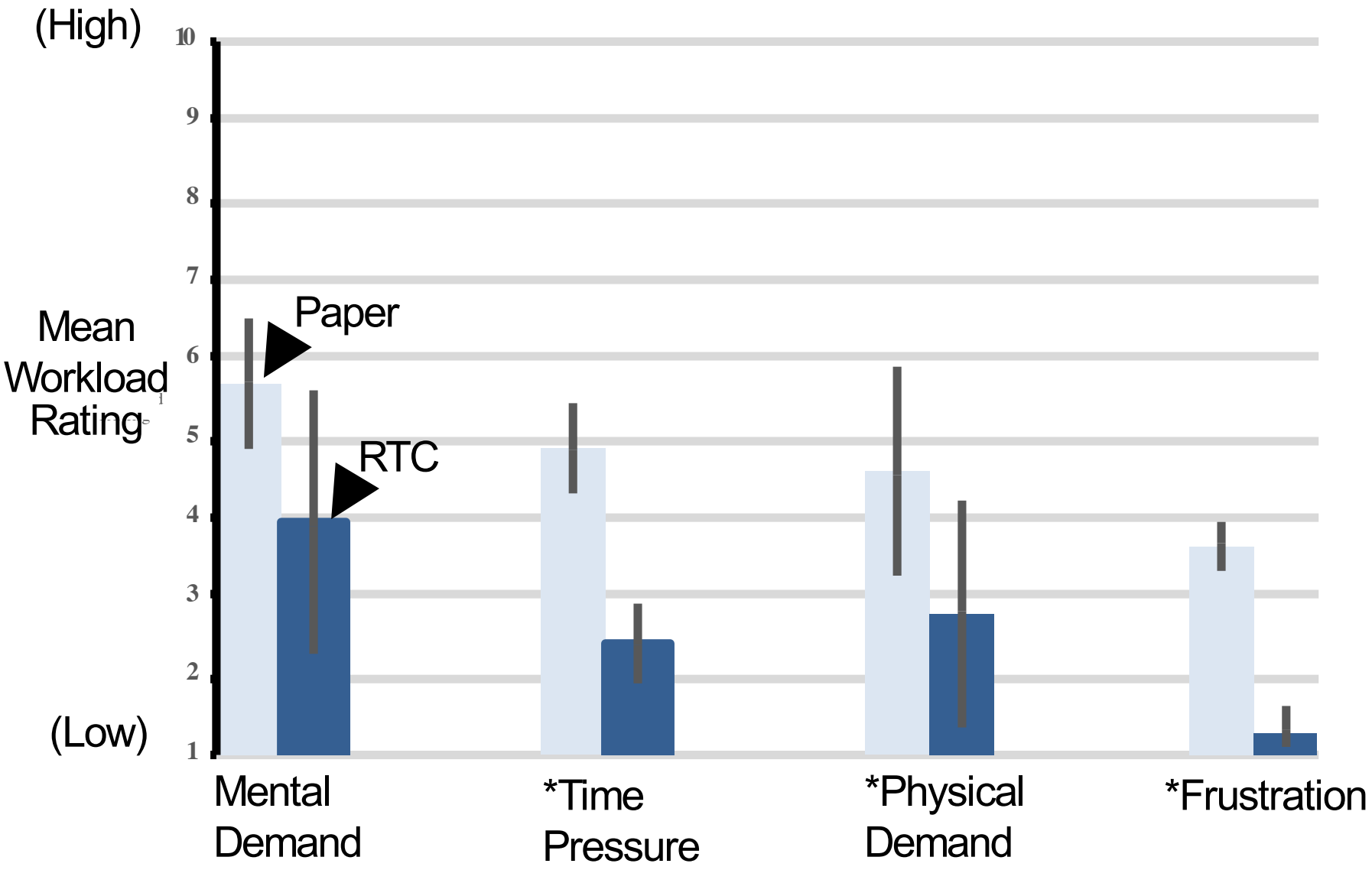
- Usability results:

Trend toward increased mean effectiveness for RTC

- Satisfaction results:

RTC preferred over Paper strips

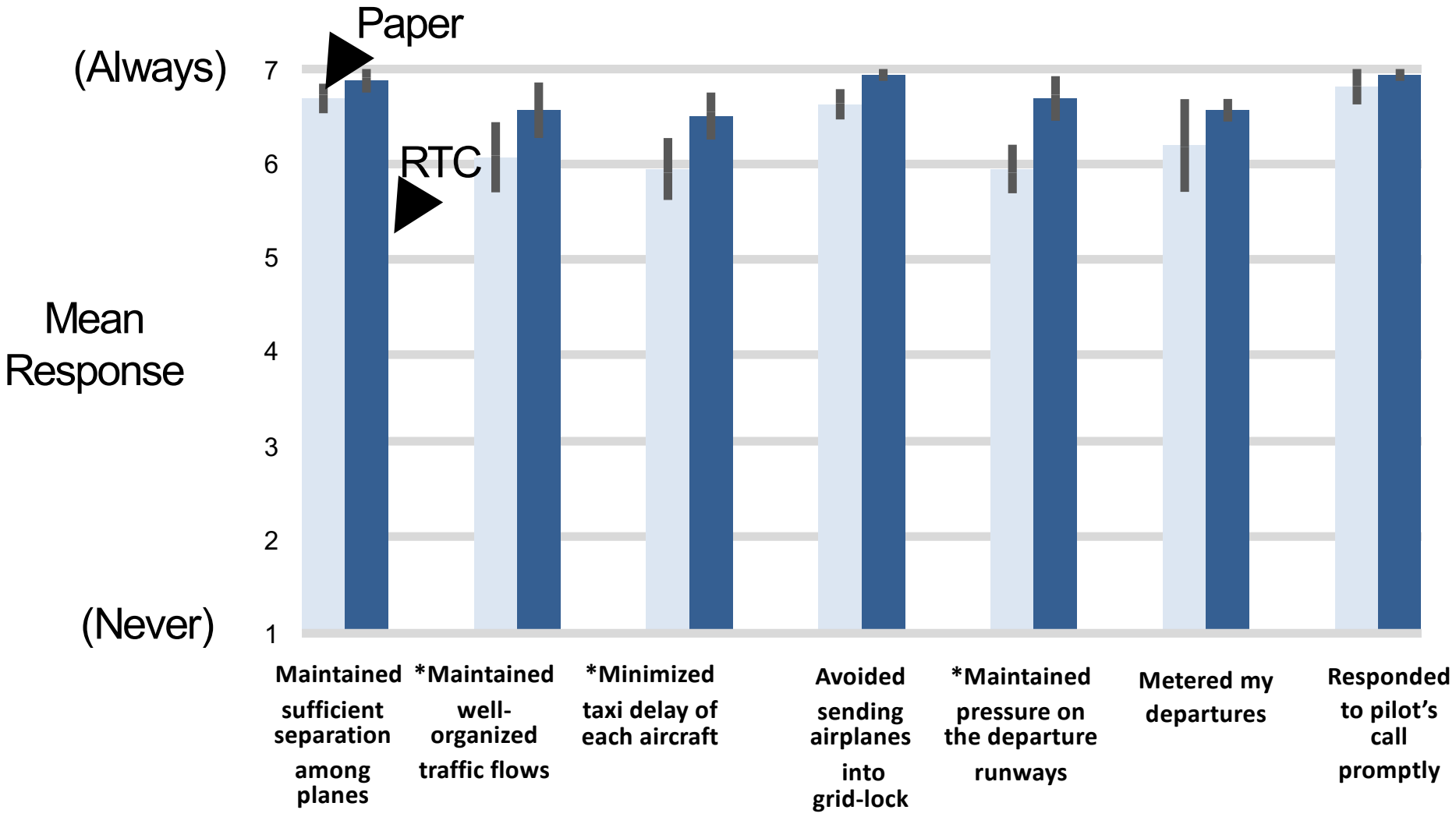
Results
Workload



Mean workload lower for RTC for three aspects of workload assessed, where * indicates p<.05

Usability-Effectiveness Aspect

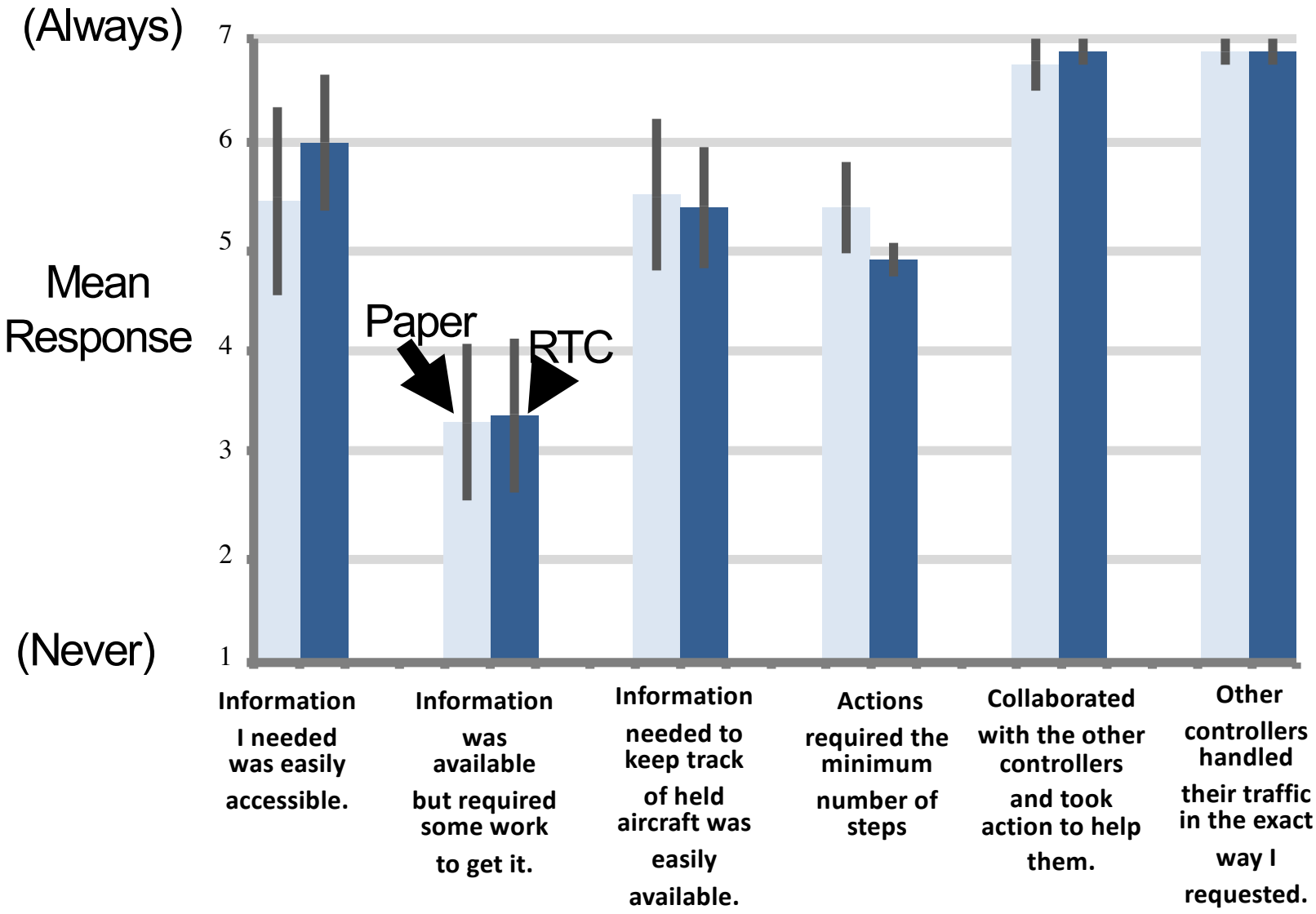
Mean Response (scale 1-7)



Mean effectiveness for RTC greater than Paper condition for three questions,

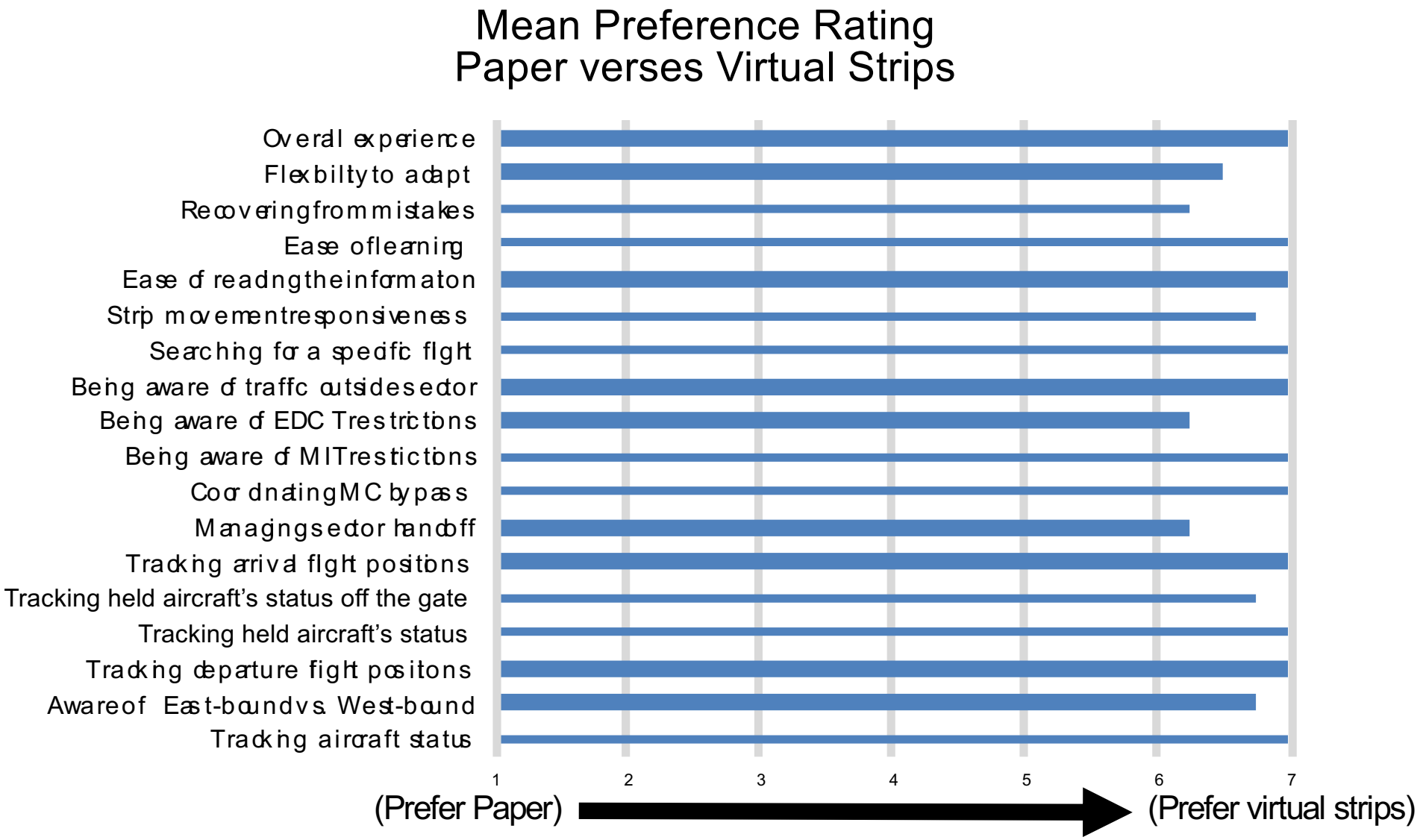
* indicates $p<.05$

Usability-Efficiency Aspect
Mean Response (scale 1-7)



Mixed results, with no statistically significant difference found between RTC and Paper

Usability
Satisfaction Aspect

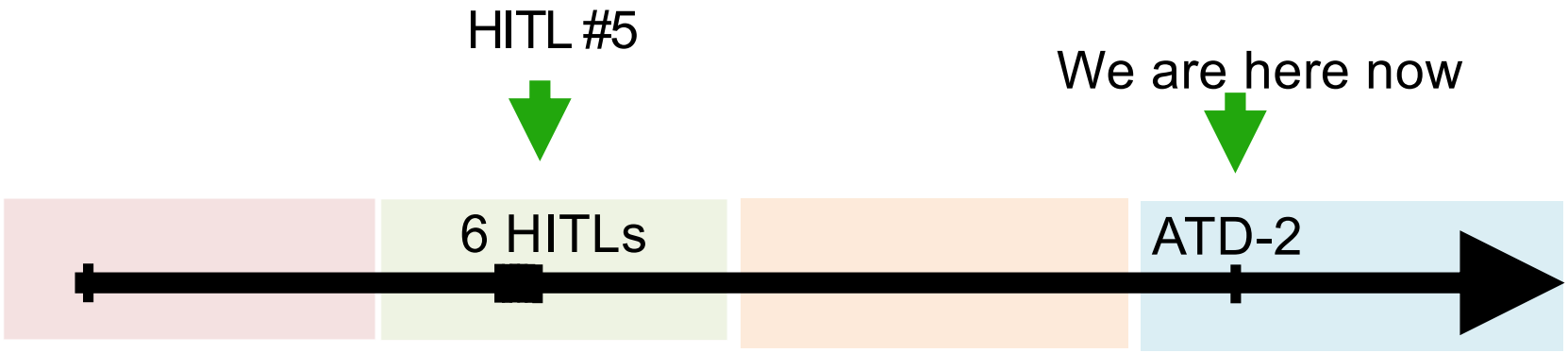


Trend towards a preference for virtual strips across all questions

Discussion

- Results indicate potential for reduced workload and increased usability with RTC
- More research required
- Actively testing in the field now

Evolution of ATD2
(Airspace Technology Demonstration 2)



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Current day field testing activities

Testing virtual strips as a part of the suite of ATD2 tools

Ramp Controllers

Some ATD-2 Field Data Results From November

Some ATD2 Colleagues are presenting some data collected from the field testing activities on Wednesday

- When active ramp controllers were asked, “Were the ATD2 tools helpful in this bank?
- Ramp controllers who used the ATD2 tools in a bank described them as helpful.

Questions?

Contact information:

victoria.l.dulchinos@nasa.gov

Extra

Ramp Managers
Some Field Data Results From November

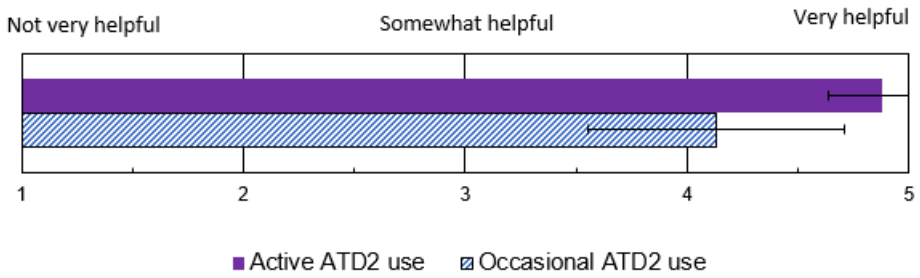
Data provided courtesy of Bonny Parke

Question Asked:

Were the ATD2 tools helpful in this bank? **(**Question asked only to those who used ATD2 tools actively or occasionally.)

Result:

Ramp managers who actively used the ATD2 tools in a bank described them as more helpful than those who used the tools occasionally.



N = 8 active, 8 occasional use of ATD2 tools in banks; $t(df\ 9.4) = 2.3$, $p = .04$, equal variances not assumed; error bar = 95% Confidence Interval.

Extra

- 2-way repeated measures analysis of variance to determine effect of flight strip type.
- found effect of condition on workload and usability
- Independent variable: Scenario, scenario1 and scenario2
- Independent variable: Condition, the first level is paper and the second level is virtual strips
- Saw no effect of scenario
- most concerned with RTC vs paper results

Results
(Workload)

Mean Participant Ratings Across Four Aspects of Workload

Aspect of Workload	Mean Response Paper	S.E. Paper	Mean Response RTC	S.E. RTC	F(1,3)=
Mental Demand	5.7	0.82	3.9	1.67	3.59,p=.155
Time Pressure	4.9	0.57	2.4	.50	48.46,*p=.006
Physical Demand	4.6	1.32	2.8	1.43	84.26,*p=.003
Frustration	3.6	0.31	1.3	0.34	29.73,*p=.012

Usability Results
Effectiveness Aspect

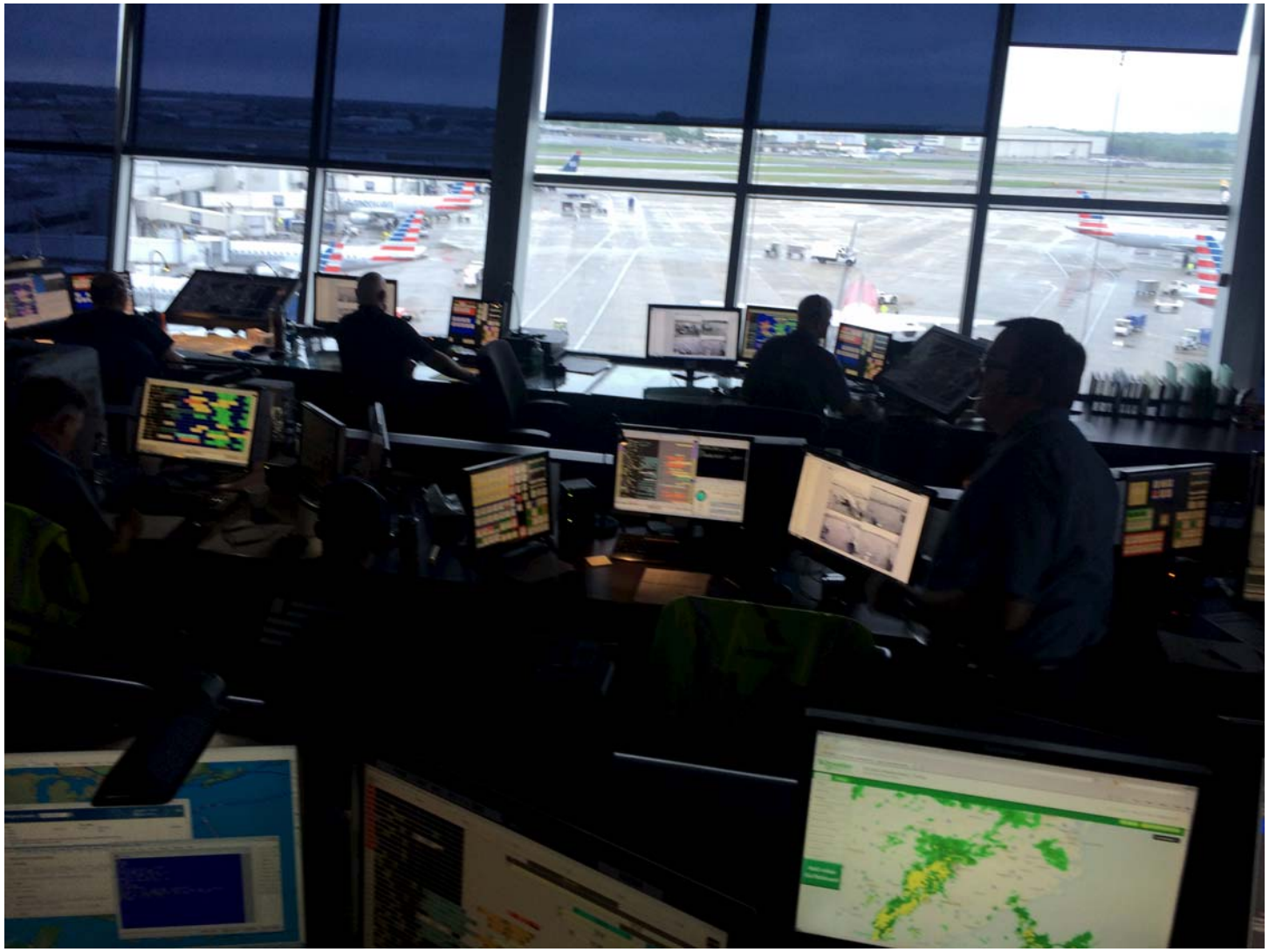
Effectiveness Question	Mean Response Paper	S.E.	Mean Response RTC	S.E.	F(1,3)=
1. Maintained separation	6.7	0.157	6.9	0.125	9,p=.058
2. Maintained flow	6.1	0.373	6.6	0.295	12,*p=.04
3. Minimized delay	5.9	0.329	6.5	0.25	22.09,*p=.018
4. Avoided gridlock	6.6	0.161	6.9	0.063	6.82,p=.088
5. Maintained pressure on runway	5.9	0.258	6.7	0.237	54,*p=.005
6. Metered departures	6.2	0.493	6.6	0.12	.73,p=.456
7. Responded promptly	6.8	0.188	6.9	0.063	.33,p=.604

Usability Results
Efficiency Aspect

Resources and Efficiency Questions Mean Response with Standard Error and F values

Efficiency Question	Mean Response Paper	S.E.	Mean Response RTC	S.E.	F(1,3)=
1. Information was accessible	5.4	0.90	6.0	0.65	1.86,p=.266
2. Information available, but required work	3.3	0.753	3.4	0.74	.03,p=.878
3. Held aircraft information available	5.5	.729	5.4	0.582	.16,p=.718
4. Actions required minimum number of steps	5.4	0.439	4.9	0.161	1.85,p=.267
5. Collaborated	6.8	0.25	6.9	0.125	.27,p=.630
6. Others handled traffic as expected	6.9	0.125	6.9	0.125	0,p=1.0

Charlotte Douglas International Airport Ramp Operations Tower



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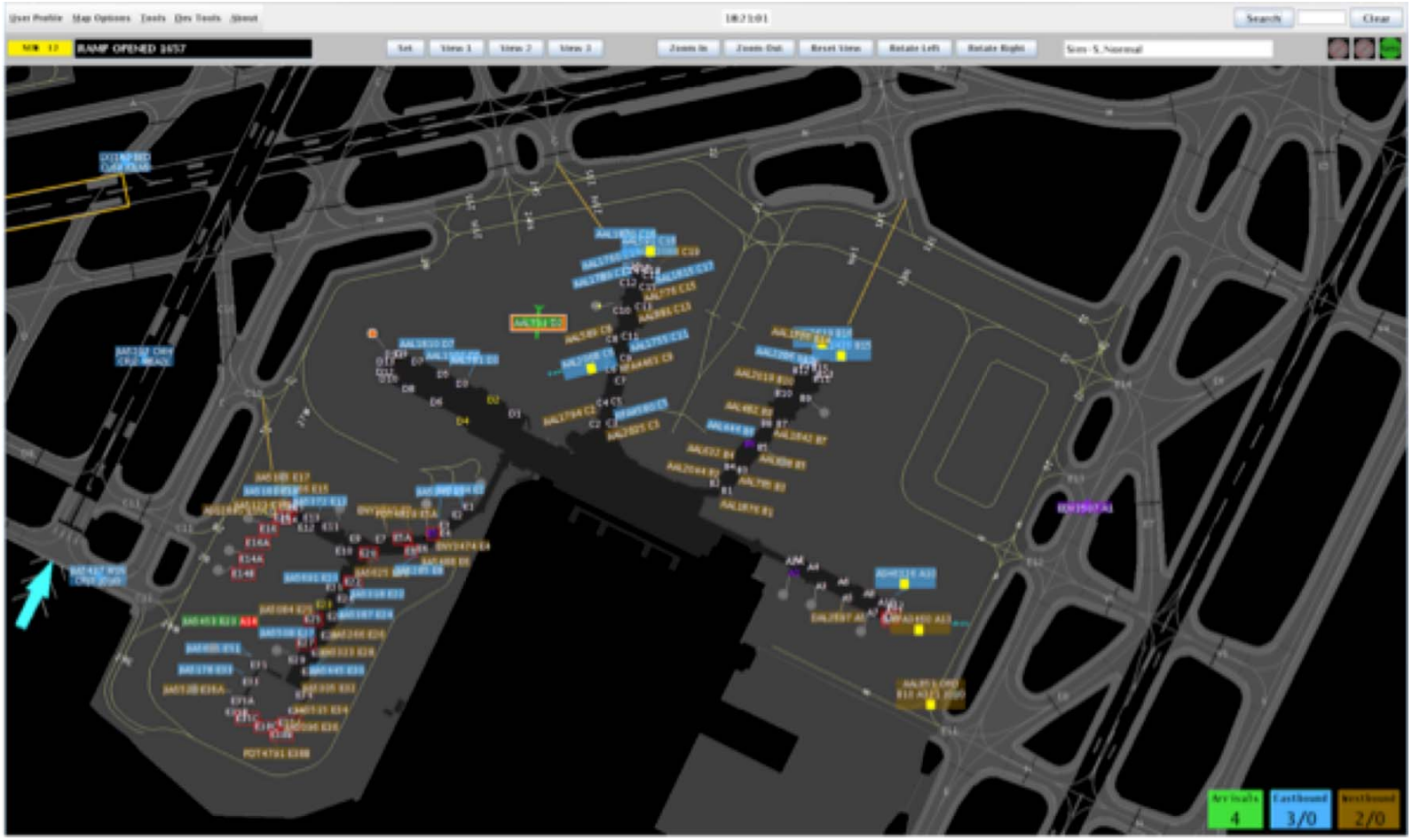
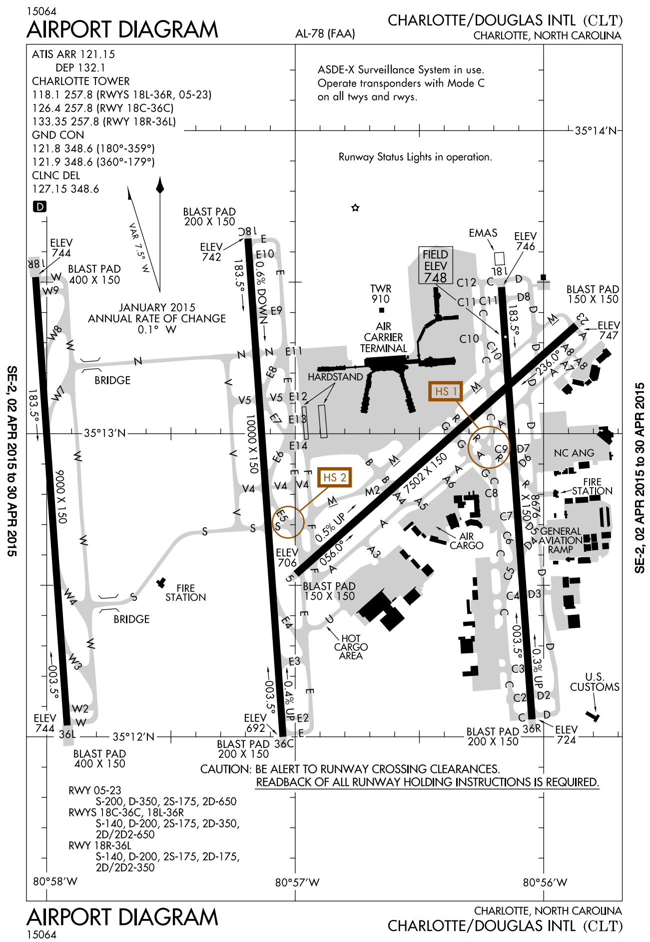


CLT


15064
AIRPORT DIAGRAM
AL-78 (FAA)
CHARLOTTE/DOUGLAS INTL (CLT)
CHARLOTTE, NORTH CAROLINA
ATIS ARR 121.15
DEP 132.1
CHARLOTTE TOWER
118.1 257.8 (RWYS 18L-36R, 05-23)
126.4 257.8 (RWY 18C-36C)
133.35 257.8 (RWY 18R-36L)
GND CON
121.8 348.6 (180°-359°)
121.9 348.6 (360°-179°)
CLNC DEL
127.15 348.6
ASDE-X Surveillance System in use. Operate transponders with Mode C on all twys and rwys.
Runway Status Lights in operation.
JANUARY 2015
ANNUAL RATE OF CHANGE
0.1° W
VAR 7.5° W
35°14′N
35°13′N
35°12′N
FIELD ELEV 748
TWR 910
AIR CARRIER TERMINAL
HARDSTAND
HS 1
HS 2
NC ANG
FIRE STATION
GENERAL AVIATION RAMP
AIR CARGO
HOT CARGO AREA
U.S. CUSTOMS
BRIDGE
EMAS
10000 X 150
9000 X 150
7502 X 150
8676 X 150
CAUTION: BE ALERT TO RUNWAY CROSSING CLEARANCES.
READBACK OF ALL RUNWAY HOLDING INSTRUCTIONS IS REQUIRED.
RWY 05-23
S-200, D-350, 2S-175, 2D-650
RWYS 18C-36C, 18L-36R
S-140, D-200, 2S-175, 2D-350, 2D/2D2-650
RWY 18R-36L
S-140, D-200, 2S-175, 2D-175, 2D/2D2-350
80°58′W
80°57′W
80°56′W
SE-2, 02 APR 2015 to 30 APR 2015
AIRPORT DIAGRAM
15064
CHARLOTTE, NORTH CAROLINA
CHARLOTTE/DOUGLAS INTL (CLT)