COE TTHP

COE TTHP Third Annual Technical Meeting

HF001

Universal Design for Learning and multimodal training

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Lei Ding
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Students: Ricardo Fraga
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Center of Excellence for Technical Training & Human Performance

Biography of Ziho Kang

- Education: Ph.D. in Industrial Engineering from Purdue University.
- Past work or collaboration: Samsung, NASA, and CASA.
- Current collaboration: FAA CAMI / FAA Center of Excellence (COE).
- Teaching: Cognitive engineering, statistical methods, and stochastic simulation.

- Research interests in human systems engineering:
  1. Eye tracking analytics (e.g. visual scanning patterns).
  2. Situation awareness (e.g. perception, comprehension, and prediction).
  3. Training intervention methods (e.g. UDL, eye tracking, VR/AR).

- Past grants:
  4 grants from CAMI and COE. 3 grants from NSA and others.
- Current grant:
  Analysis of human behaviors and strategies for risk reduction: Application in high-fidelity VR simulation of airports. (CAMI)

Universal Design for Learning (UDL)?

- **What is UDL?**

  Training material developed to meet diverse needs.

  Information representation (e.g. visualize data, link contents)

  Action and expression (e.g. build it yourself, express and share)

  Engagement (e.g. role playing, motivation)

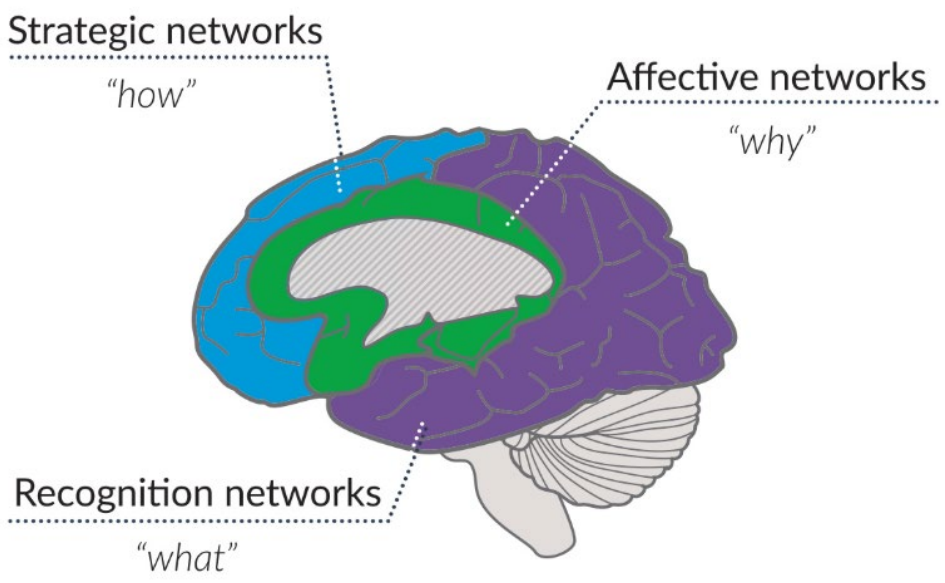

Image retrieved from http://cast.org.

Universal Design for Learning (UDL)?

- **Why need UDL?**

  Address trainees' diverse needs ➡ Training performance increase

- **Seems so simple! Why aren't we implementing it?**

  Implemented in K-12 education, but not actively implemented above K-12…

  Takes time and effort to develop practical implementation examples.

Image retrieved from http://cast.org.

Image retrieved from CBAST.

FAA COE - HF001 (A17-0161): Universal Design for Learning and Multimodal Training

Value

Increase training effectiveness (e.g. passing rate) of FAA Academy trainees by recommending effective and enriched training methods and materials.

Achievements

1. Developed UDL implementation examples
2. Evaluated UDL training performances
3. Conducted ATC training content analysis
4. Evaluated FAA trainees' learning styles
5. Benchmarked best practices

1 technical report.
40 UDL implementation examples.
4 conference or journal papers.
4 poster exhibitions.

People:

Lead-PI: Ziho Kang
Co-PIs: Randa Shehab
Lei Ding
Han Yuan
TM: Rachel Seely

FAA Academy support:
Keith DeBerry
Ken MacNeill
Rusty Smith
Course instructors

FAA CAMI (AAM-520) support:
Interviews with instructors:
Jerry Crutchfield
Learning styles data collection:
Dana Broach
Linda Pierce
Multimodal benchmarking:
Larry Bailey

Key Takeaways

- Developed UDL implementation examples using 4 key courses:
  - Air Traffic Basics (50043)
  - Initial En Route Qualification Training (50148)
  - Terminal Basics Radar Training (50034)
  - Initial Tower Cab Training (50046).

- Quiz evaluation of using UDL materials:
  - Performance scores were higher with marginal increase of training time.
  - Note: Participants were college students at the University of Oklahoma.

- Eye movement evaluation of using UDL materials:
  - Eye movements were much more active and meaningful.

Key Takeaways (continued)

- Classroom and lab observations:

  Some UDL and multimodal training methods were already implemented.

- Learning style evaluation of approx. 500 Academy trainees:

  Trainees' learning styles tended to be "visual learners" and "sensing learners," but in general, the trainees did not strongly favor certain learning styles.

- Benchmarking shows viable potentials of applying state-of-the-art technologies:

  Eye tracking

  Virtual reality / Augmented reality

Note: Visual learners - Prefer to learn through visualizations, rather than verbal descriptions.

Sensing learners - Prefer to learn through data and facts, rather than theory or concepts.

Recommendations and benefits

Recommendations

- Design training methods and materials by referencing the UDL implementation examples.
- Adapt state-of-the-art multimodal training and performance evaluation approaches. (e.g. VR / AR, eye tracking)
- Expand UDL and multimodal training methods to other technical courses.

Benefits

- Increase training performance (i.e. passing rate).
- Save training cost and time (to train new trainees).
- Increase trainees' well-being.

Examples

- Contents:

  1-3. UDL implementation examples.
  4. Portion of experiment results using the UDL implementation examples.
  5. Summary of FAA Academy trainees' learning styles (500 trainees).
  6. Example of benchmarking state-of-the-art technologies.

1. UDL implementation examples: Information representation (Total of 22 principles)

- **Example: UDL principle of Information Representation (R2.1.) – Provide additional visual guidance (e.g. visual diagrams, charts, etc.).**
- **Data provided as a table is additionally transformed as a visual diagram to provide trends.**

FOR APPROACH TO THE NEARER OF STAGGERED PARALLEL RUNWAYS	
DISTANCE BETWEEN CENTERLINES	THRESHOLD STAGGER
2,400 feet	500 feet
2,300 feet	1,000 feet
2,200 feet	1,500 feet
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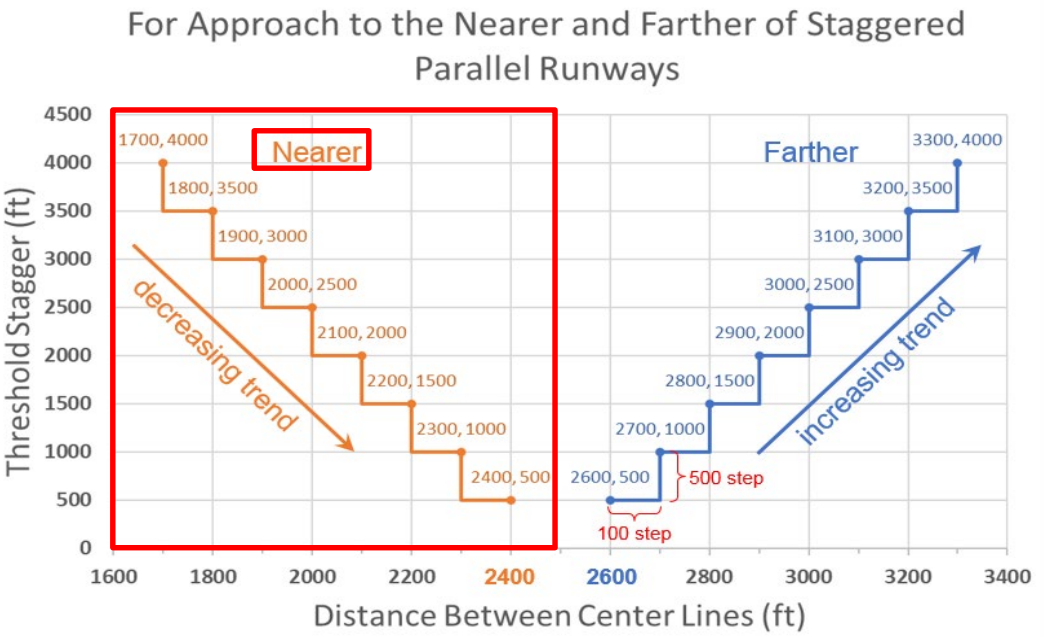
19

NOTE: The above table is not all-inclusive. It is meant to give you an idea of how the stagger increases as the distance between the centerlines decreases.



Original contents in Initial Tower Cab Training (50046) – Lesson 24 (PRS/SLP 24) IFR Arrival and Departure Procedures.

UDL-inspired contents: The trends and steps are clearly visible enabling the students to better understand and memorize the contents.

2. UDL implementation examples: Action and Expression (Total of 27 principles)

- **Example: UDL principle of Action and Expression (A4.3.) – Use story webs, outlining tools, or concept mapping tools (i.e. web applications).**
- **Word Cloud activities allow the trainees to brainstorm key concepts and share them to foster discussions.**

QUESTION: Why would emergencies and unusual situations create stress for a controller?

NOTE: *Discuss reasons why emergencies and unusual situations create stress, such as:*

- *Happen infrequently*
- *Unpredictable*
- *Controller is not sure how to handle*
- *Create an overwhelming sense of urgency*
- *Controller wants the situation to have a safe ending*

Knowing what to do in an emergency or unusual situation will increase your confidence as a controller.

Word Cloud - Activity

Click on the link above to participate in the Word Cloud activity among your peers.

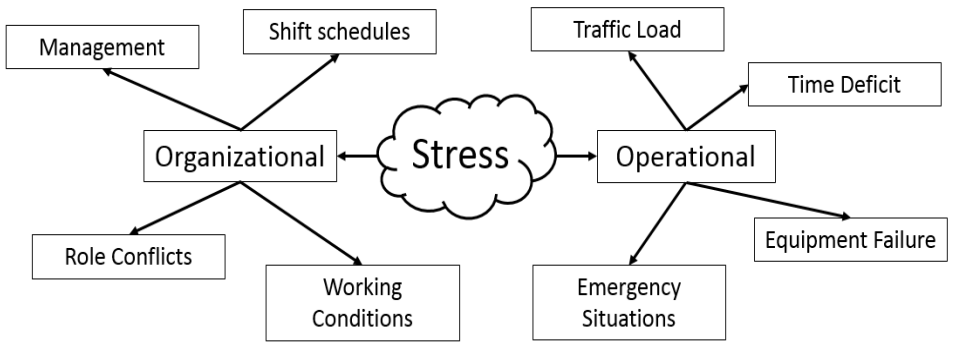
Enter as many keywords or sentences to answer the following questions:

What sources of stress might exist that should be handled by an air traffic controller?

Answers: (example) Having to cope with allocated shift schedules can be stressful.

Time remaining: 60 seconds

See concept map created from everyone's inputs: Open results



Note: Instructor will lead a discussion based on the results obtained from the trainees' inputs.

Word Cloud activity added beneath the original content in Terminal Basic Radar Training (50034) – Lesson 16 (PRS/SLP 16)

UDL-inspired contents: Upon clicking on the link, the students can participate in the Word Cloud activity that will produce aggregated results that are shared.

3. UDL implementation examples: Engagement (Total of 38 principles)

- **Example: UDL principle of Engagement (E6.1.) – Create cooperative learning groups with clear goals, roles, and responsibilities.**
- **Provide team-based activities that have well-defined components such as goal, roles, and responsibilities.**

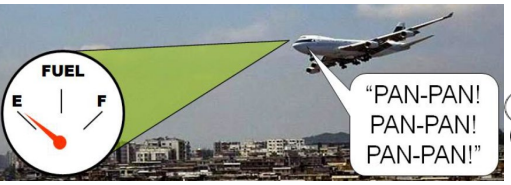
Example group activity for Terminal Basic Radar Training

A. Goals:

1. Resolve issues that occur during emergencies and unusual situations.
2. Summarize and present your group activities at the end of the class.

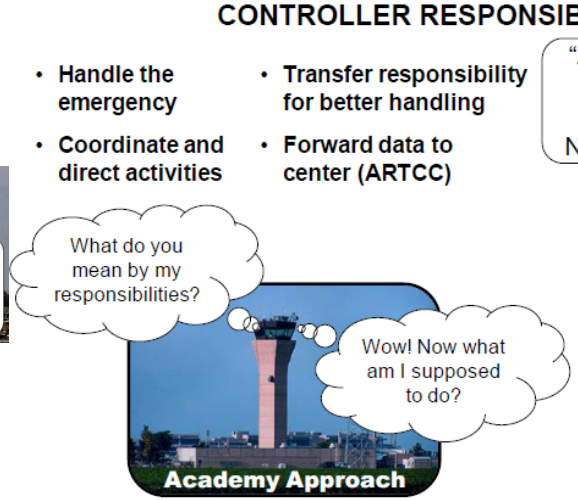
B. Case Study:

Consider an emergency when … (instructors could include the details here)



C. Roles:

1. Each trainee takes on a role (e.g. pilot, co-pilot, controller 1, controller 2)
2. Trainees should meet the requirements provided in the figure below:



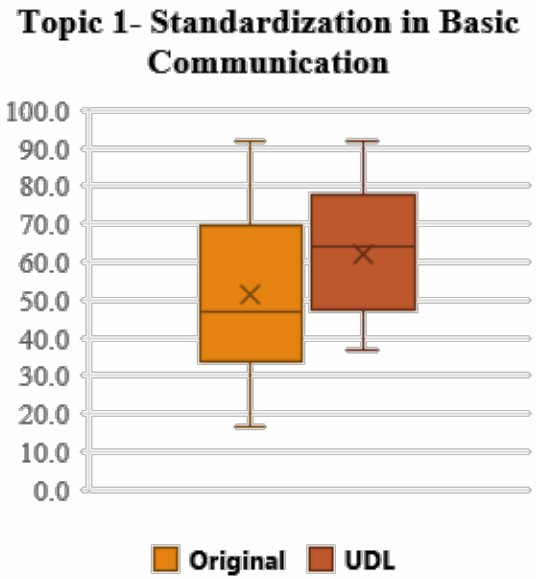
D. Execute Responsibilities:

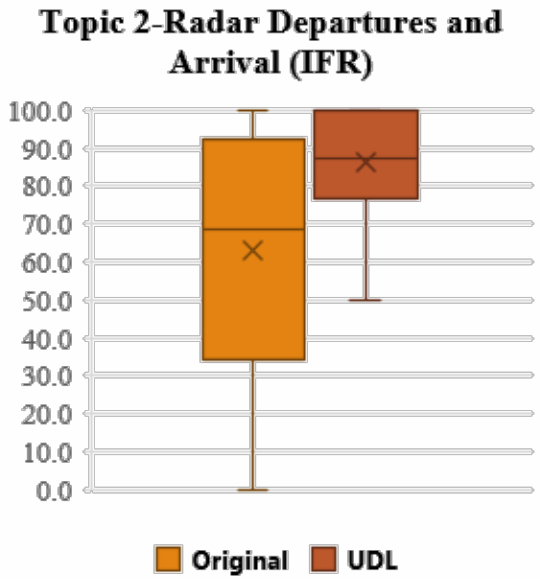
- Record every detail
- Learn from mistakes.
- Maintain transparency.
- Ask questions to the instructor about unclear requirements and responsibilities.

4. Portion of experiment results using the UDL implementation examples

- **Performance scores:**

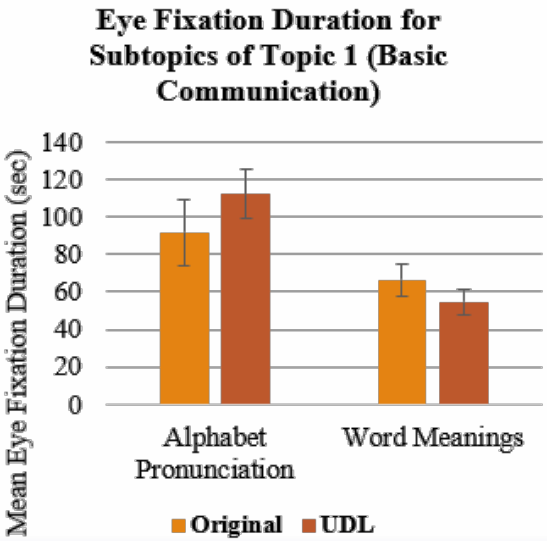
  Higher scores.

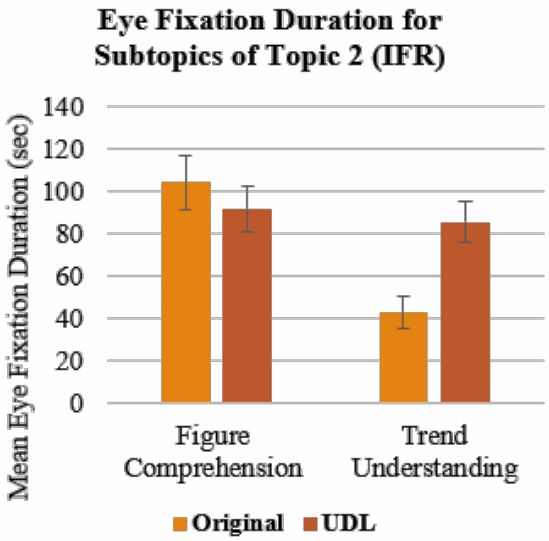




- **Eye fixation durations:**

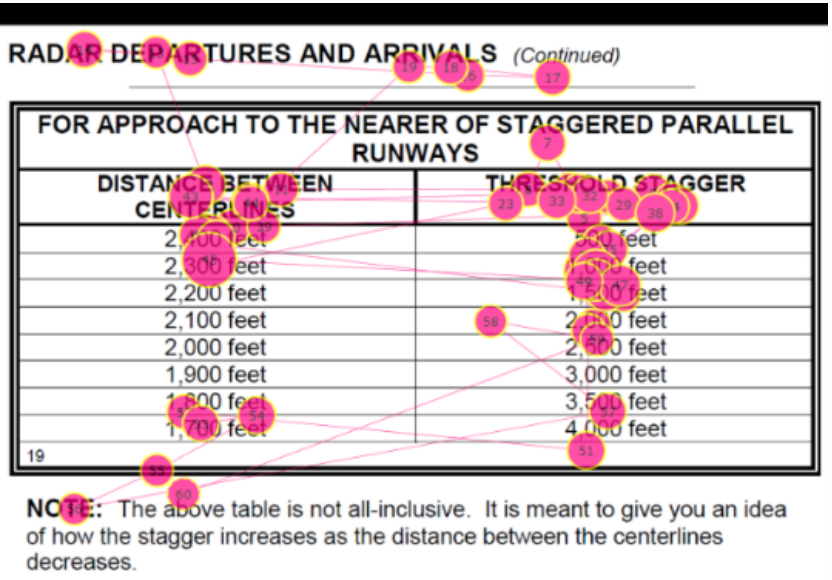
  Marginal increase of training time.





4. Portion of experiment results using the UDL implementation examples (cont'd)

- **Eye movement characteristics:**



RADAR DEPARTURES AND ARRIVALS *(Continued)*

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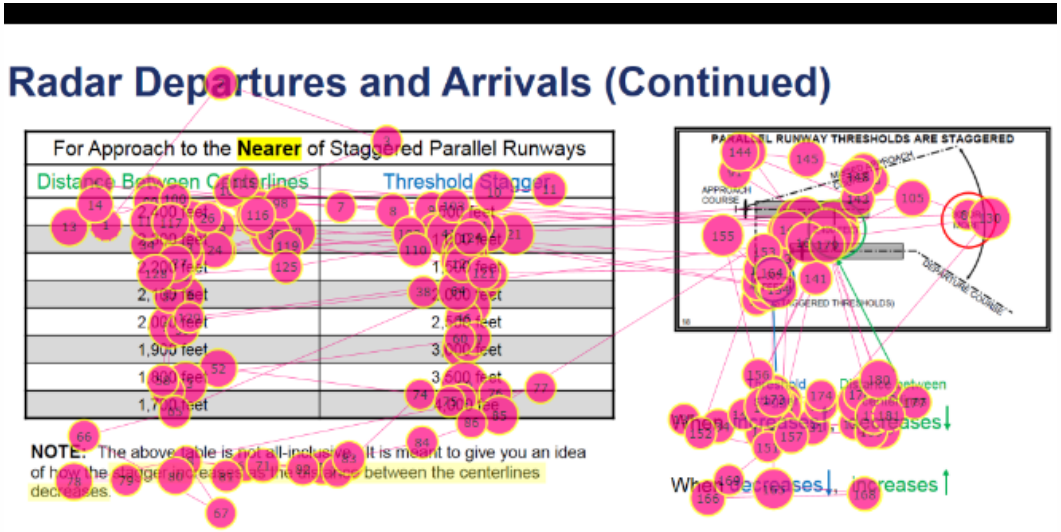

Radar Departures and Arrivals (Continued)

For Approach to the Nearer of Staggered Parallel Runways	
Distance Between Centerlines	Threshold Stagger
2,400 feet	500 feet
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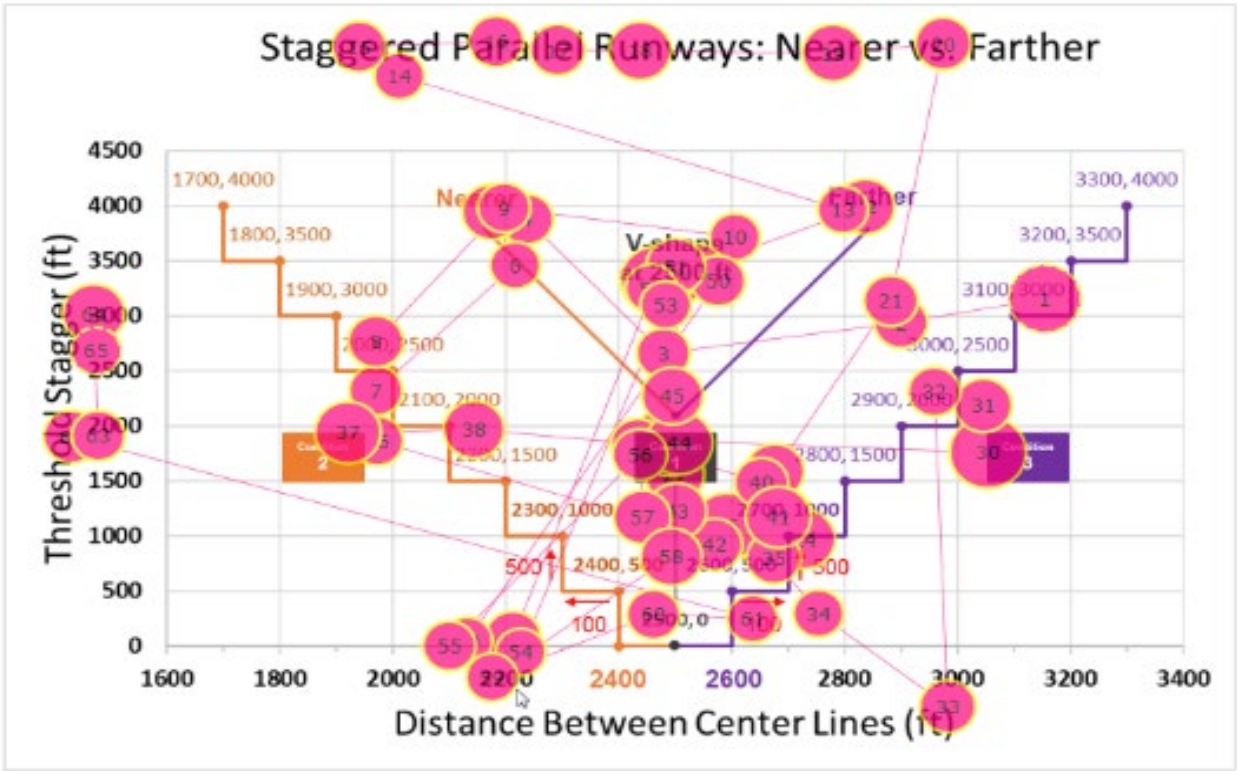
PARALLEL RUNWAY THRESHOLDS ARE STAGGERED

Original contents: Eye movements occur on some data points.

UDL-inspired contents: **Eye fixations cover most data. In addition, eye fixation transitions show active reading behavior.**

Appendix 2 : Portion of experiment results using the UDL implementation examples (cont'd)

- **Eye movement characteristics (continued):**

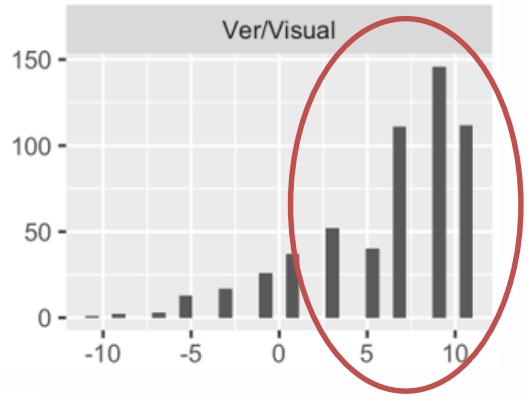


UDL-inspired contents: **Active interrogation of visualized data.** Increasing and decreasing trends can be better observed when a figure is used.

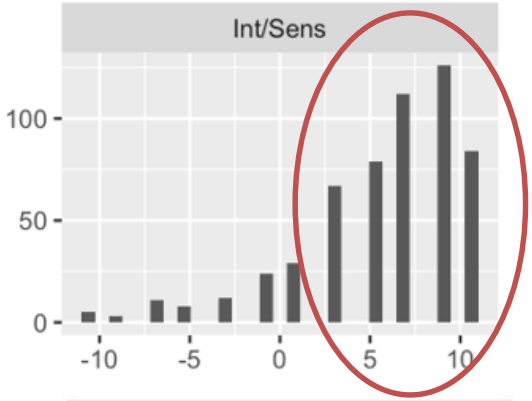
Appendix 5: Summary of FAA Trainees' learning styles (500 trainees)

- **Preferred learning styles of incoming FAA candidates (approx. 500 students)**

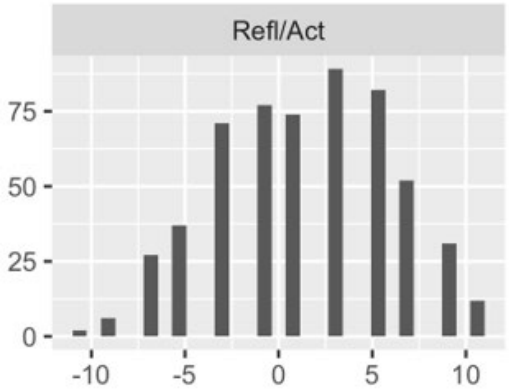
Verbal vs. Visual



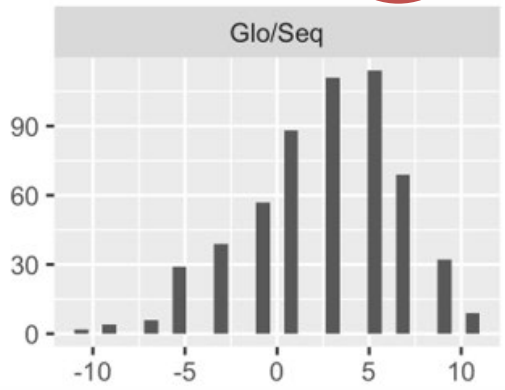
Intuitive vs. Sensing



Reflective vs. Active



Global vs. Sequential



Students tend to favor visual and sensing* learning styles. However, in general, they do not heavily favor one style over another when observing the overall learning styles.

**Sensing learners like data and facts, while intuitive learners like theories or concepts.*

Note: FAA CAMI (AAM 520) helped in data collection.

6. Example of benchmarking state-of-the-art technologies for multimodal training

- **Using Microsoft HoloLens for remote training.**
- There were no significant performance differences between onsite training and remote training.
- OU Capstone team* identified that there is potential for an 80% cost reduction in trainee travel for this one course (i.e. STAR G4 remote tower training course) alone.

Instructor is able to see what the student in viewing (in real time). The instructor is able to provide instructions verbally or visually (e.g. X mark or arrow marks). The trainee can see the marks through augmented reality.

**Note: FAA CAMI (AAM 520) lead the research and University of Oklahoma Capstone team assisted the research. The PI (Ziho Kang) was the faculty advisor of the Capstone team.*

Training in Automation, Trust, and Decision Making

Recommendations

- UDL and multimodal approaches can be applied to automated system design and automation training.

1. What are the operators' diverse needs when interacting with an automated system? We shouldn't displace human interactions, but empower it.

2. How can we associate the UDL principles (i.e. Information representation, action and expression, and engagement) to facilitate decision making training?

3. Does diversified (and redundant) information representation methods increase validity and trust?

Publications

Published Journal Papers (Total: 1)

- Kang, Z., Dragoo, M. R., Yeagle, L. N., Shehab, R. L., Yuan, H., Ding, L., and West, S.G. (2018). Adaptive learning pedagogy of Universal Design for Learning (UDL) for multimodal training. *Journal of Aviation/Aerospace Education and Research*, 27(1), 23-48.*

Note: Research contents have been substantially modified after the publication of the journal in Jan, 2018. Please see the technical report to read the modifications. Additional journal papers are in preparation.

Published Conference Papers (Total: 3)

- Yeagle, L. N. and Kang, Z. (2018). Universal design for learning (UDL) for STEM and higher education: Characterizations and applicability. In *Proceedings of the 2018 ISER International Conference on STEM* , June 18-19, Seoul, South Korea.

- Kang, Z., Dragoo, M. Yeagle, L., Shehab, R. L., Yuan, H., Ding, L., and West, S. G. (2017). Adaptive learning pedagogy in Universal Design for Learning and multimodal training. In *Proceedings of the 2017 National Training Aircraft Symposium (NTAS)*, Daytona Beach, FL., USA.

- Yuan, H., Rippetoe, J., Ding, L., Kang, Z., Shehab, R. L., and West. S. G. (2017). Universal Design for Learning in the framework of neuroscience-based education and neuroimaging-based assessment. In *Proceedings of the 2nd International Conference on Bio-engineering for Smart Technologies (BioSmart)*, Paris, France.

Publications

Poster Exhibitions (Total: 4)

- Kang, Z., Shehab, R. L., Ding, L., Yaun, H., West, S. G., Ricardo Palma Fraga, Mattlyn R. Dragoo, Lauren Yeagle, Josiah Rippetoe, Mel Rosa Plata, Amin G. Alhashim, Rashimi Annandi Reddi, and Jamie Jezier (2019). Universal Design for Learning and Multimodal Training. Poster session in *Solutions for Operational Aviation Research (SOAR) Q2 meeting, Federal Aviation Administration Center of Excellence*, Apr. 3-5. Columbus, OH.*

  **Note: Most recent and updated poster.*

- Kang, Z., Shehab, R. L., Ding, L., Yaun, H., West, S. G., Dragoo, M. R., Yeagle, L. N., Fraga, R. P., and Rippetoe, J. (2018). Adaptive learning pedagogy of Universal Design for Learning (UDL) for multimodal training. In *Proceedings of the 2018 Interservice/ Industry Training, Simulation and Education Conference (I/ITSEC)*, Nov. 26-30, Orlando, FL.

- Kang, Z., Shehab, R. L., Ding, L., Yaun, H., West, S. G., Dragoo, M. R., Yeagle, L. N., Fraga, R. P., and Rippetoe, J. (2017). Universal Design for Learning and Multimodal Training. *Solutions for Operational Aviation Research (SOAR) Q4 meeting*, Federal Aviation Administration Center of Excellence, FAA headquarters, Jun. 11-15, Washington D.C.

- Kang, Z., Shehab, R. L., Ding, L., Yaun, H., West, S. G., Dragoo, M. R., Yeagle, L. N., Fraga, R. P., and Rippetoe, J. (2017). Universal Design for Learning and Multimodal Training. Poster session in *Solutions for Operational Aviation Research (SOAR) Q3 meeting*, Federal Aviation Administration Center of Excellence, Apr. 3-5. Philadelphia, PA.

Publications

Presentations and Invited Panels (Total: 9)

- Fraga, R. P. and Kang, Z. (2018). Adaptive learning pedagogy of Universal Design for Learning (UDL) for multimodal training. In *Proceedings of the 2018 Interservice/ Industry Training, Simulation and Education Conference (I/ITSEC)*, Nov. 26-30, Orlando, FL. **(poster presentation)**

- Kang, Z. (2018, June): Human factors research roadmap. *Center of Excellence For Technical Training and Human Performance Workshop*, Jun. 5-6, Norman, OK. **(invited panel)**

- Kang, Z. (2018, June). Universal design for learning (UDL) for STEM and higher education: Characterizations and applicability. In *Proceedings of the 2018 ISER International Conference on STEM*, Jun. 18-19, Seoul, South Korea. **(lecture)**

- Kang, Z. (2018, May): Human systems integration: Eye tracking for training, *Human Systems Integration Summit*, Mike Monroney Aeronautical Center, Federal Aviation Administration, OKC, OK. **(invited lecture)**

- Kang, Z. (2018, April). Improving the mission readiness of employees and safety of the NAS, *Solutions for Operational Aviation Research (SOAR) Q2 meeting*, Federal Aviation Administration Center of Excellence, Philadelphia, PA. **(invited panel)**

Publications

Presentations and Invited Panels (Total: 9) (continued)

- Kang, Z. (2017, August). Adaptive learning pedagogy in Universal Design for Learning and multimodal training. In *Proceedings of the 2017 National Training Aircraft Symposium (NTAS)*, Aug. 13 - 17, Daytona Beach, FL., USA. **(lecture)**

- Kang, Z., (2017, August). Universal Design for Learning in the framework of neuroscience-based education and neuroimaging-based assessment. In *Proceedings of the 2nd International Conference on Bio-engineering for Smart Technologies (BioSmart)*, Aug. 30 - Sep. 1, Paris, France. **(lecture)**

- Kang, Z. (2017, June). Universal Design for Learning and Multimodal Training. *Solutions for Operational Aviation Research (SOAR) Q4 meeting*, Federal Aviation Administration Center of Excellence, FAA headquarters, Jun. 11-15, Washington D.C. **(poster presentation)**

- Fraga, R. P. (2017, April). Universal Design for Learning and Multimodal Training. Poster session in *Solutions for Operational Aviation Research (SOAR) Q3 meeting*, Federal Aviation Administration Center of Excellence, Apr. 3-5. Philadelphia, PA. **(poster presentation)**

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