Human Systems Division

Save and Improve Airmen's Lives

USAF Fighter, Bomber, and Trainer Anthropometric Accommodation Evaluations

25 March 2026

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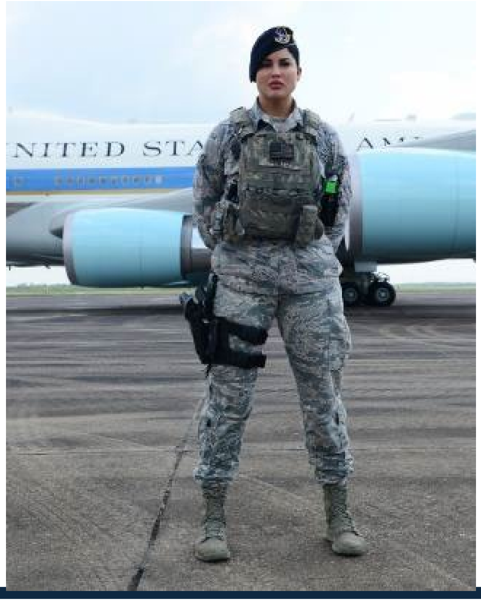
Airmen Accommodation Lab - Mission

We ensure that relevant Airmen size and shape variability are considered in equipment and workstation/cockpit design, modification, and upgrades.

By doing this, we seek to maximize mission effectiveness and safety in Aircrew Operator Stations and Flight Equipment Design



Background

- AAL was tasked with revisiting and updating the body size accommodation envelopes for the fighter/bomber/trainer aircraft
  - Last anthropometric evaluations were completed over 20 years ago
    - Many updates to cockpits without revisit (control panels, seats, HUDs, AFE, functional requirements)
    - Modern more accurate methods now used
  - Only pilots evaluated previously
    - Tasked with evaluating other rated officer positions now

Pilot Data from CEA Evaluations

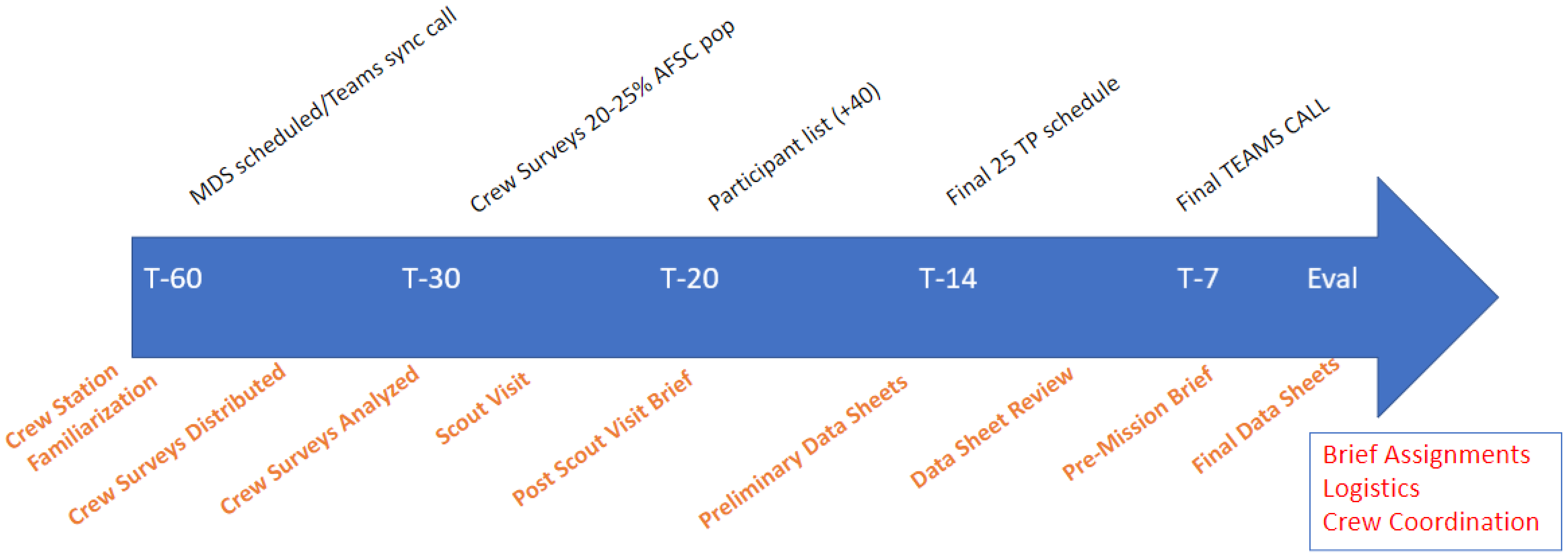
- GOAL: Updated anthropometric standards for ALL aircrew
  - Career Enlisted Aviators (CEA): Minimum statures derived for 9 AFSCs on 22 aircraft
  - Pilot data captured during most of the CEA evals

Aircraft




- Completed: T-6, T-38, T-1, Bell 505, F-16, A-10, F-35, T-7, B-1, B-2, F-15, F-22
  - First CSO anthropometric standards established from T-6 eval
- In coordination: B-52
- Additionally:
  - F-15 was evaluated with both the ACES II and ACES 5 with the NGES program
  - T-7 conducted on test aircraft after delivery
  - B-52 will be evaluated along with MIP upgrades (current and upgraded design)

Evaluation Milestones



Evaluation Method

Define Functional Requirements

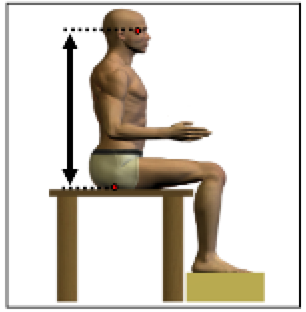
- **What crew member must see, reach, and stay clear of**
- **Flight Manuals, Original Functional Requirements in TR, SME Surveys, Scouting Trips**

Bell 505 Functional Requirements	
Vision	Pilots must see over the glare shield and down 5 degrees in a comfortable seated position with normal scan.
Anti-Torque Pedal Authority	After adjusting pedals, the pilot must be able to apply full left and right pedal in a comfortable seated position with minimal impact to cyclic control authority.
Reach to Controls	The pilot needs to be able to reach and operate all necessary controls with the seat belt secured.
Body Clearance	The pilot's shins and helmet must remain clear of the main instrument panel and ceiling, respectively. The pilot's abdomen and thighs need to have minimal impact on cyclic and collective range of motion.

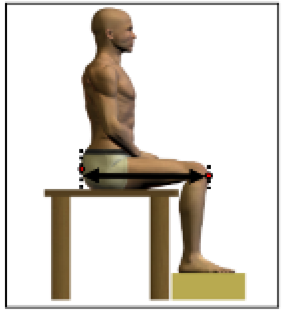
Evaluation Method cont.

Collect anthropometry data

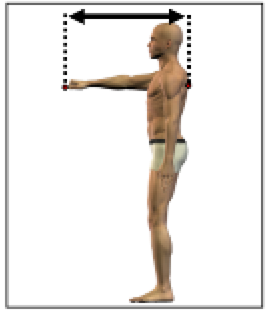
- 6 basic "cockpit" anthropometric measures
- Additional variables representing thigh, abdomen, and chest size (circumferences, depths, etc.)
- ~25 measurements taken
- Anthro taken traditionally and with PassFit



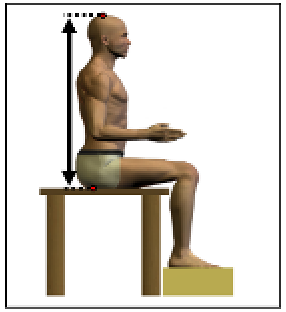
Eye Height



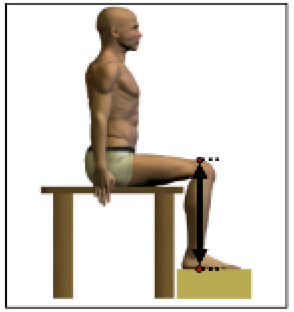
Buttock-Knee Length



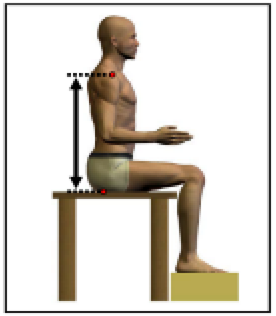
Thumb Tip Reach



Sitting Height



Knee Height

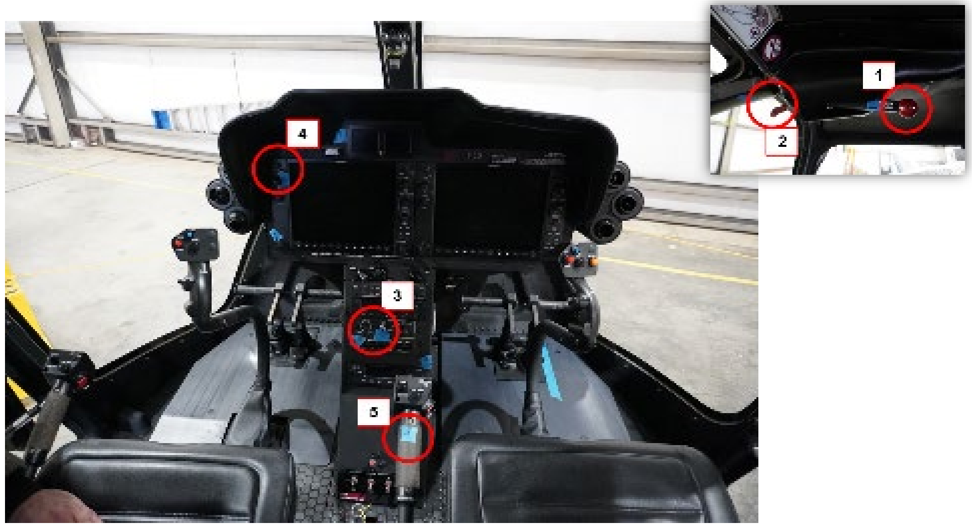


Shoulder Height

Evaluation Method cont.

Collect cockpit/crew station reach performance data

- Reaches selected to represent the hardest functional requirements
- Data collected using the FARO arm
- 20-25 Test Participants of varying body size



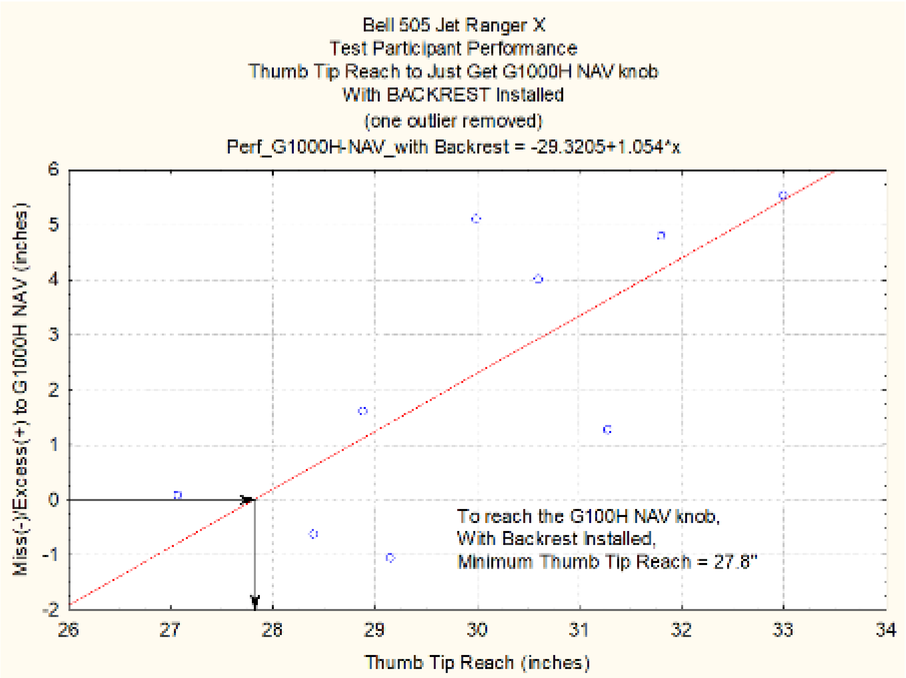
Evaluation Method cont.

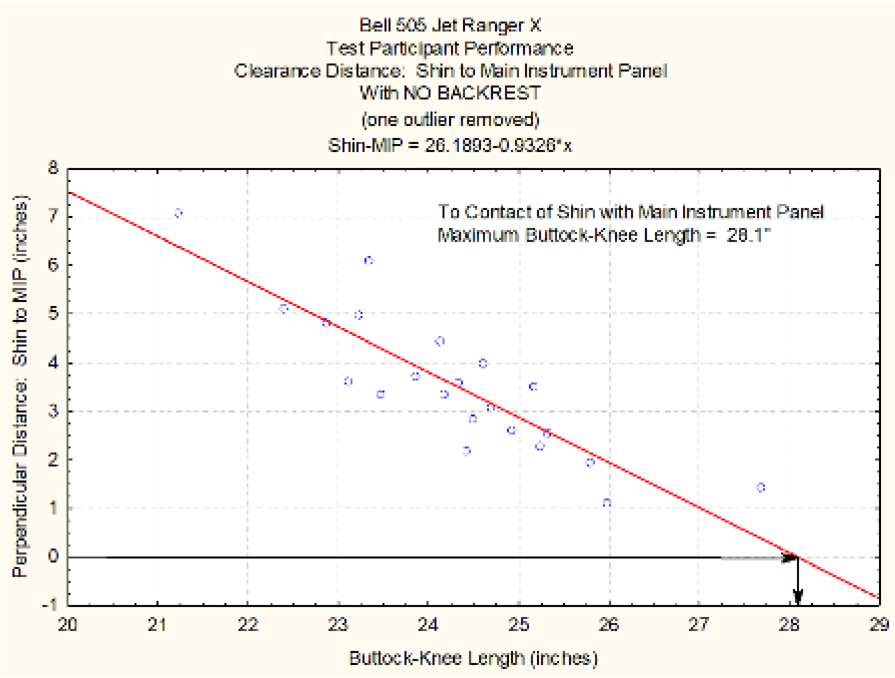
Collect cockpit/crew station reach performance and clearance data

- Cyclic/Stick/Yoke clearance
- Anti-Torque Pedal (or Rudder Pedal) performance
- Overhead and shin clearances

Calculating Accommodation Envelope

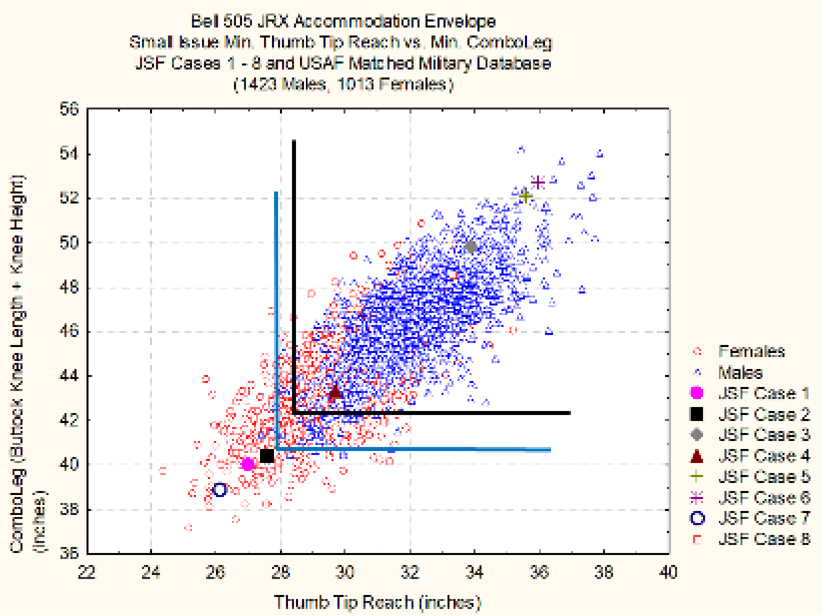
- TPs performance measurements are linked to their anthropometry to generate accommodation envelopes
- Regression analysis used to calculate minimums and maximums

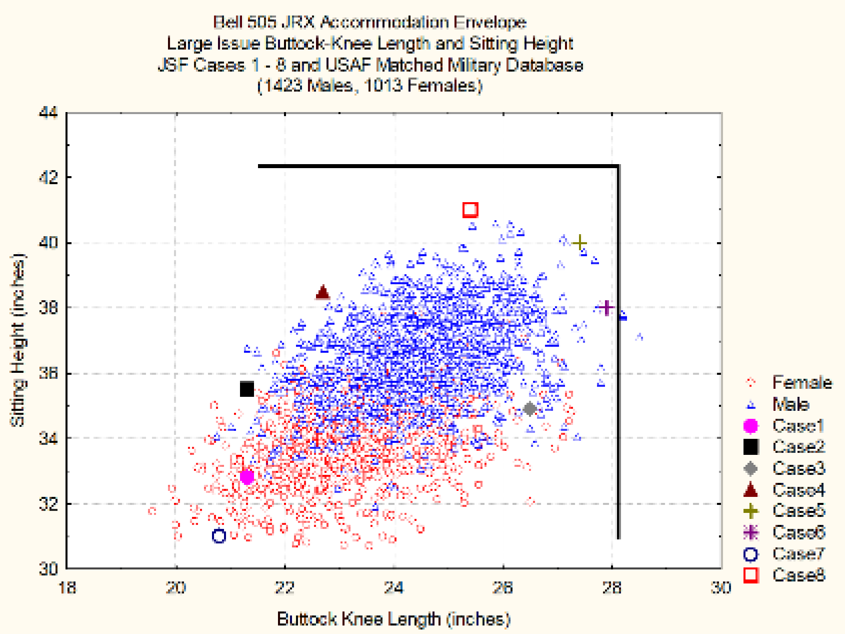




Accommodation Envelopes

- **Accommodation envelopes are generated for each crew position**
  - **Min combo leg (buttock knee + knee height), min thumb tip reach, min eye height**
  - **Max sitting height, max buttock knee length**





WebPASS

- Web-based Pilot Accommodation Screening Software (WebPASS)
- Pilot candidates are measured and run through if they are outside the legacy 64”-77” stature requirements
  - Outputs green/yellow/red coding for each aircraft based on accommodation
  - Algorithm attempts to find a seat position where candidate meets all body size requirements

WebPASS

Stature:	62.7	Arm Span:	61.7
Sitting Height:	34.3	Eye Height:	30.4
Buttock to Knee Length:	20.7	Shoulder Height:	24.7
Knee Height:	17.7	Thigh Clearance:	
Combo Leg:	38.4	Weight:	104.2

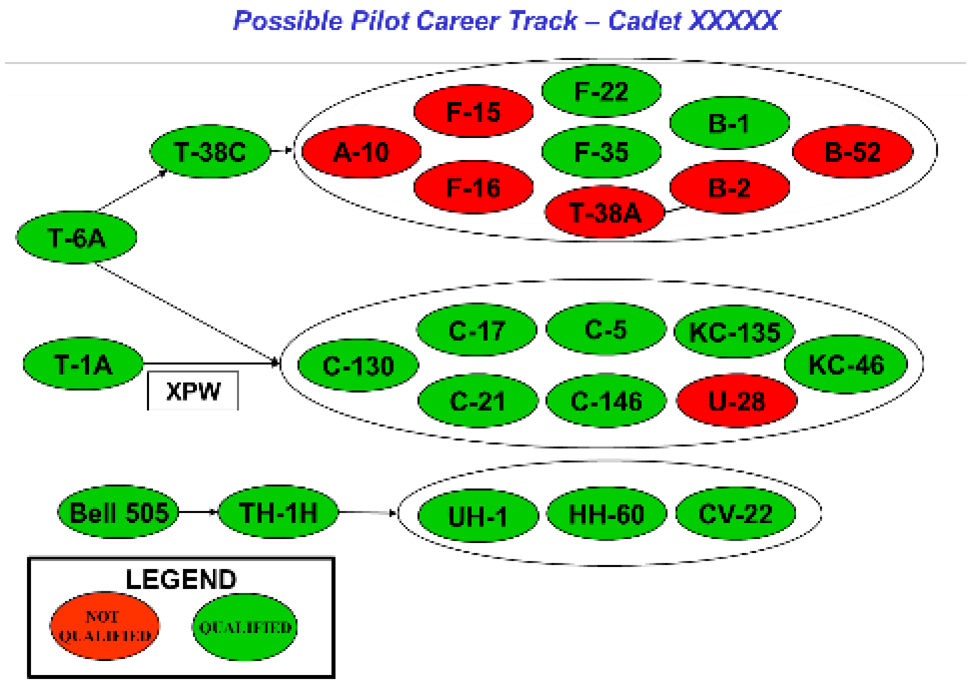
Assessment Results

Aircraft	Aircraft Classification	Seat Position (adjuste	Seat Lowered Amount	Vision (full-up)	Rudder	Controls	Max Butock to Knee	Max Sitting Height	Weight	F
B-1B	Bomber	-3.11	-3.110 Inches	3.1	3.55	-1.35	6.8	10.1	0	
B-2	Bomber	-1.6	-1.600 Inches	1.6	-0.98	-0.46	9.4	21	0	
B-52	Bomber	-0.1	-0.100 Inches	0.1	-3.13	-3.69	7.2	18.7	-26.8	
A-10	Fighter	-1.1	-1.100 Inches	1.1	-2.12	-1.99	5.5	9.3	0	N
F-15	Fighter	0	0.000 Inches	-0.4	0.75	-2.24	6	9.8	0	
F-16	Fighter	0	0.000 Inches	-0.1	1	0.18	5.9	5.4	0	N
F-22	Fighter	-1.1	-1.100 Inches	1.1	0.05	-2.13	6.7	9.1	0	
F-35A	Fighter	-1.6	-1.600 Inches	1.6	4.61	3.38	7.2	8	0	V 2 H
C-130	Heavy	0	0 Notches	2.1	1.8	-0.48	7.8	8.7	0	
C-17	Heavy	-0.9	-0.900 Inches	0.9	-0.74	1.05	7.8	8.7	0	
C-21	Heavy	-3	-2 Notches	4	2	10	5.1	4.7	0	
C-5	Heavy	-0.94	-2 Notches	1.2	0.75	0.5	7.8	8.7	0	
KC-10	Heavy	0	0.000 Inches	4	2.2	1.9	6.8	7.7	0	
KC-135	Heavy	-2.5	-5 Notches	2.8	4.77	0.47	7.8	8.7	0	
MH-60 with body armor	Helicopter	-2	-4 Notches	2.3	-0.3	-2.02	5.7	7.7	0	
UH-1	Helicopter	-3	-4 Notches	3.5	-0.05	-0.74	7.8	8.7	0	
CV-22 Unofficial	Misc	-1.8	-3 Notches	2.1	-0.59	0.18	5.36	65.7	0	r
U-2 Unofficial	Misc	-0.3	-0.300 Inches	0.3	-2.18	-5.55	5.8	5.7	0	r
U-28 Unofficial	Misc	-1.444	-2 Notches	2	-1.9	1.4	5.8	5.7	0	r
T-1	Trainer	0	0 Notches	0.5	0.9	2	6.2	9.1	0	
T-38	Trainer	-0.35	-0.350 Inches	0.35	-3.33	-1.4	6.8	5.7	0	
T-38 ESUP	Trainer	-2.36	-2.360 Inches	2.35	-0.22	0.63	7.1	6.5	0	p i
T-6	Trainer	-5.11	-5.110 Inches	5.1	2.92	3.85	6.7	7.2	0	

Save and Improve Airmen's Lives

AETC Process and WebPASS Updates

- Receive Excel sheet export
- Manually create a bubble chart using PowerPoint
- Determine if candidate is eligible based on results of career tracks
- Waiver completed if candidate is eligible
- WebPass Updates
  - Add new aircraft/update existing aircraft
  - Automate bubble charts



Automating Anthropometric Measurements

- **PassFit – portable 3D anthropometry system**
  - **Estimates ANSUR-equivalent body dimensions**
- **Implementing into measurement locations (USAFA, USAFSAM, MEPS)**

Current Published Guidance

- DAFI 63-101/20-101
  - New instruction mandates design specifications must accommodate body sizes of at least the central 95% of the US recruiting population
- Anthropometry Program Guide
  - Designates responsibilities for standards development, authority on methods used to measure aircrew candidates and aircraft crew stations, and authorized measurement facilities
  - Formally defines minimum number of aircraft an aircrew candidate must be accommodated in
  - Defines Exception to Policy considerations

Goals

- Updated anthropometric accommodation envelopes for all crew positions across platforms
- Screening software for all crew positions
- Defined re-visit/update requirements
  - When any major modification is made to the crew station
  - Every 10 years?
    - Evaluate change to crew stations (that were made without AAL knowledge)
    - Re-determine functional requirements
    - Significant change in methodology

MULTIDISCIPLINARY ANTHRO TEAM

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Ron Richardson
Brian Ostermann
Lori Brattin Basham
Sarah Hollis

And thank you to all of the Test Participants!

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Questions?

National Defence Défense nationale

ASSISTANT DEPUTY MINISTER (MATERIEL)

Director General Aerospace Equipment and Program Management

Developing Expertise in Cockpit Fit and Anthropometric Accommodation Modelling

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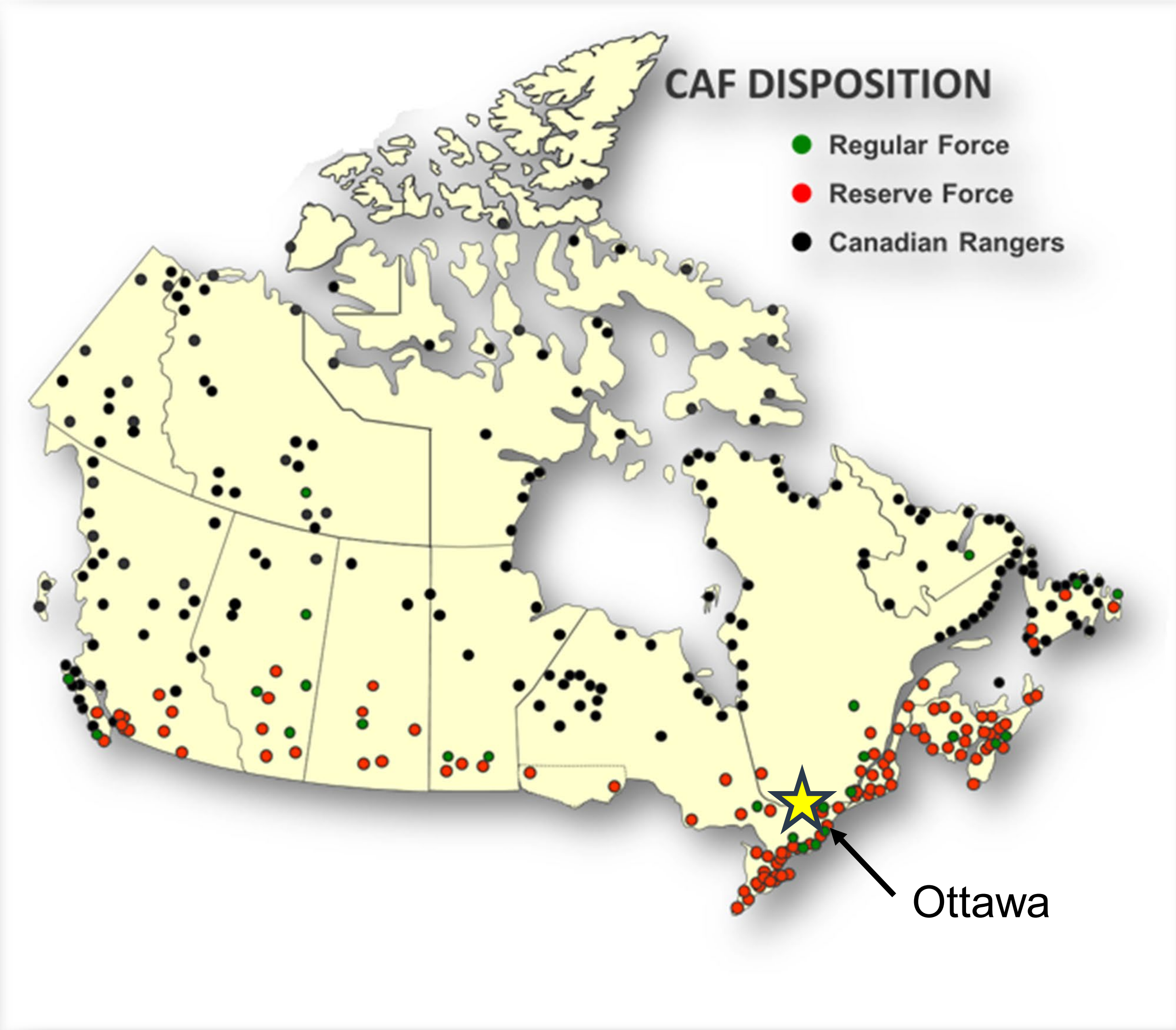
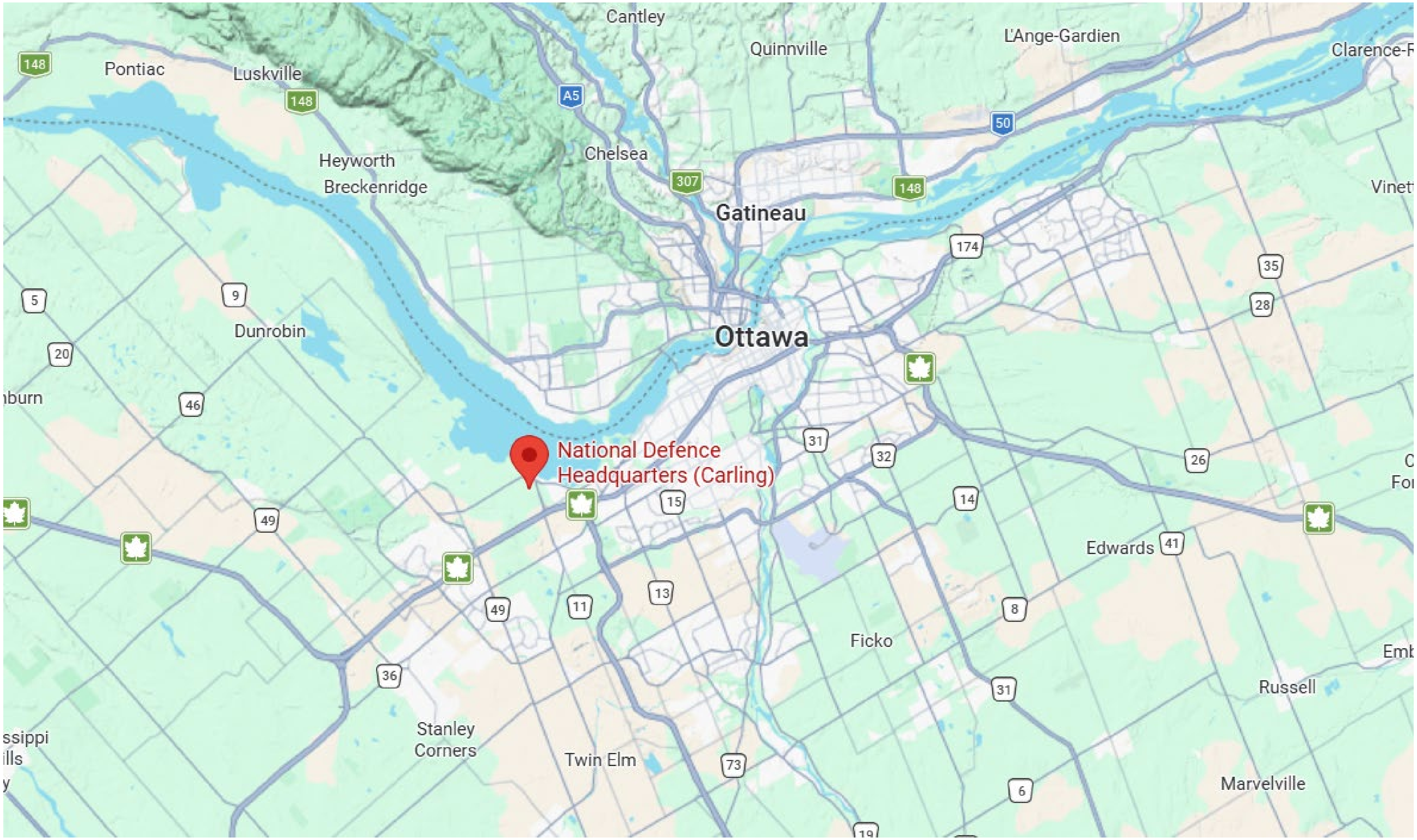
The opinions expressed in this presentation are those of the author and do not reflect the any position of the Department of National Defence or National Research Council

Canada



CAF DISPOSITION
Regular Force
Reserve Force
Canadian Rangers
Ottawa



Cantley
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Ottawa
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DTAES
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Mission

To ensure and maintain an acceptable level of safety and effectiveness for the Canadian military aviation, in compliance with the DND/CAF Airworthiness Program.

DTAES| **Regulator**

Aircraft

Certification Basis

Transport Canada
Canada

Federal Aviation Administration

EASA
European Union Aviation Safety Agency

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Airworthiness Approval & DND Type Certificate

National Defence Défense nationale

DEPARTMENT OF NATIONAL DEFENCE

Type Certificate

22 August 2017   Number: CC130J-02

Under authority granted to the Minister of National Defence by the Aeronautics Act, this Type Certificate is issued to the ***CC130J Hercules Weapon System Management Organization***.

This certifies that the

CC130J Hercules

aircraft type meets the requirements for airworthiness approval as described in the Technical Airworthiness Manual Part 2 Chapter 1 with the design operating limitations, airworthiness limitations and approved publications listed in the CC130J Hercules Type Certificate Data Sheet (AEPM RDIMS #769310).

This certificate and the Type Certificate Data Sheet, which is a part hereof, shall remain in effect until surrendered, suspended, revoked or otherwise terminated by the Technical Airworthiness Authority of the Department of National Defence.

Signature: ________________

André Pelchat
Technical Airworthiness Authority
for Minister of National Defence

Example Human Factors Requirement

§ 25.777 Cockpit controls.

(a) Each cockpit control must be located to provide convenient operation and to prevent confusion and inadvertent operation.

(b) The direction of movement of cockpit controls must meet the requirements of § 25.779. Wherever practicable, the sense of motion involved in the operation of other controls must correspond to the sense of the effect of the operation upon the airplane or upon the part operated. Controls of a variable nature using a rotary motion must move clockwise from the off position, through an increasing range, to the full on position.

(c) The controls must be located and arranged, with respect to the pilots' seats, so that there is full and unrestricted movement of each control without interference from the cockpit structure or the clothing of the minimum flight crew (established under § 25.1523) when any member of this flight crew, from 5′2″ to 6′3″ in height, is seated with the seat belt and shoulder harness (if provided) fastened.

Human Factors | **Areas of Responsibility**

- Alerting
- Emergency provisions and equipment
- **Ergonomics and workstation design**
- Flightcrew interface
- Lighting (external, internal, NVIS)
- Workload
- Noise & vibration
- Speech intelligibility

RCAF | **Generational Change**

End of Service

Replacement / New

Operational

















Trainers










RCAF | **Generational Change**

End of Service

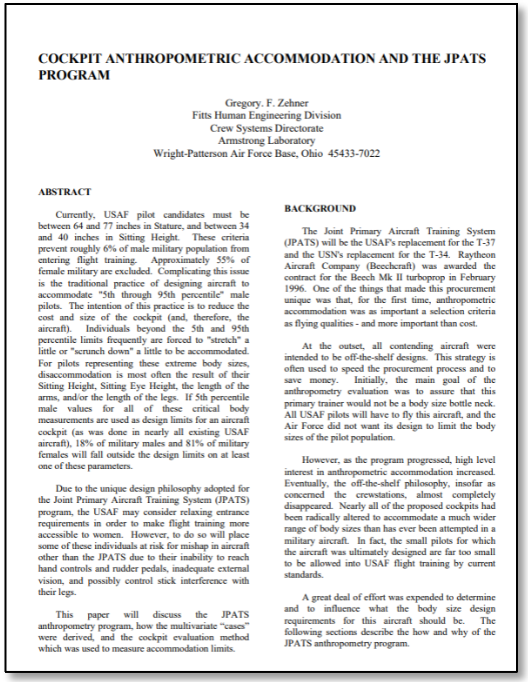
Replacement / New

Operational

Trainers

June 2025, National Research Council, Ottawa, Ontario

Literature Review



COCKPIT ANTHROPOMETRIC ACCOMMODATION AND THE JPATS PROGRAM

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ABSTRACT

Currently, USAF pilot candidates must be between 64 and 77 inches in Stature, and between 34 and 40 inches in Sitting Height. These criteria prevent roughly 6% of male military population from entering flight training. Approximately 55% of female military are excluded. Complicating this issue is the traditional practice of designing aircraft to accommodate "5th through 95th percentile" male pilots. The intention of this practice is to reduce the cost and size of the cockpit (and, therefore, the aircraft). Individuals beyond the 5th and 95th percentile limits frequently are forced to "stretch" a little or "scrunch down" a little to be accommodated. For pilots representing these extreme body sizes, disaccommodation is most often the result of their Sitting Height, Sitting Eye Height, the length of the arms, and/or the length of the legs. If 5th percentile male values for all of these critical body measurements are used as design limits for an aircraft cockpit (as was done in nearly all existing USAF aircraft), 18% of military males and 81% of military females will fall outside the design limits on at least one of these parameters.

Due to the unique design philosophy adopted for the Joint Primary Aircraft Training System (JPATS) program, the USAF may consider relaxing entrance requirements in order to make flight training more accessible to women. However, to do so will place some of these individuals at risk for mishap in aircraft other than the JPATS due to their inability to reach hand controls and rudder pedals, inadequate external vision, and possibly control stick interference with their legs.

This paper will discuss the JPATS anthropometry program, how the multivariate "cases" were derived, and the cockpit evaluation method which was used to measure accommodation limits.

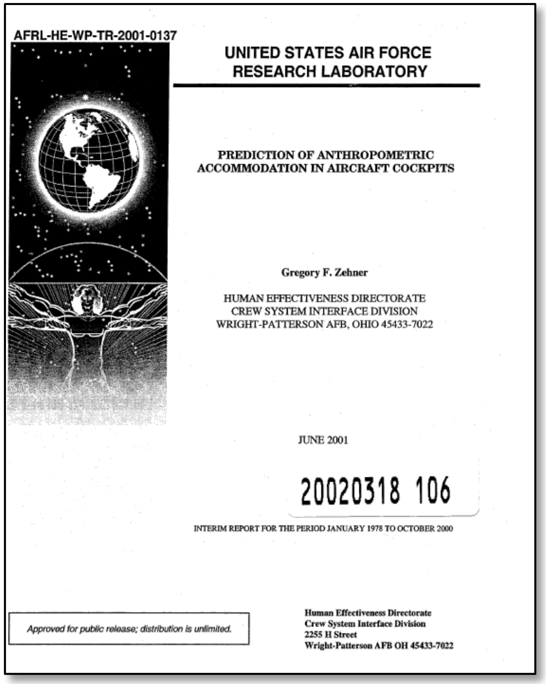
BACKGROUND

The Joint Primary Aircraft Training System (JPATS) will be the USAF's replacement for the T-37 and the USN's replacement for the T-34. Raytheon Aircraft Company (Beechcraft) was awarded the contract for the Beech Mk II turboprop in February 1996. One of the things that made this procurement unique was that, for the first time, anthropometric accommodation was as important a selection criteria as flying qualities - and more important than cost.

At the outset, all contending aircraft were intended to be off-the-shelf designs. This strategy is often used to speed the procurement process and to save money. Initially, the main goal of the anthropometry evaluation was to assure that this primary trainer would not be a body size bottle neck. All USAF pilots will have to fly this aircraft, and the Air Force did not want its design to limit the body sizes of the pilot population.

However, as the program progressed, high level interest in anthropometric accommodation increased. Eventually, the off-the-shelf philosophy, insofar as concerned the crewstations, almost completely disappeared. Nearly all of the proposed cockpits had been radically altered to accommodate a much wider range of body sizes than has ever been attempted in a military aircraft. In fact, the small pilots for which the aircraft was ultimately designed are far too small to be allowed into USAF flight training by current standards.

A great deal of effort was expended to determine and to influence what the body size design requirements for this aircraft should be. The following sections describe the how and why of the JPATS anthropometry program.



AFRL-HE-WP-TR-2001-0137

UNITED STATES AIR FORCE
RESEARCH LABORATORY

PREDICTION OF ANTHROPOMETRIC ACCOMMODATION IN AIRCRAFT COCKPITS

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JUNE 2001

20020318 106

INTERIM REPORT FOR THE PERIOD JANUARY 1978 TO OCTOBER 2000

Approved for public release; distribution is unlimited.

Human Effectiveness Directorate
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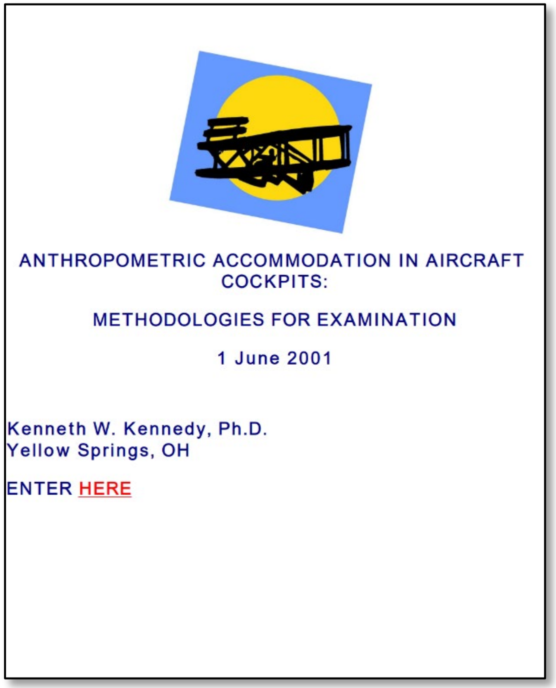
2255 H Street
Wright-Patterson AFB OH 45433-7022



ANTHROPOMETRIC ACCOMMODATION IN AIRCRAFT COCKPITS:

METHODOLOGIES FOR EXAMINATION

1 June 2001

Kenneth W. Kennedy, Ph.D.
Yellow Springs, OH

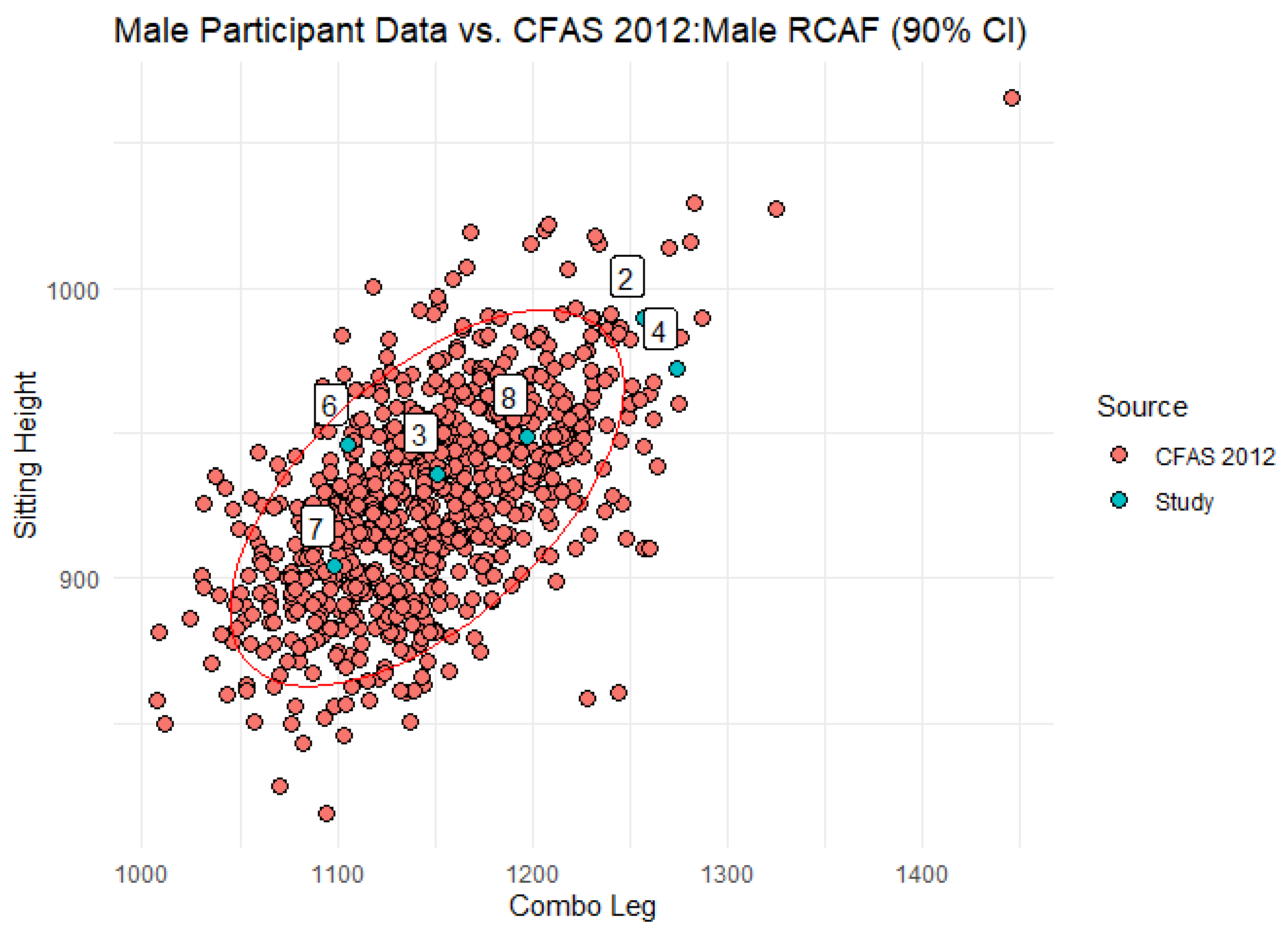
ENTER HERE

And more!

Anthropometry

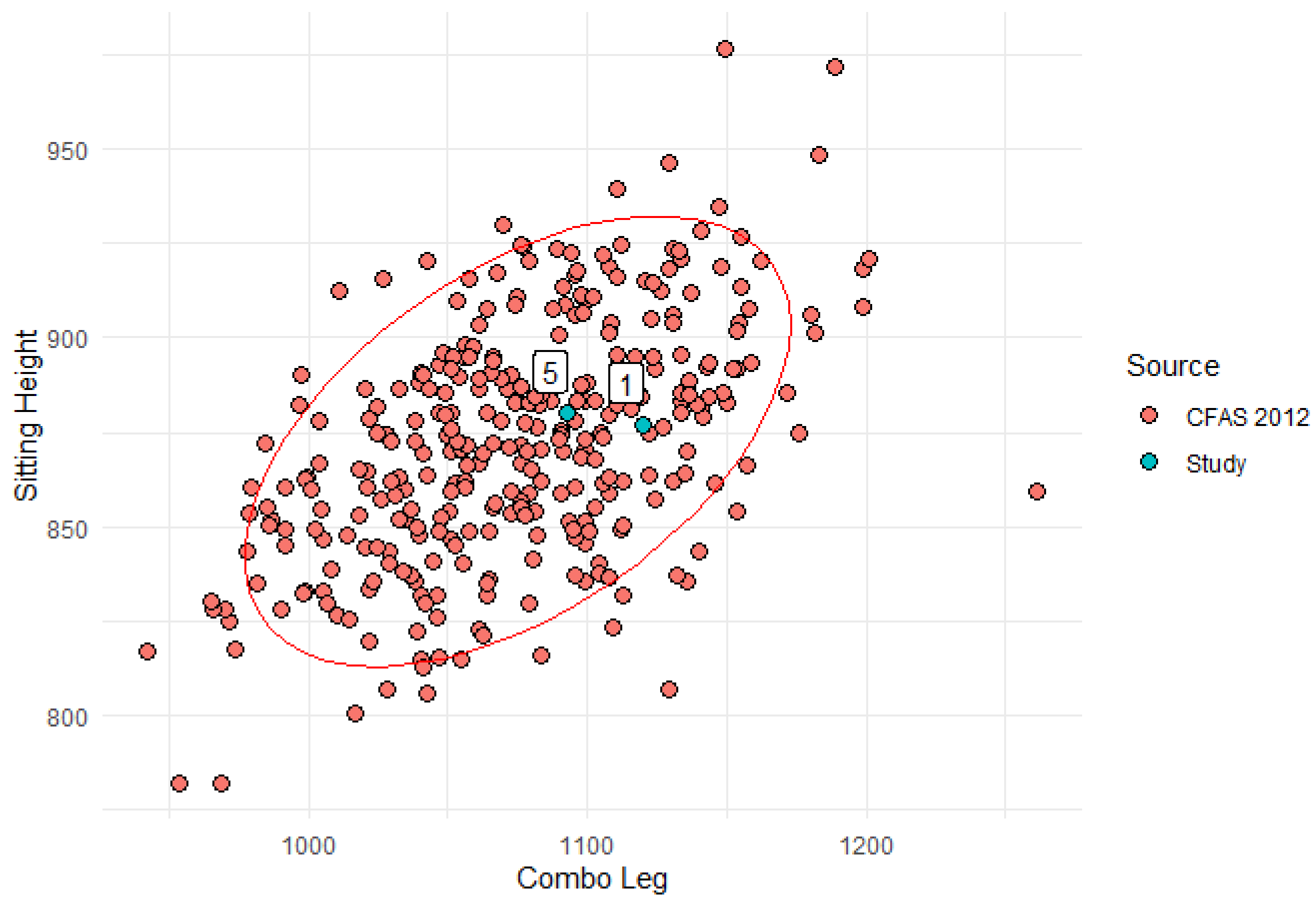
ID	Sex	Stature (boot)	Waist Depth	Weight	Stature (%)	Sitting Height (%)	Eye Height - Sitting (%)	Acromial Height - Sitting (%)	Knee Height - Sitting (%)	Thigh Clearance (%)	Biacromial Breadth (%)	Buttock-Knee Length (%)	Thumbtip Reach (%)	Combo Leg (%)	BMI (%)
1	F	1701	206	71.58	1687 (78.4%)	877 (55.8%)	779 (71.3%)	585 (59.5%)	522 (85.9%)	163 (50.7%)	382 (78.9%)	598 (72%)	785 (97%)	1120 (80.6%)	25.15 (45.5%)
5	F	1635	234	74.66	1622 (41.2%)	880 (59.5%)	767 (56.1%)	581 (53.5%)	512 (75.6%)	170 (66.5%)	374 (65.3%)	581 (49.1%)	709 (46.9%)	1093 (63.3%)	28.38 (72%)
2	M	1910	235	92.26	1882 (95.3%)	990 (96.2%)	882 (98.4%)	649 (92.5%)	609 (99.6%)	171 (43.6%)	427 (78.6%)	648 (90.3%)	826 (77.3%)	1257 (97.9%)	26.05 (31.9%)
3	M	1767	232	82.19	1747 (38.2%)	936 (59.3%)	811 (49.1%)	584 (20.9%)	563 (82%)	167 (34.4%)	420 (66.8%)	588 (24.2%)	775 (33.2%)	1151 (52.7%)	26.93 (39.8%)
4	M	1903	335	126.01	1884 (95.6%)	972 (89.7%)	833 (74.1%)	653 (94.3%)	619 (99.9%)	199 (93.5%)	417 (61%)	655 (93.8%)	887 (98.5%)	1274 (99.1%)	35.5 (96.4%)
6	M	1752	238	83.91	1742 (35.5%)	946 (69.9%)	834 (75.1%)	624 (71.8%)	511 (15.5%)	174 (50.7%)	421 (68.6%)	594 (30.8%)	785 (42%)	1105 (21.5%)	27.65 (46.6%)
7	M	1732.5	231	71.3	1703 (17.3%)	904 (24.8%)	792 (27.4%)	580 (17.2%)	531 (39.2%)	173 (48.3%)	431 (84.1%)	567 (8%)	724 (5.3%)	1098 (17.9%)	24.58 (20.5%)
8	M	1835	311	101.79	1808 (72.4%)	949 (72.8%)	844 (83.7%)	616 (61.8%)	576 (91.9%)	159 (19%)	471 (99.9%)	621 (65.6%)	836 (83.6%)	1197 (82.2%)	31.14 (77.4%)

Note. Percentiles based RCAF males (n=707), and CAF females (n=318) populations in the 2012 Canadian Forces Anthropometric Survey (CFAS)



Male Participant Data vs. CFAS 2012:Male RCAF (90% CI)
Sitting Height
1000
900
Combo Leg
1000
1100
1200
1300
1400
2
4
6
8
3
7
Source
CFAS 2012
Study

Female Participant Data vs. CFAS 2012:Female CAF (90% CI)

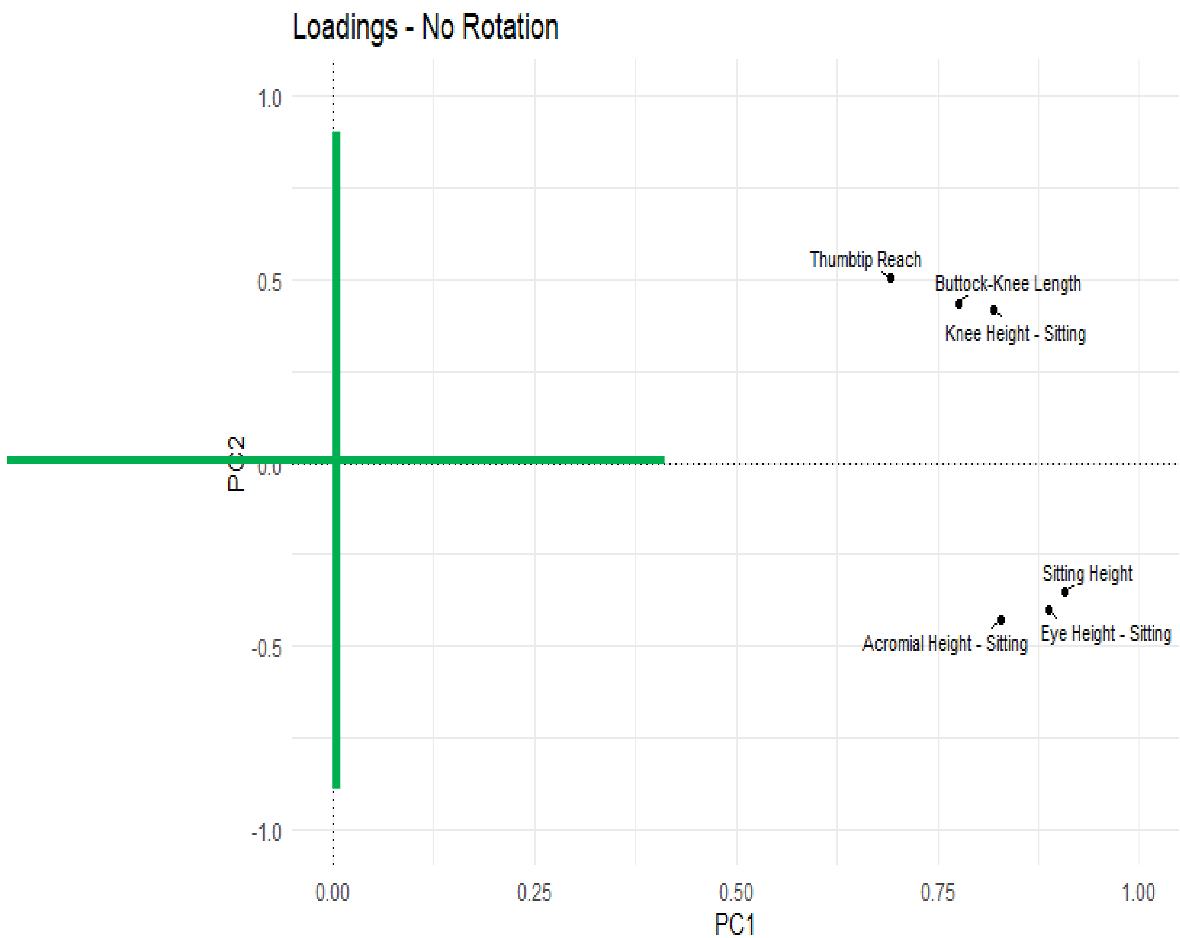


Principal Component Analysis | **Male**

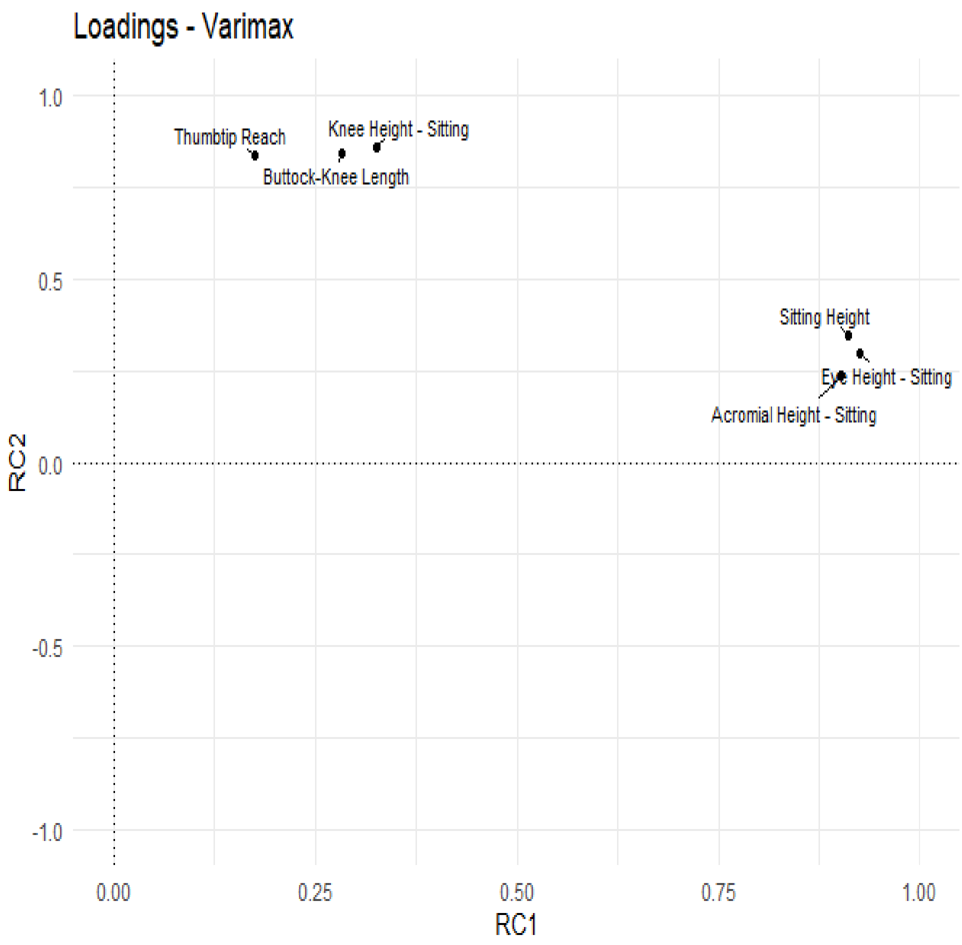
```
## Loadings:
##                             PC1    PC2    PC3    PC4    PC5    PC6
## Sitting Height               0.908 -0.354        -0.110 -0.134 -0.135
## Eye Height - Sitting         0.887 -0.400        -0.107 -0.156  0.128
## Acromial Height - Sitting    0.827 -0.429         0.238  0.274
## Knee Height - Sitting        0.819  0.421 -0.171 -0.281  0.211
## Buttock-Knee Length          0.776  0.437 -0.362  0.222 -0.162
## Thumbtip Reach               0.691  0.503  0.512
##
##                  PC1   PC2   PC3   PC4   PC5   PC6
## SS loadings    4.046 1.091 0.426 0.215 0.188 0.035
## Proportion Var 0.674 0.182 0.071 0.036 0.031 0.006
## Cumulative Var 0.674 0.856 0.927 0.963 0.994 1.000
```

So…PC1 represents all variables strongly, but PC also represents a ration between torso and limb measures?

R version 4.5.0 (2025-04-11 ucrt)
PCA calculated using “psych” version 2.5.3


Loadings - No Rotation
1.0
0.5
0.0
-0.5
-1.0
PC2
0.00
0.25
0.50
0.75
1.00
PC1
Thumbtip Reach
Buttock-Knee Length
Knee Height - Sitting
Sitting Height
Acromial Height - Sitting
Eye Height - Sitting

Varimax Rotation | **Male**



Varimax Rotation | **Male**

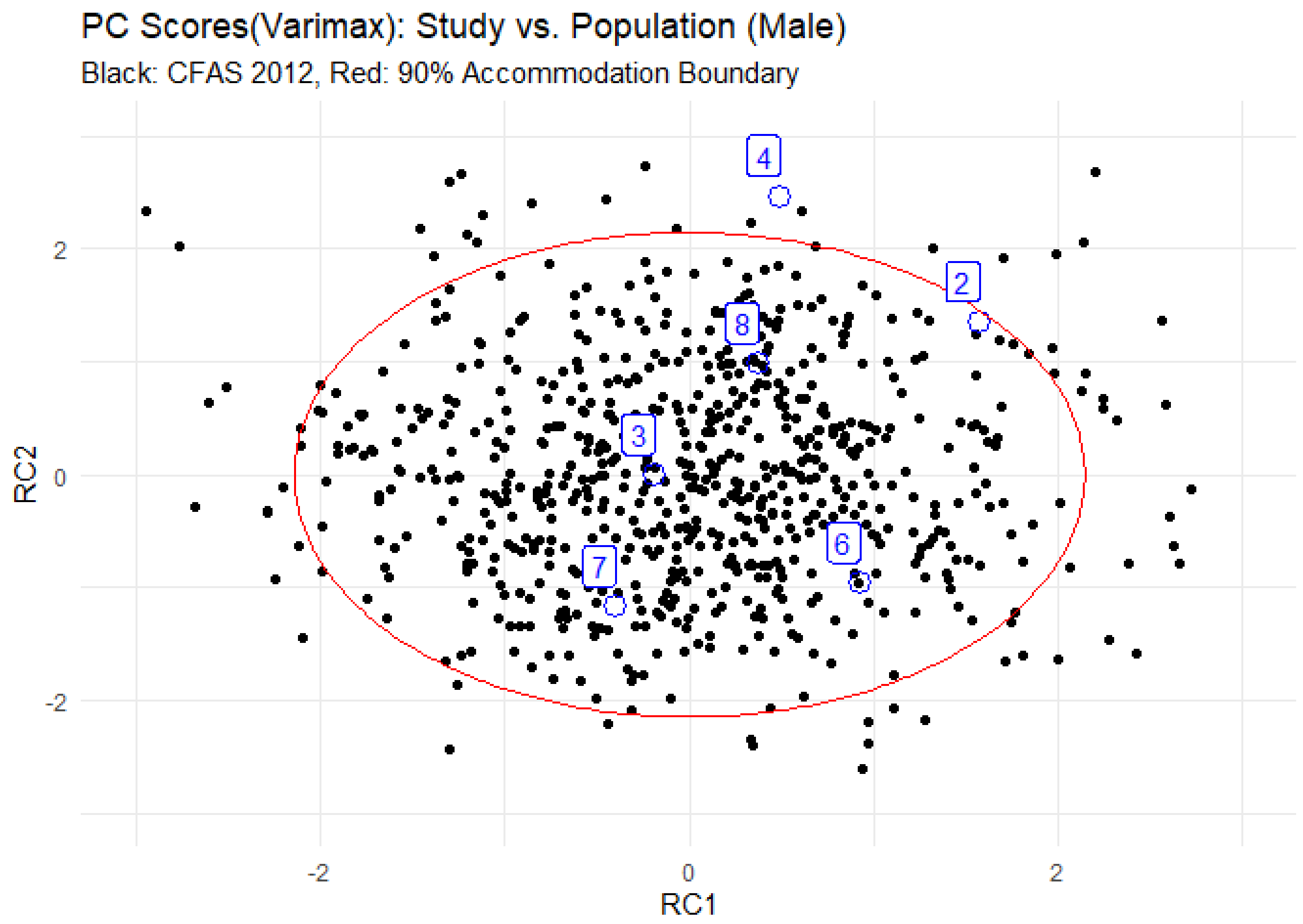
```
## Loadings:
##                             RC1   RC2
## Sitting Height              0.911 0.346
## Eye Height - Sitting        0.926 0.298
## Acromial Height - Sitting   0.901 0.237
## Knee Height - Sitting       0.325 0.861
## Buttock-Knee Length         0.283 0.845
## Thumbtip Reach              0.175 0.837
##
##                  RC1   RC2
## SS loadings    2.716 2.420
## Proportion Var 0.453 0.403
## Cumulative Var 0.453 0.856
```

Varimax rotation forces loadings closer to 1 or zero, making it easier to explain what each component represents

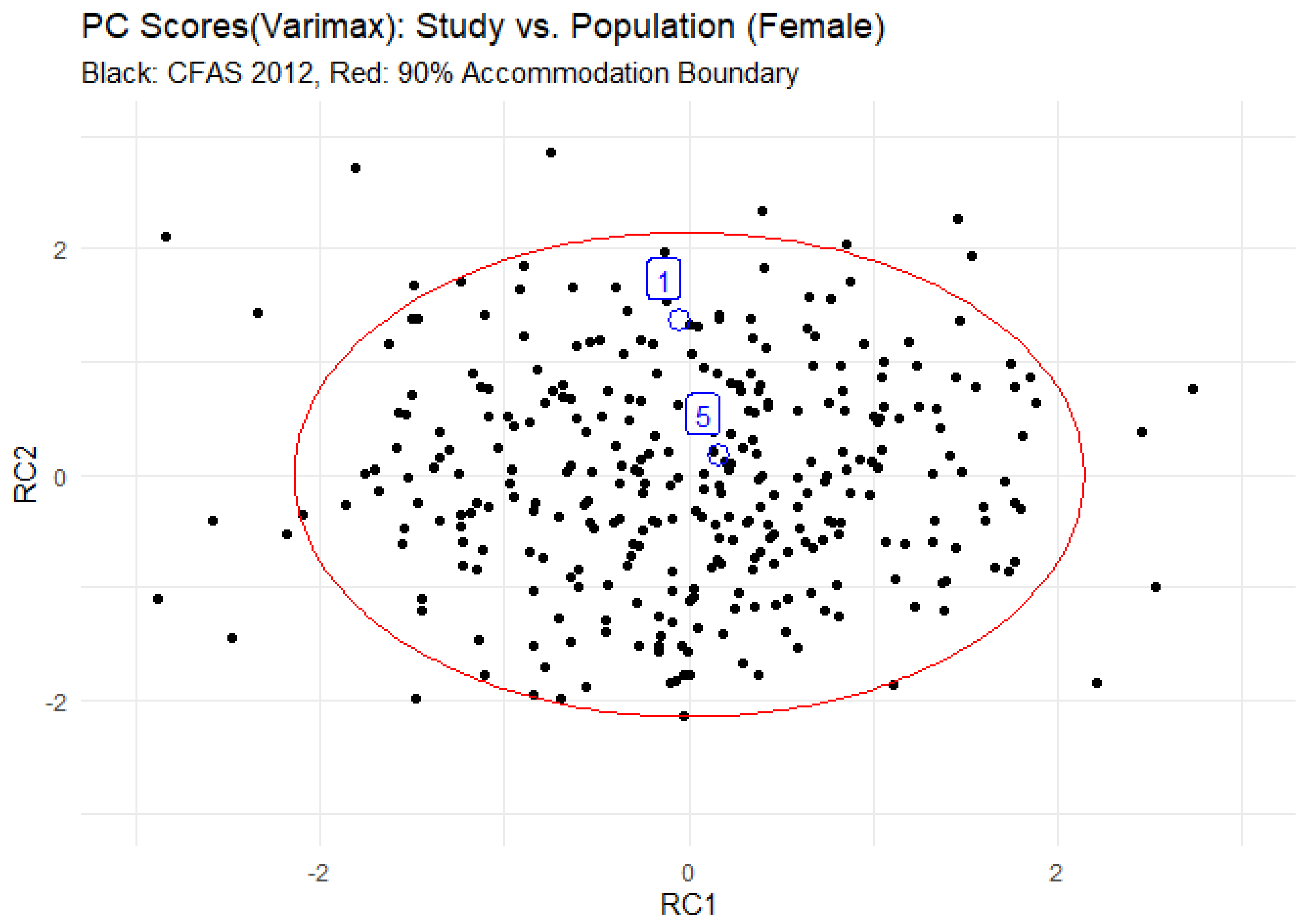
The cumulative variance of RC1 and RC2 is the same as before VARIMAX. However, now the proportion of variability shared by each component is shared more equally.

PC1 loads on torso measurements, and PC2 loads on limb measurements. Got it!

RC is the R notation for Rotated Components

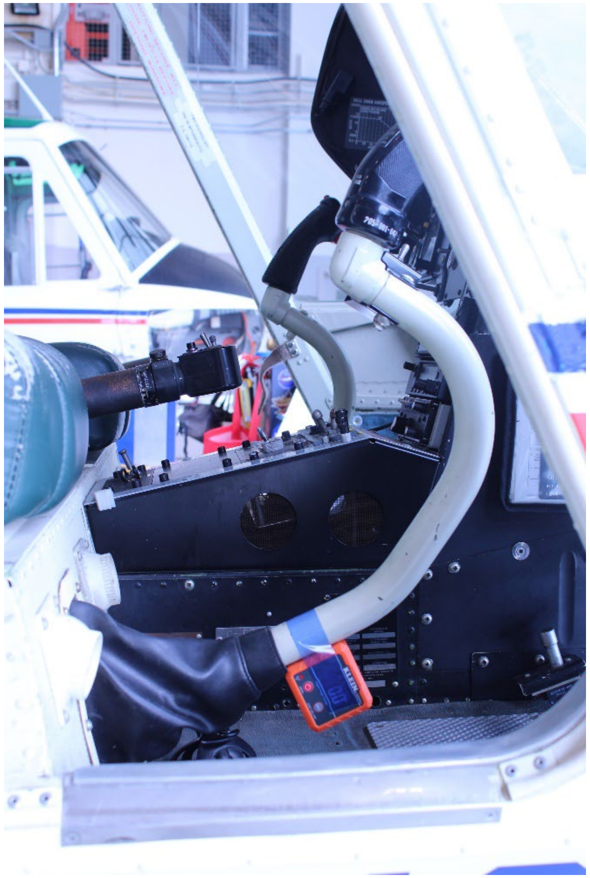


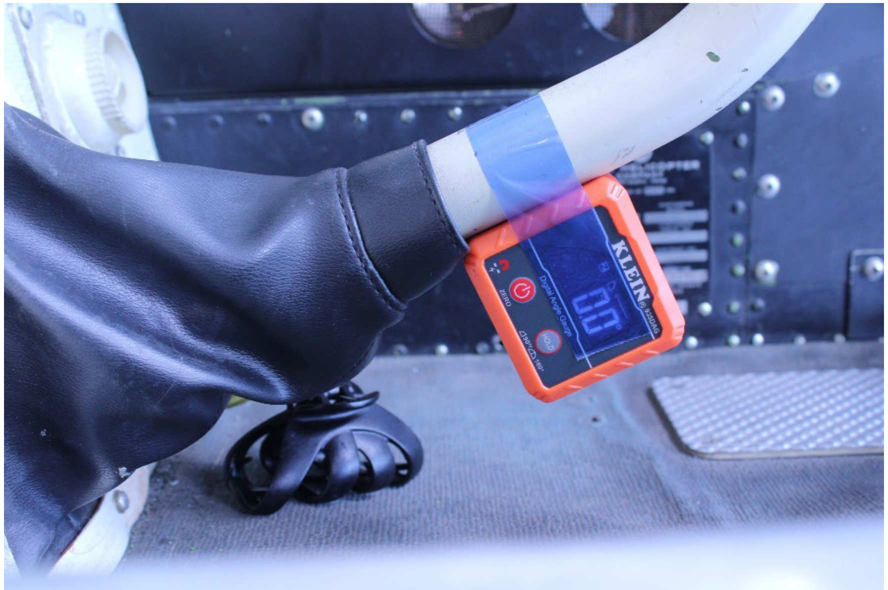
PC Scores(Varimax): Study vs. Population (Male)
Black: CFAS 2012, Red: 90% Accommodation Boundary
RC2
2
0
-2
RC1
-2
0
2
4
2
8
3
6
7


PC Scores(Varimax): Study vs. Population (Female)
Black: CFAS 2012, Red: 90% Accommodation Boundary
1
5
2
0
-2
RC2
-2
0
2
RC1

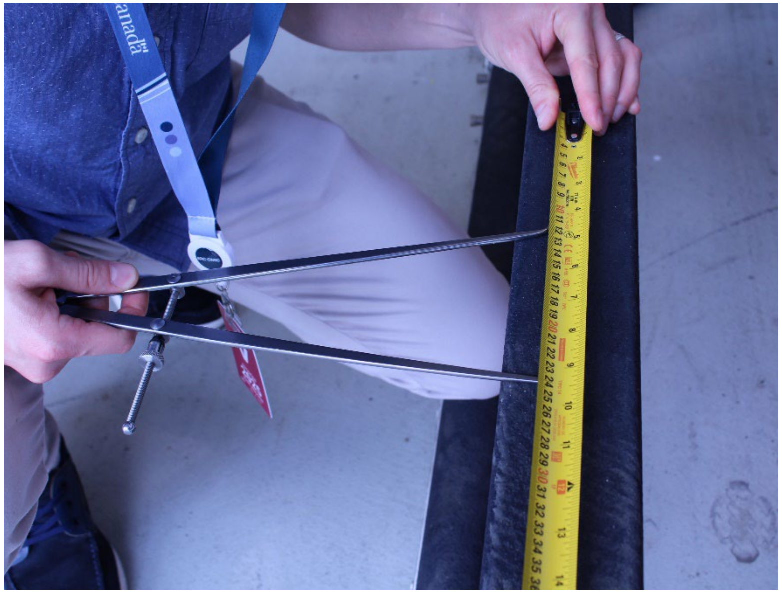
Rudder Pedal Position (Leg Reach)

Cyclic Position | Longitudinal



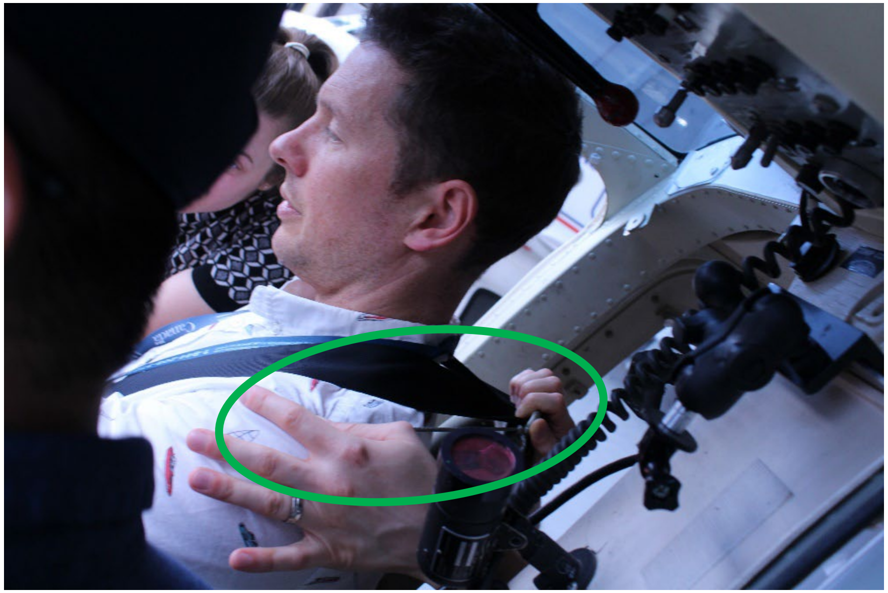


Clearance

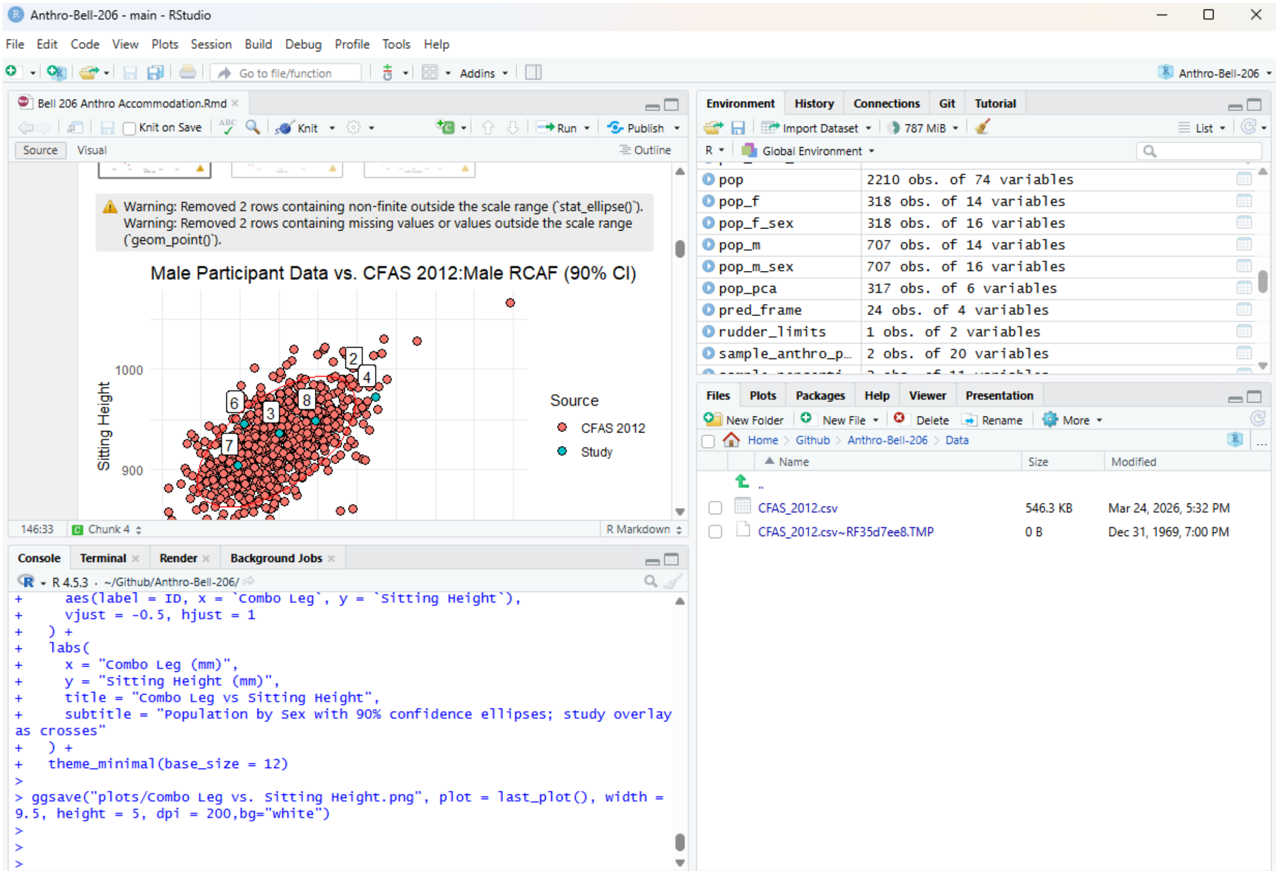


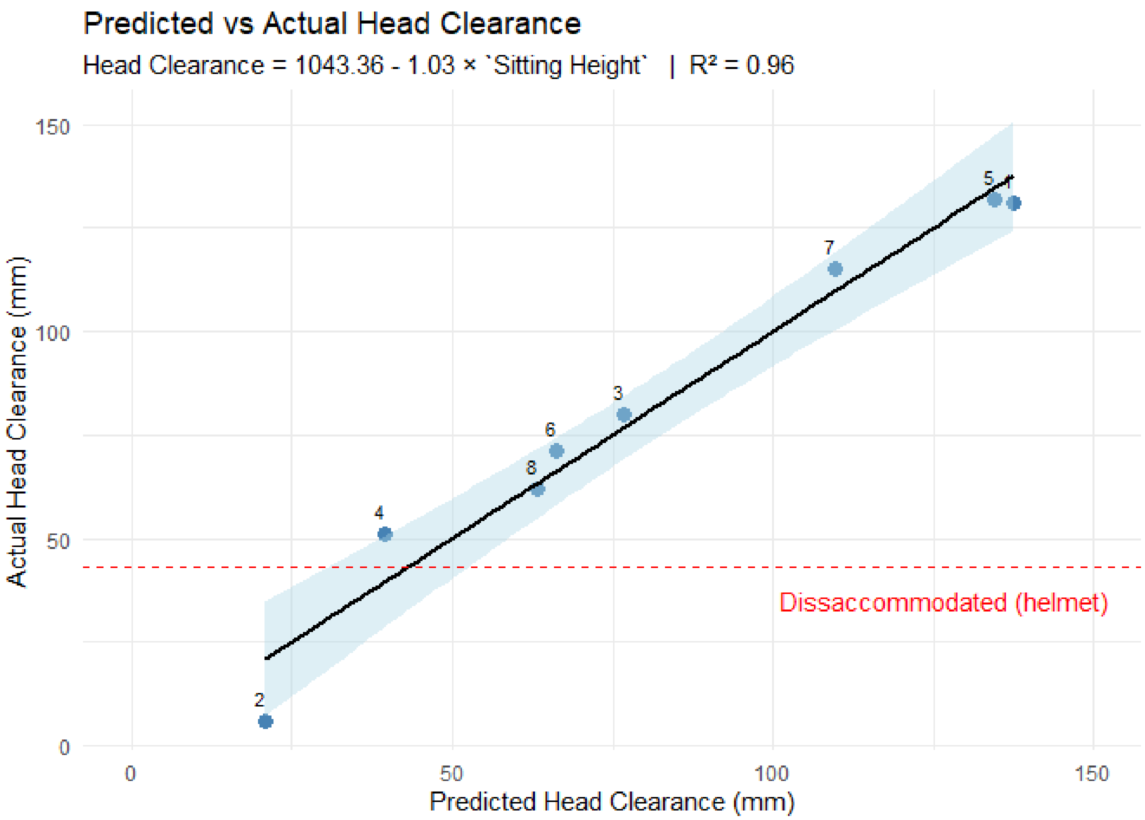
Vision Angle

Arm Reach

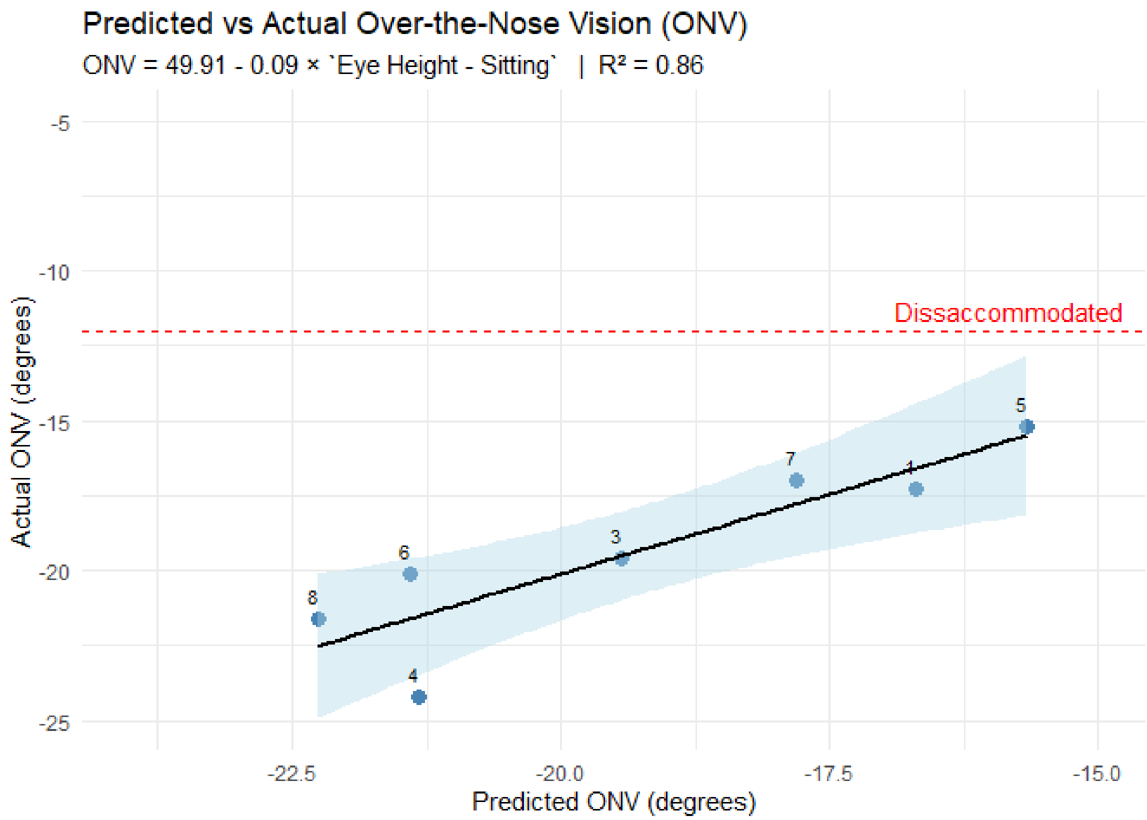


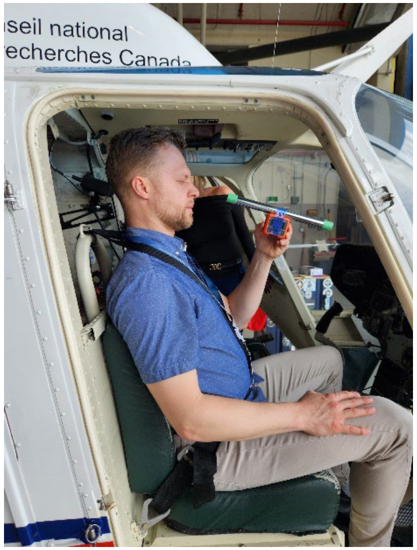
R scripts | **Live data visualization**



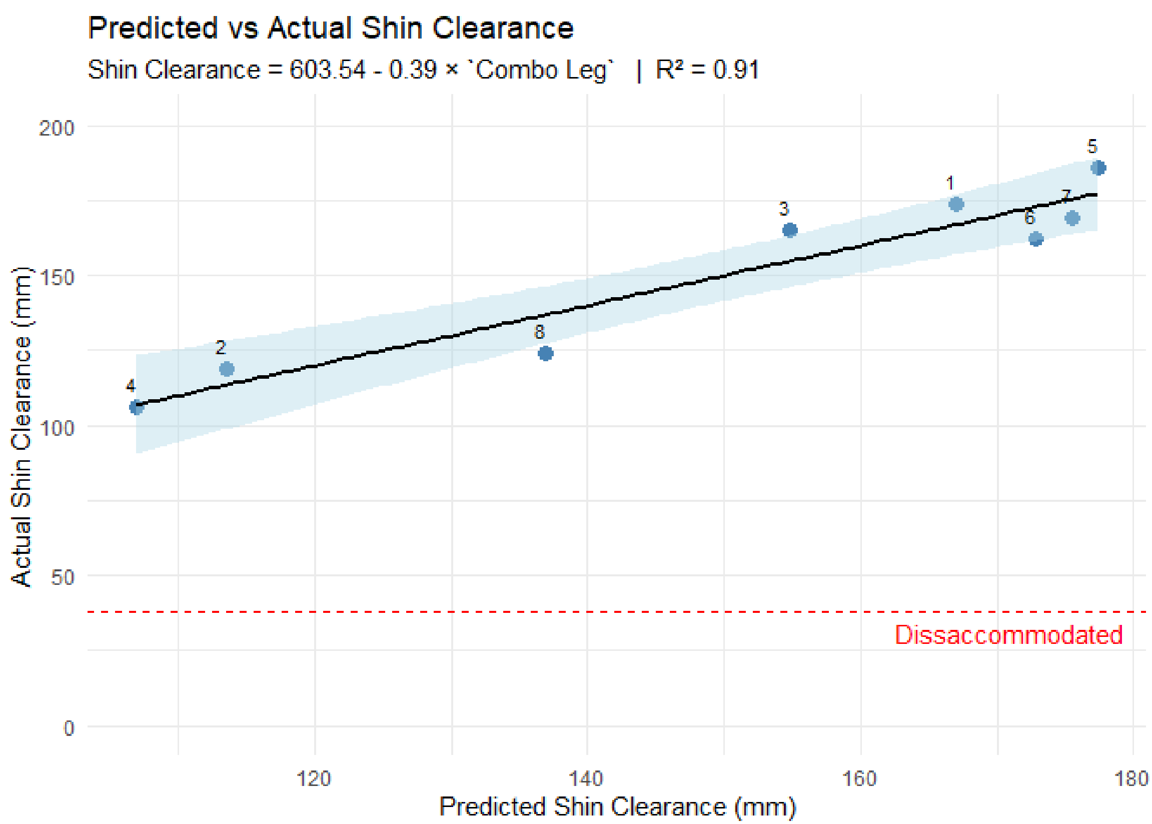


Note. All “disaccommodated” lines are arbitrary and for exploratory purposes only

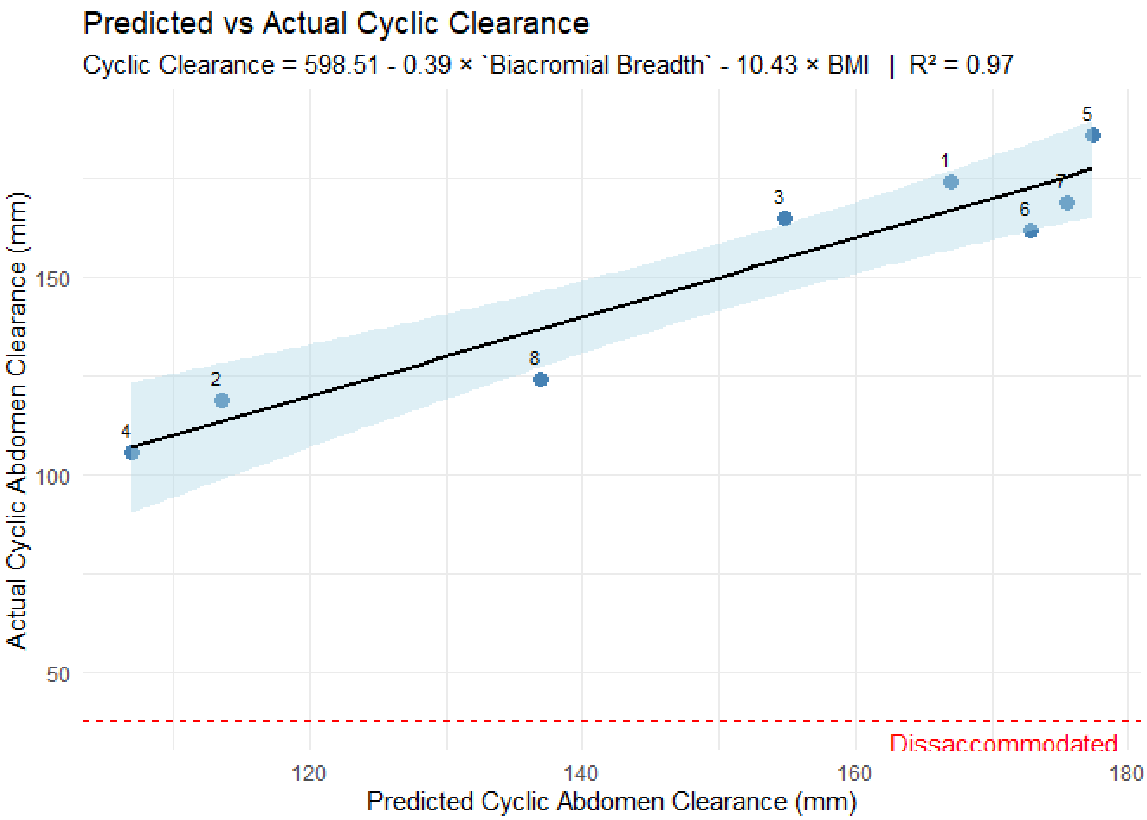


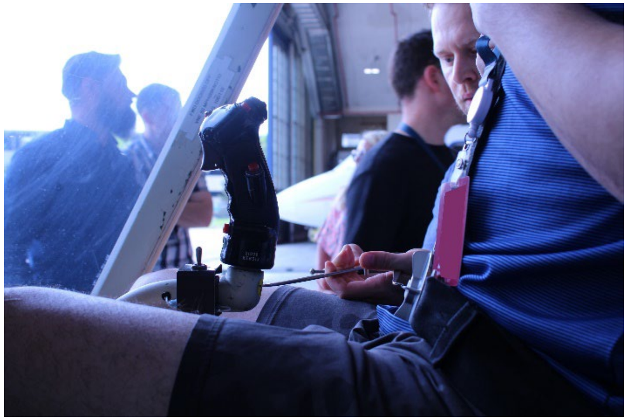


Note. All “disaccommodated” lines are arbitrary and for exploratory purposes only

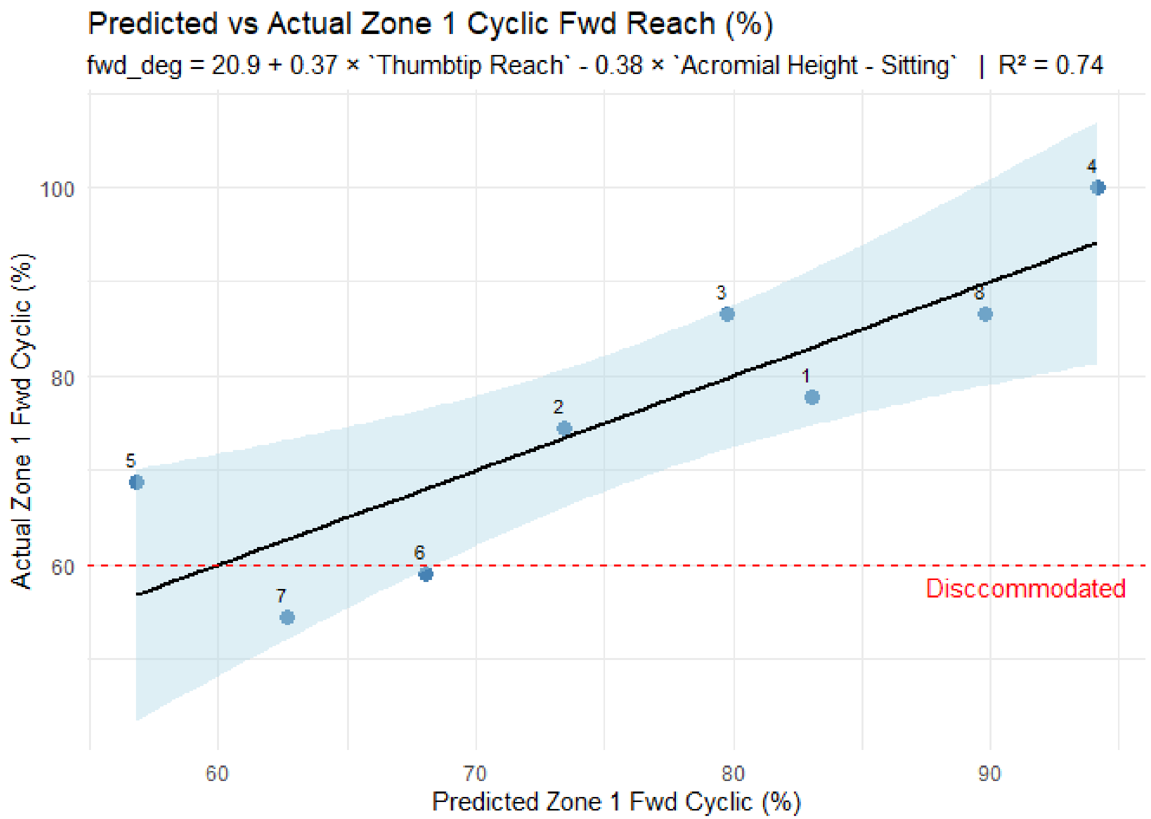


Note. All "disaccommodated" lines are arbitrary and for exploratory purposes only



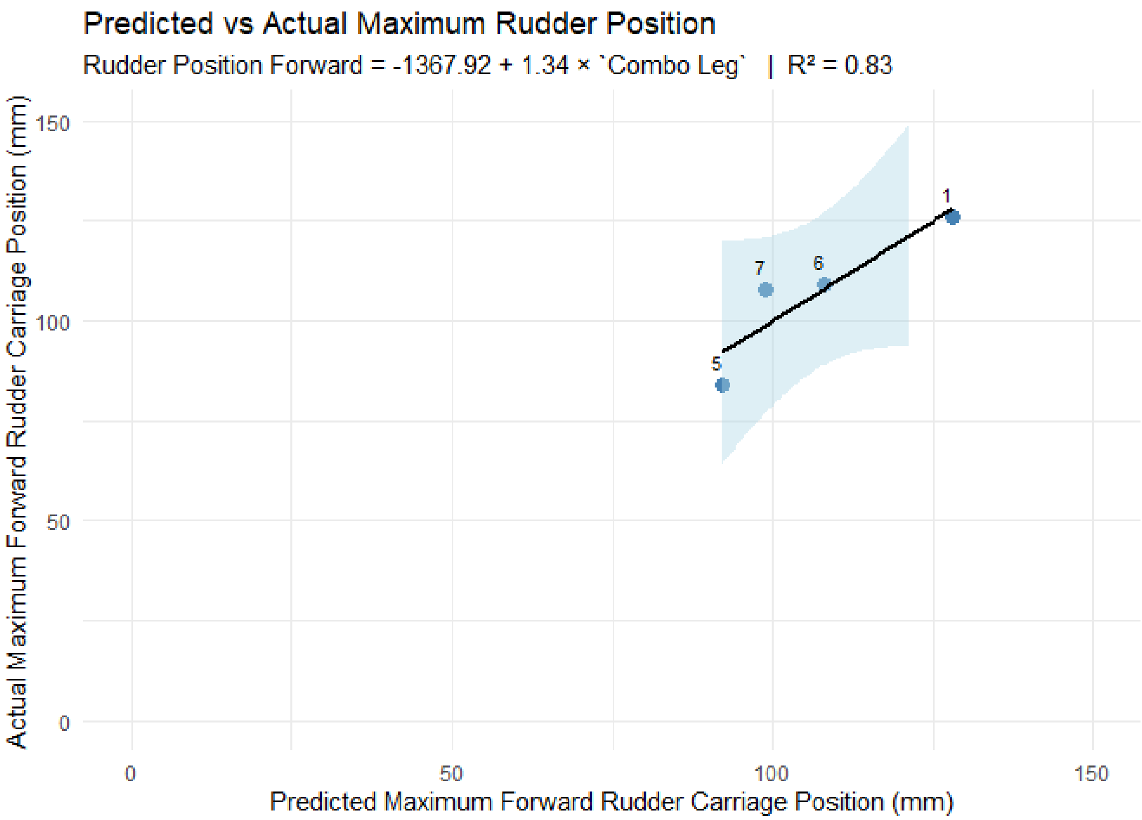


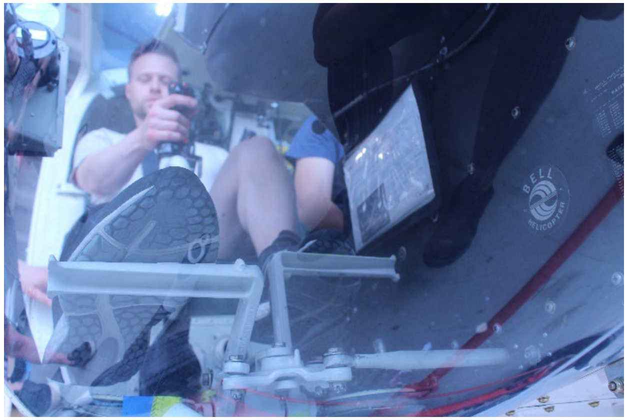
Note. All "disaccommodated" lines are arbitrary and for exploratory purposes only



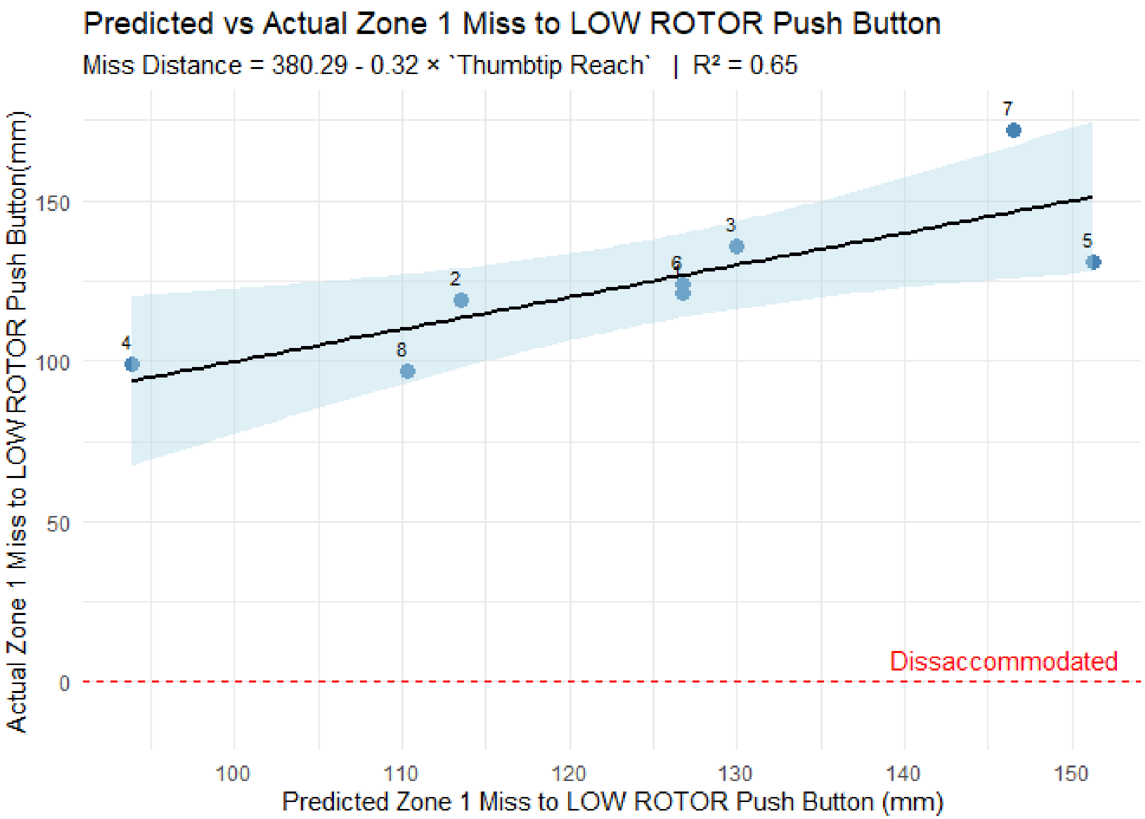
No image

Note. All “disaccommodated” lines are arbitrary and for exploratory purposes only

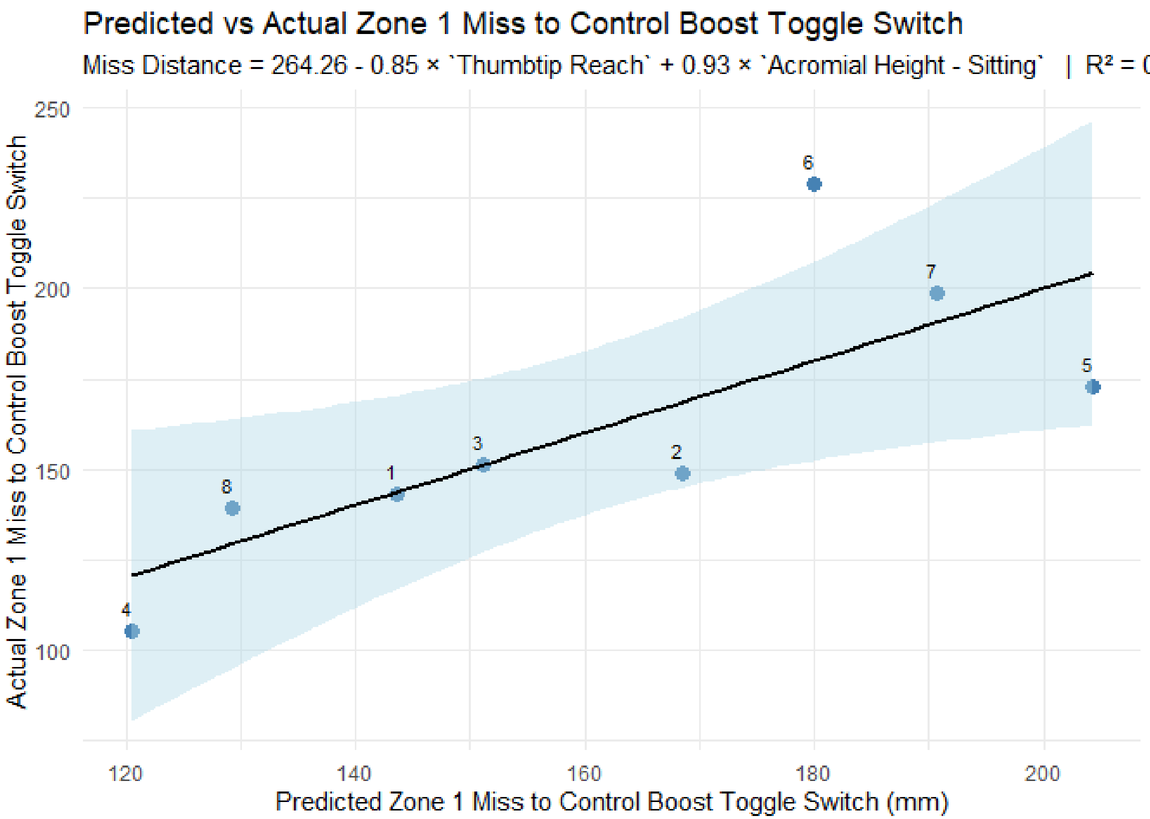




Note. All “disaccommodated” lines are arbitrary and for exploratory purposes only



Note 1. All "disaccommodated" lines are arbitrary and for exploratory purposes only
Note 2. We only assessed Zone 1 reach without shoulder movement to priority analysis of fail and pass data



Note 1. All “disaccommodated” lines are arbitrary and for exploratory purposes only
Note 2. We only assessed Zone 1 reach without shoulder movement to priority analysis of fail and pass data

What can we do with these models?

Table 2. Percent accommodation of RCAF males and CAF females in the Bell 206 Jet Ranger based on arbitrary criteria. For illustrative purposes only.

	Head Clearance	ONV	Shin Clearance	Cyclic Clearance	Zone 1 Cyclic Reach	Rudder Pedal Reach	Overall
Male	88.8%	99.4%	100%	97.7%	87.4%	99.6%	75.5%
Female	99.4%	89.0%	100%	98.7%	44.3%	84.3%	33.7%

What about the Boeing 737

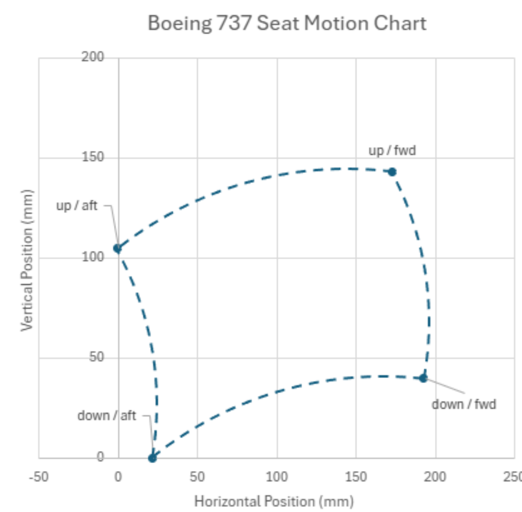
Up

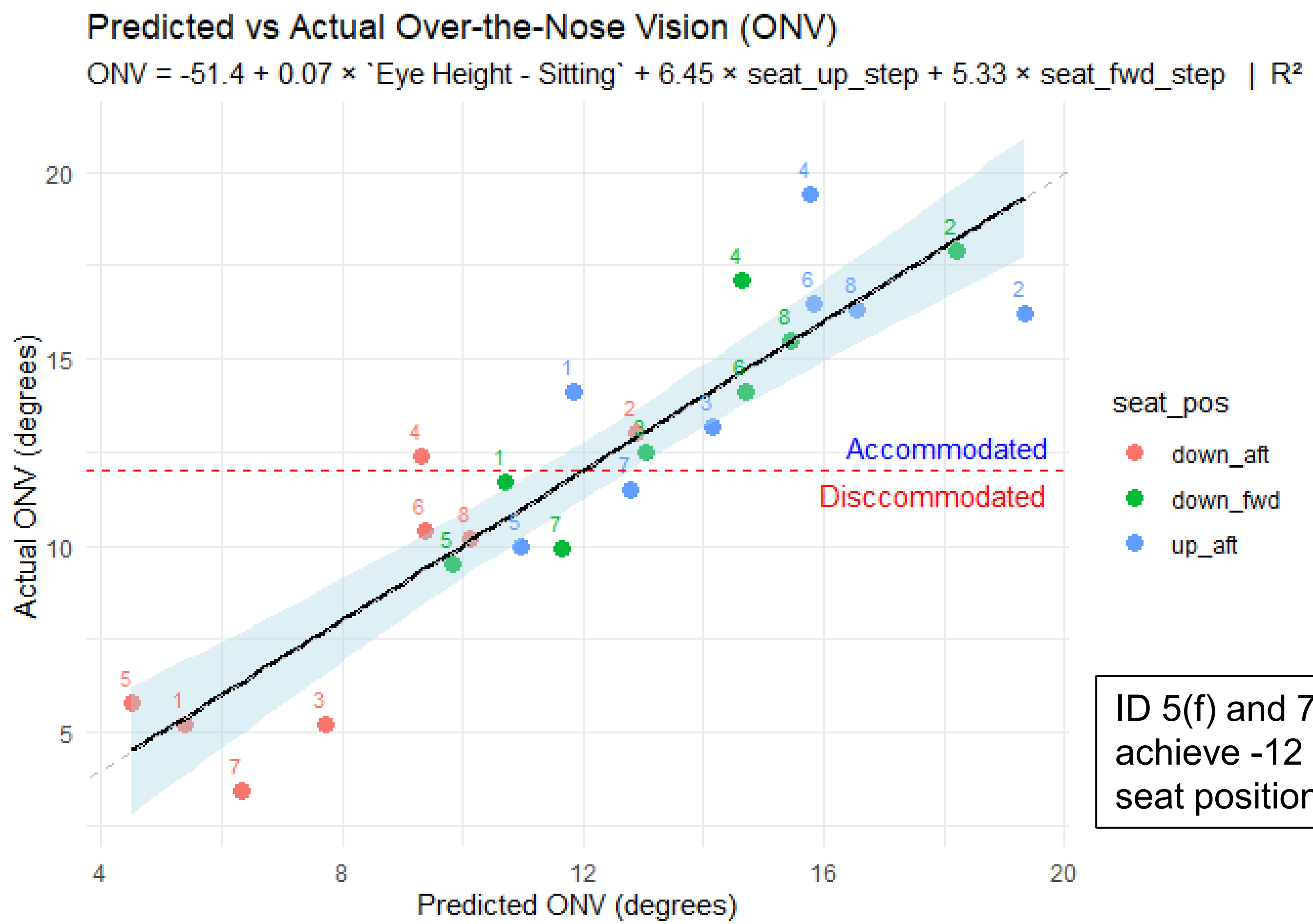
Down

No image

Aft

Forward





ID 5(f) and 7(m) unable to achieve -12 deg in tested seat positions (note 2).

Note 1. All “disaccommodated” lines are arbitrary and for exploratory purposes only
Note 2. up_fwd was difficult to achieve and was abandoned from the test protocol

Conclusions

- We were successful in applying the USAF multivariate accommodation protocol
- Validated results against a previous Canadian head clearance assessment of the Bell 206
- We identified some tool improvements
- Real time data validate was an effective learning aid

What’s next

- Seat adjustability
- Add clothing and ALSE encumbrance
- Explore benefits / challenges with modern technology (3D scanning, FARO)
- Is linear regression required? What about bivariate pass/fail data?

Thank you

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Directorate Technical Airworthiness and Engineering Support
Aerospace Equipment Program Management Division / Material Group
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Backup slides

Canada's Defence Anthropometry Resource Tool (C-DART)

Overview | Data Sources | Explore | Multivariate | 3D - Library | Resources

Welcome to the DND/CAF Web-Based Anthropometry Tools website.

These tools were created by Defence Research and Development Canada with the goal of allowing users to interactively visualize and analyse anthropometric data collected as part of the 2012 Canadian Forces Anthropometric Survey. This tool allows users to investigate 1D, 2D, 3D, and multivariate (4 measures or more) anthropometric design challenges effectively and efficiency.

Anthropometry is the scientific study of human physical size and shape. The knowledge of anthropometric measures affords the ability to quantify human size and shape variability in relation to key design elements. These measurements are invaluable in the development of requirements and specifications for system acquisition when the accommodation of the human is considered. In particular, anthropometry is important for the design and evaluation of clothing, equipment, platforms and workspaces. Proper consideration of these measures can increase the users' safety, comfort and performance while decreasing acquisition and logistics costs.

This tool is under constant development and additional functionality will be added as it becomes available.

INNOVISION

Comfort and Fit Copilot (ComFit Copilot)

Jatin Kashyap, Wenye He, and Zhiqing Cheng

Innovision, LLC.

Dayton, Ohio

The 2nd Biomechanical Engineering and Anthropometry Meeting (BEAM) 2026

BEAM

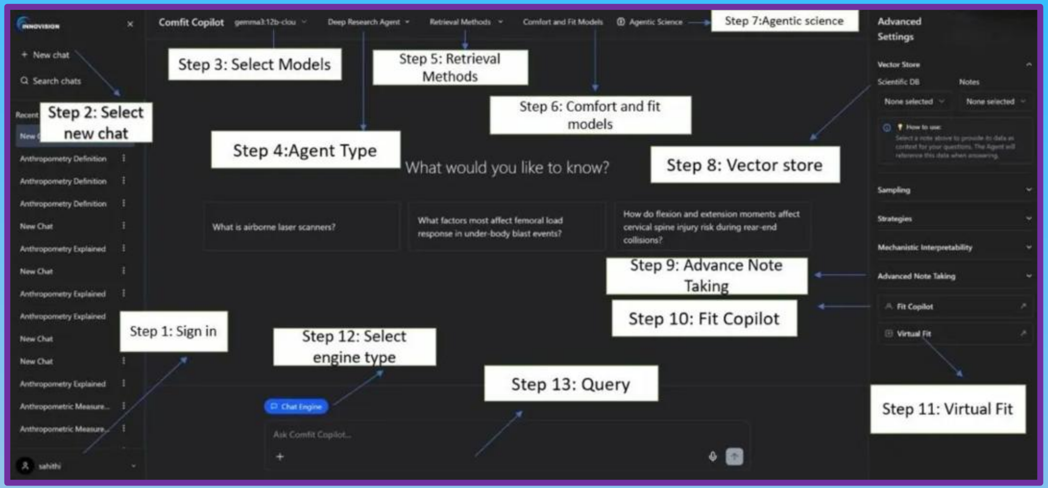
Wednesday, March 25, 2026

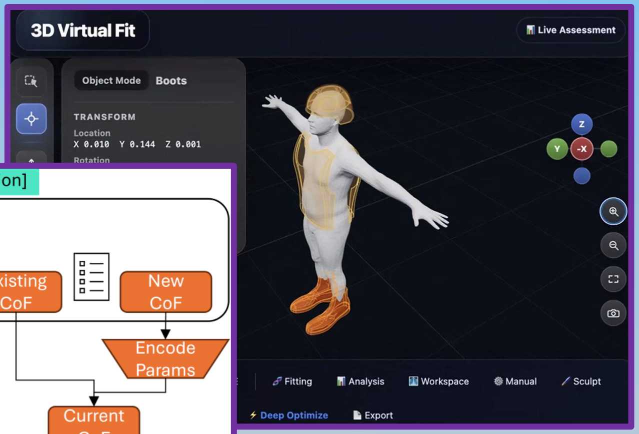
Outline

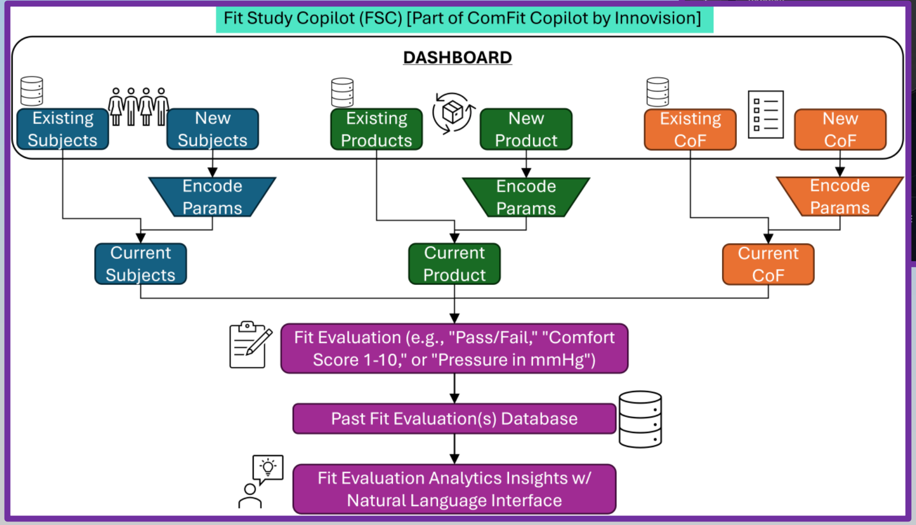
- Need of ComFit Copilot
- Concept of Solution
- Technology
  - Fine-tuning
  - RAG
  - Steer
- Capabilities
  - Evaluation
  - 2D/3D content
  - Modules: ComFit Notes, Fit Study Copilot, 3D Virtual Fit

Comfort and Fit Copilot (ComFit Copilot)

- ComFit Copilot – anthropometric and ergonomics practitioners
- A scientific knowledge base with natural language interface
- Contains specialized modules i.e. Note taking, Fit Study Copilot, 3D Virtual Fit
- **Core Value Proposition:** ComFit Copilot transforms the ergonomic workflow from "Searching for Data" to "Designing with Insight."

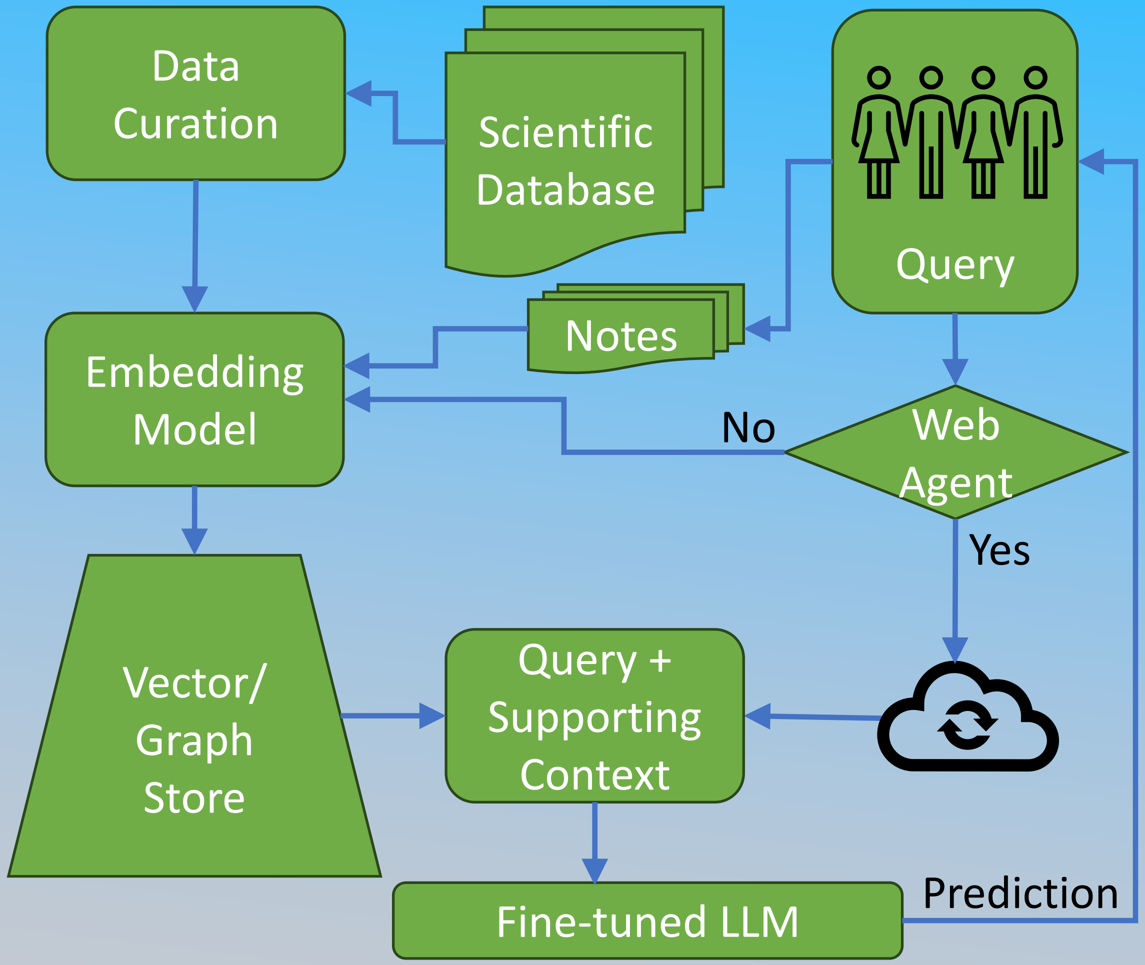






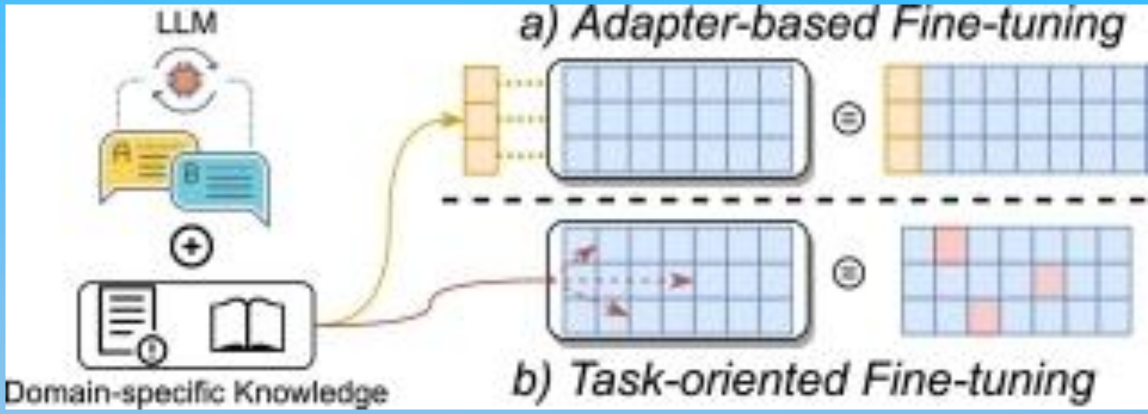
Why ComFit Copilot needed?

- Domain fine tuned SLMs grounded in scientific literature
- Hybrid retrieval across preloaded database and live internet sources
- Multi RAG pipeline with reflection, multi step query engines, and reranking
- Explainable, citation linked outputs in a secure research workflow

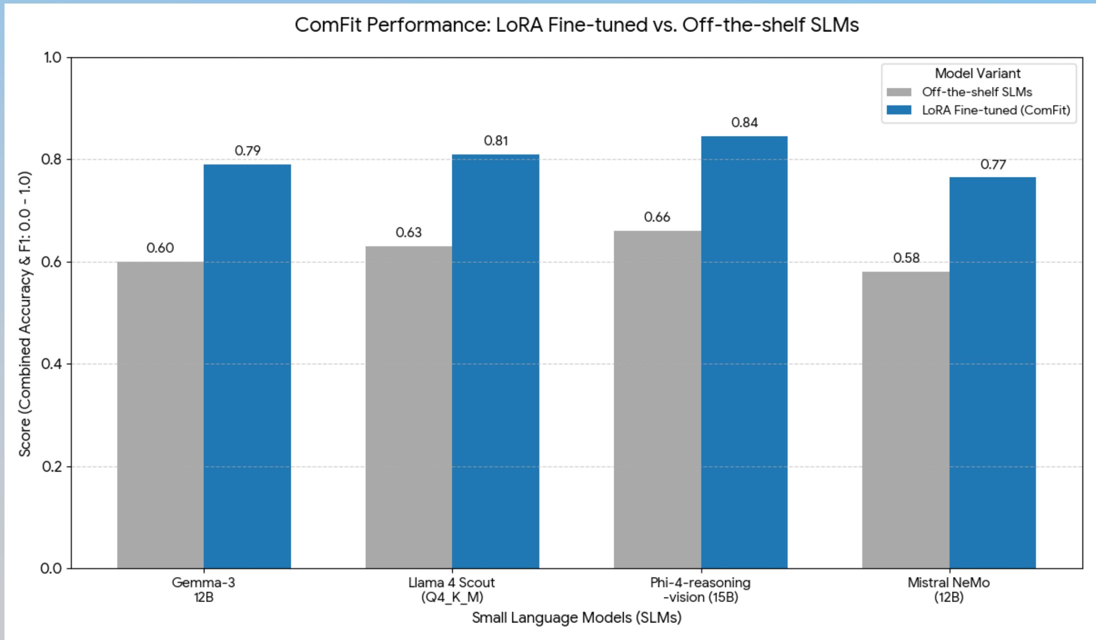


Beyond General AI: Fine-Tuned SLMs

- **Core Tech:** Transition from General LLMs to Reasoning Small Language Models (SLMs).
- **The Difference:** Models specifically fine-tuned on scientific domain databases rather than just general internet text.
- **Key Benefit:** High-performance reasoning on complex anthropometric data with a smaller computational footprint.

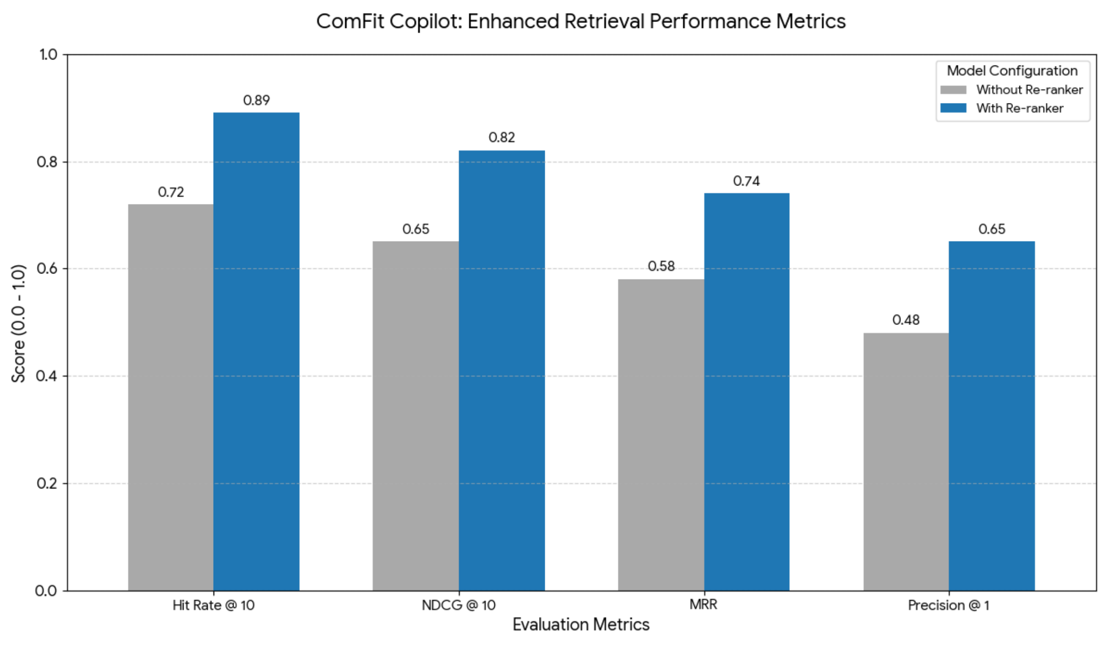


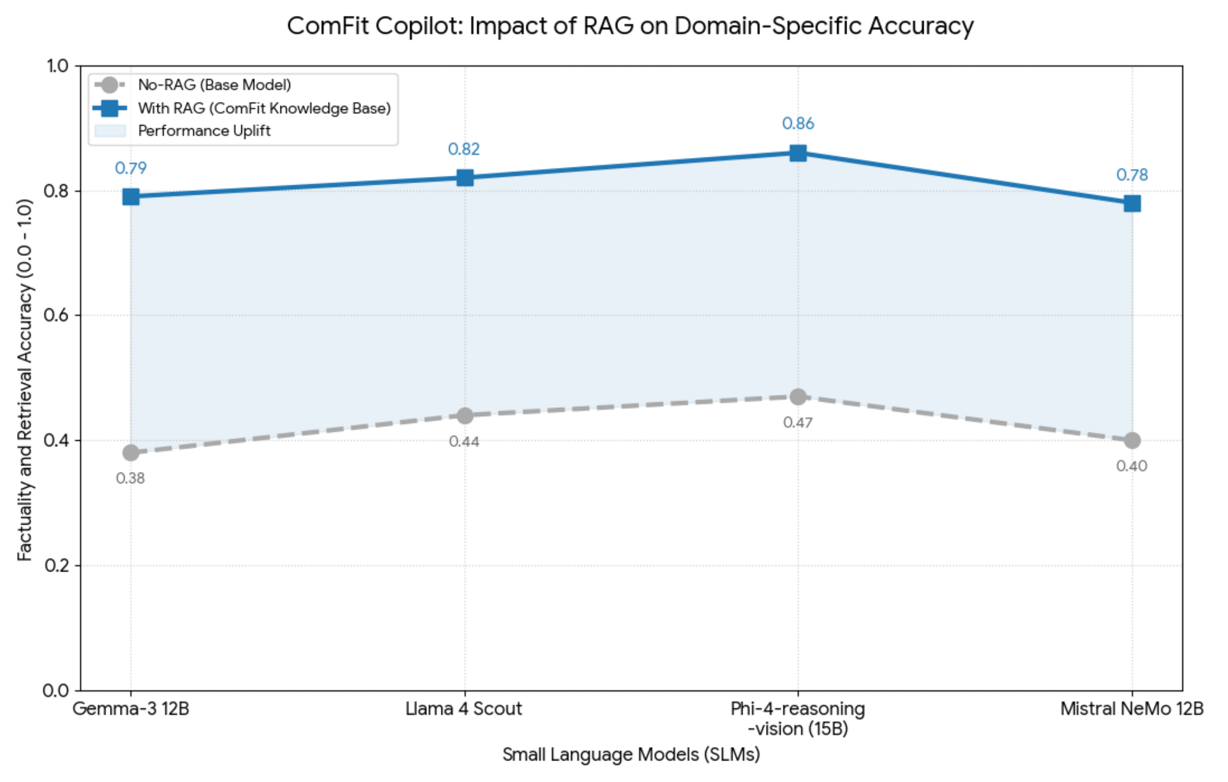
Ling, C., Zhao, X., Lu, J., Deng, C., Zheng, C., Wang, J., Chowdhury, T., Li, Y., Cui, H., and Zhang, X., 2023, "**Domain Specialization as the Key to Make Large Language Models Disruptive: A Comprehensive Survey**," ACM Comput Surv



RAG & Re-ranker

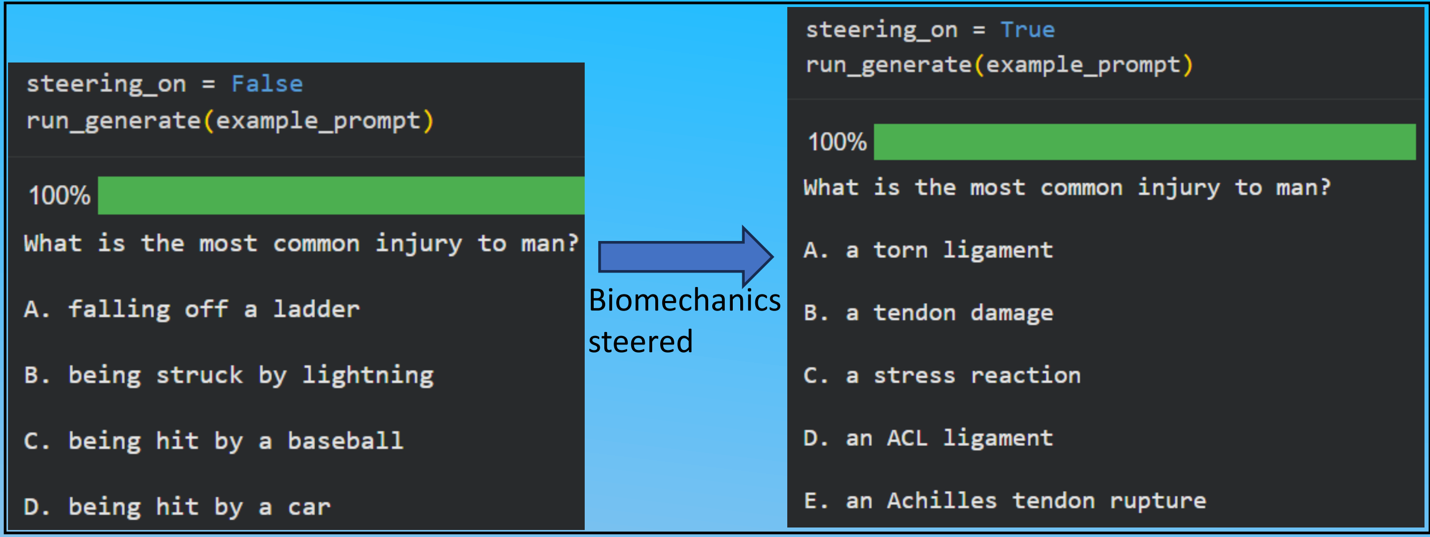
- RAG grounds responses in curated ergonomic and anthropometric literature
- Re-ranker prioritizes the most query relevant evidence before answer synthesis
- Together, they improve retrieval precision, answer quality, and trustworthiness
- Performance gains over non RAG and non re-ranked baselines are shown in the figures

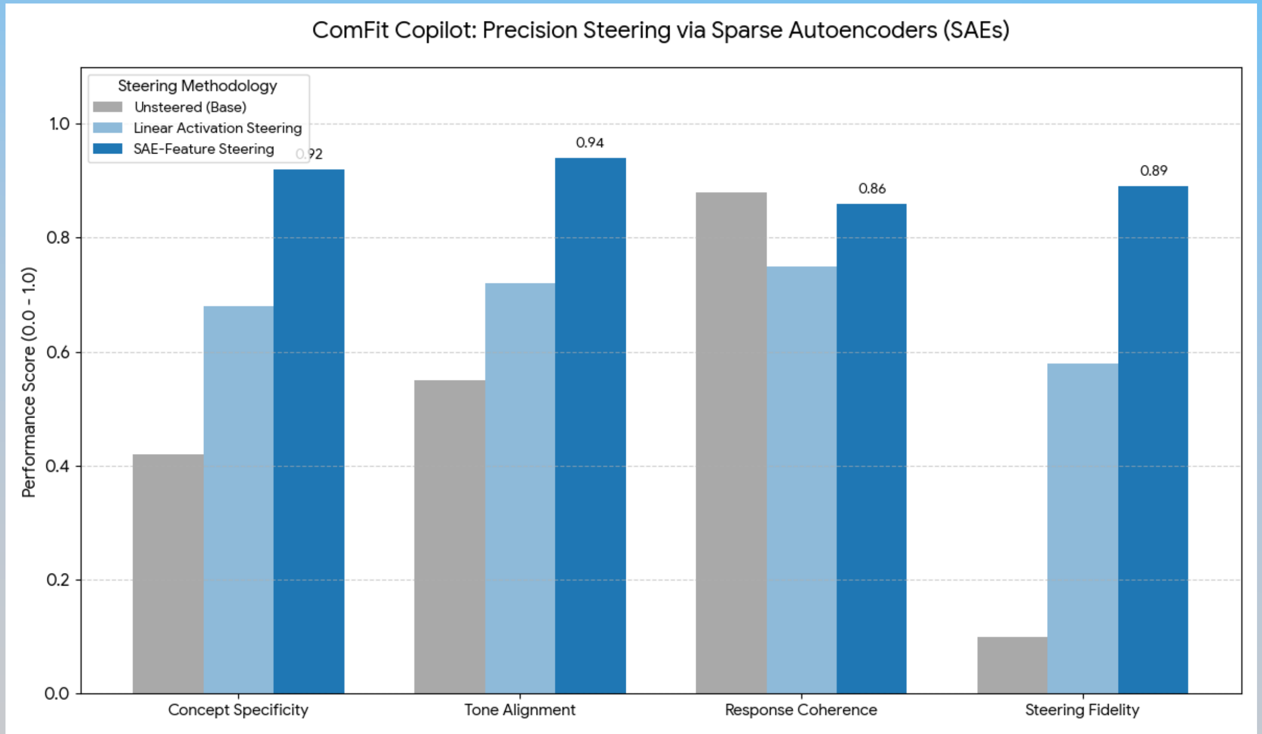




Model Steering

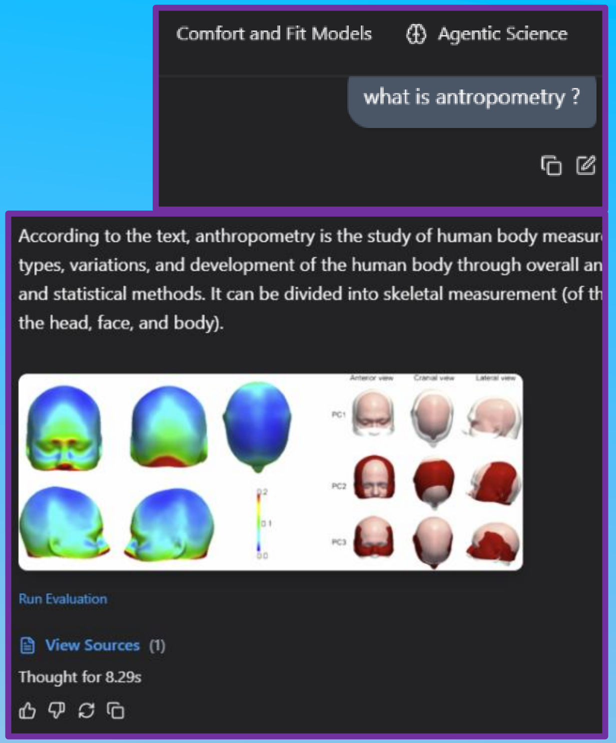
- Steering vectors guide the model toward more reliable domain specific reasoning
- Mechanistic interpretability provides a targeted way to influence answer behavior
- Steering improves response quality without changing the underlying knowledge base
- Performance gains of the steered model over the non steered model are shown in the figure

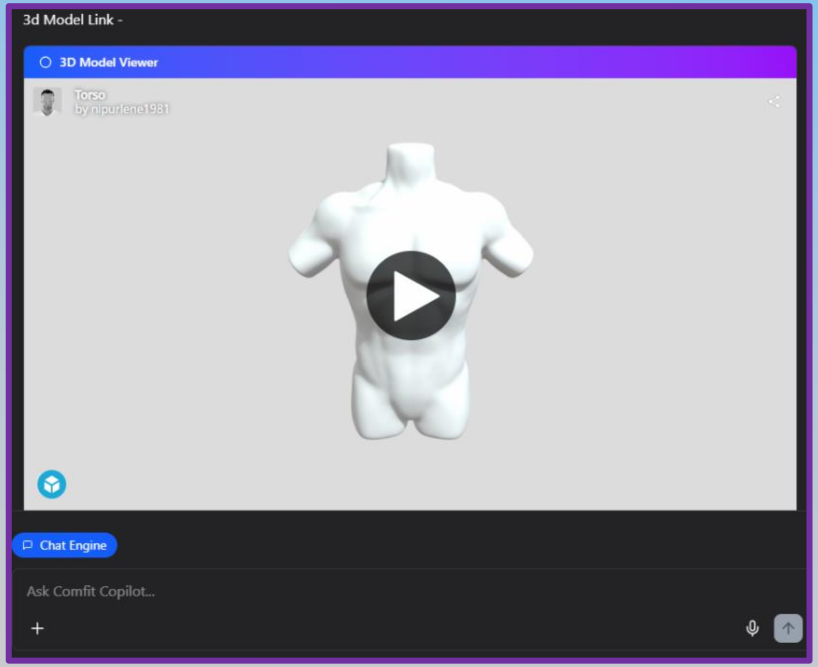




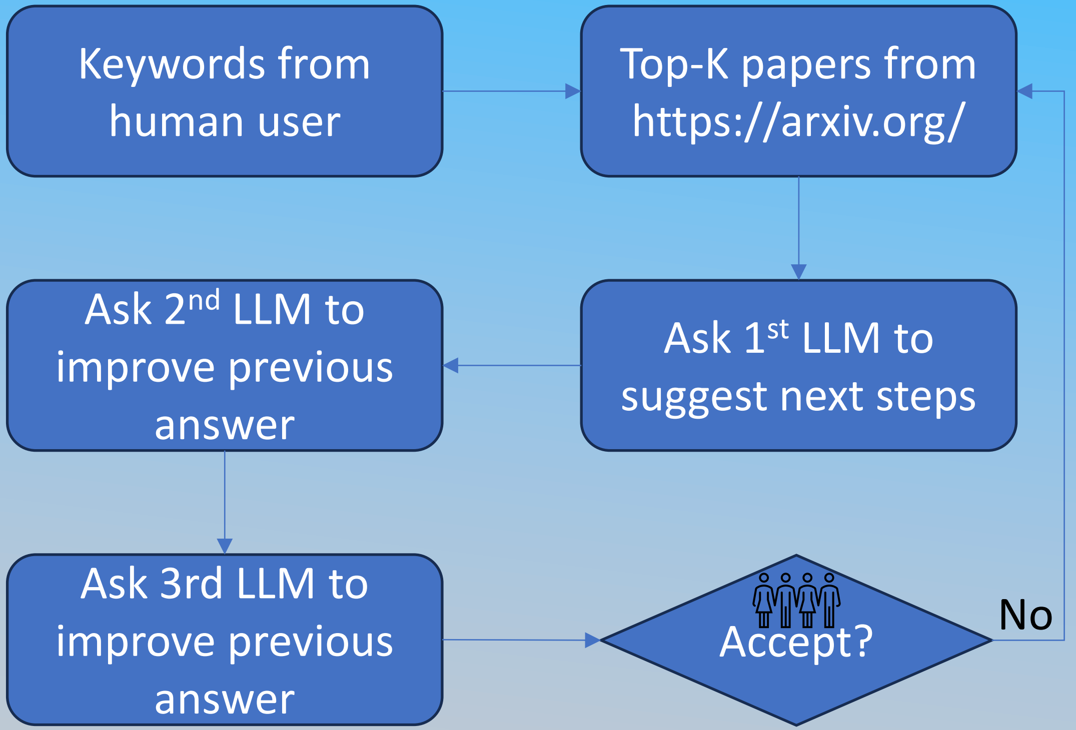
Multimodal Evidence Integration

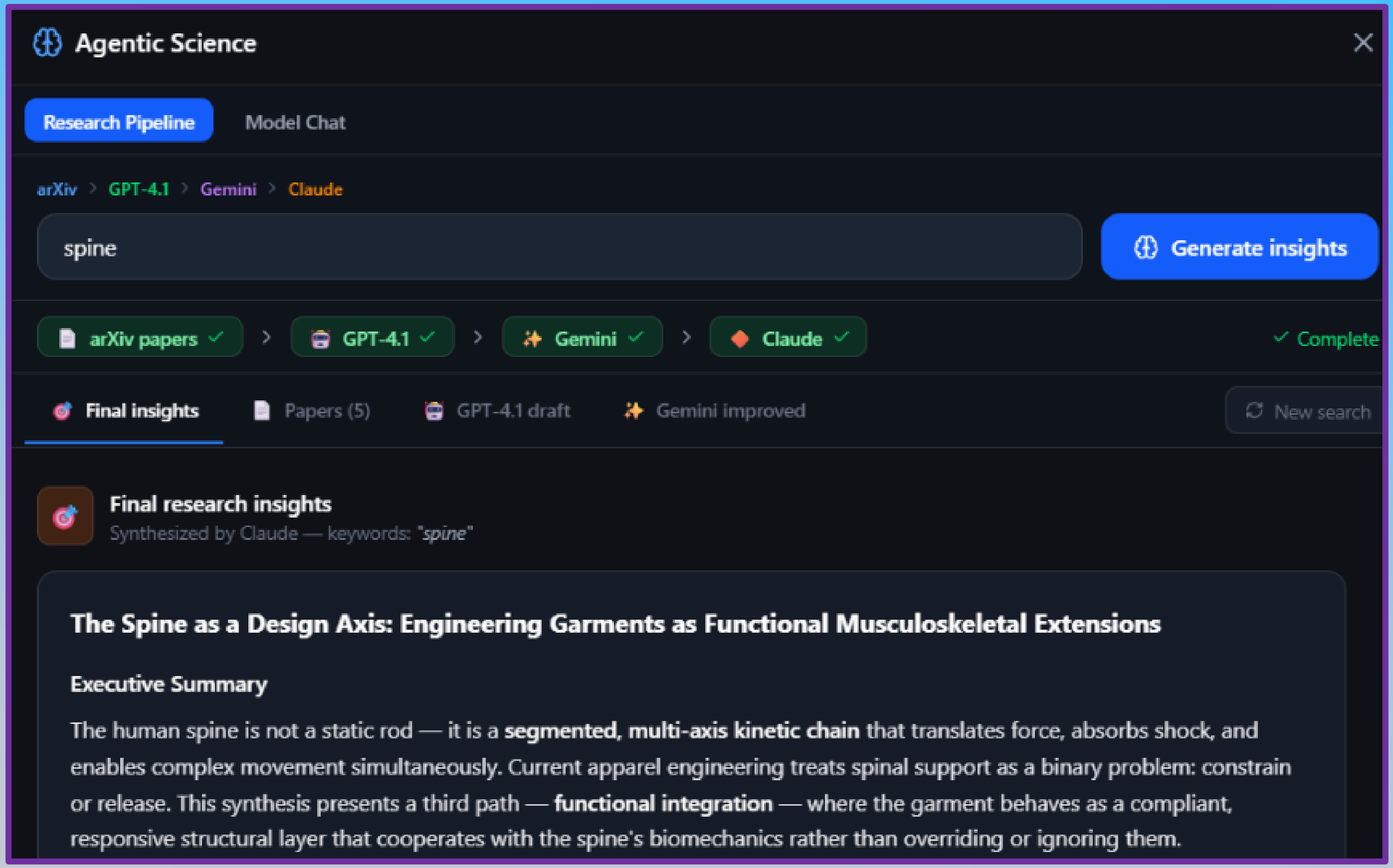
- Retrieves query relevant scientific images, charts, and tables from literature
- Links every visual directly to the original peer reviewed source
- Integrates interactive 3D body scans for spatial ergonomic analysis
- Supports comparison of scan geometry against comfort and fit models





Agentic Science Module





- **Usage**: when user knows only keywords and looking for next steps e.g. {high Y-stress, helmet}
- **Three LLMs**: Claude, Gemini, ChatGPT

Notes Taking Module

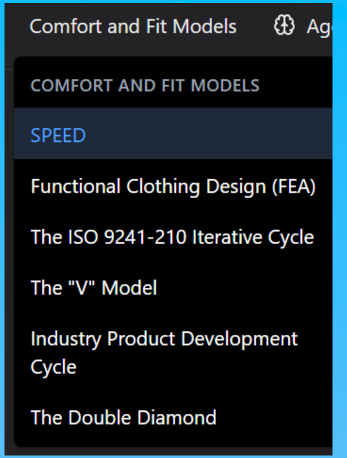
Common Practitioner Note Taking Patterns Supported

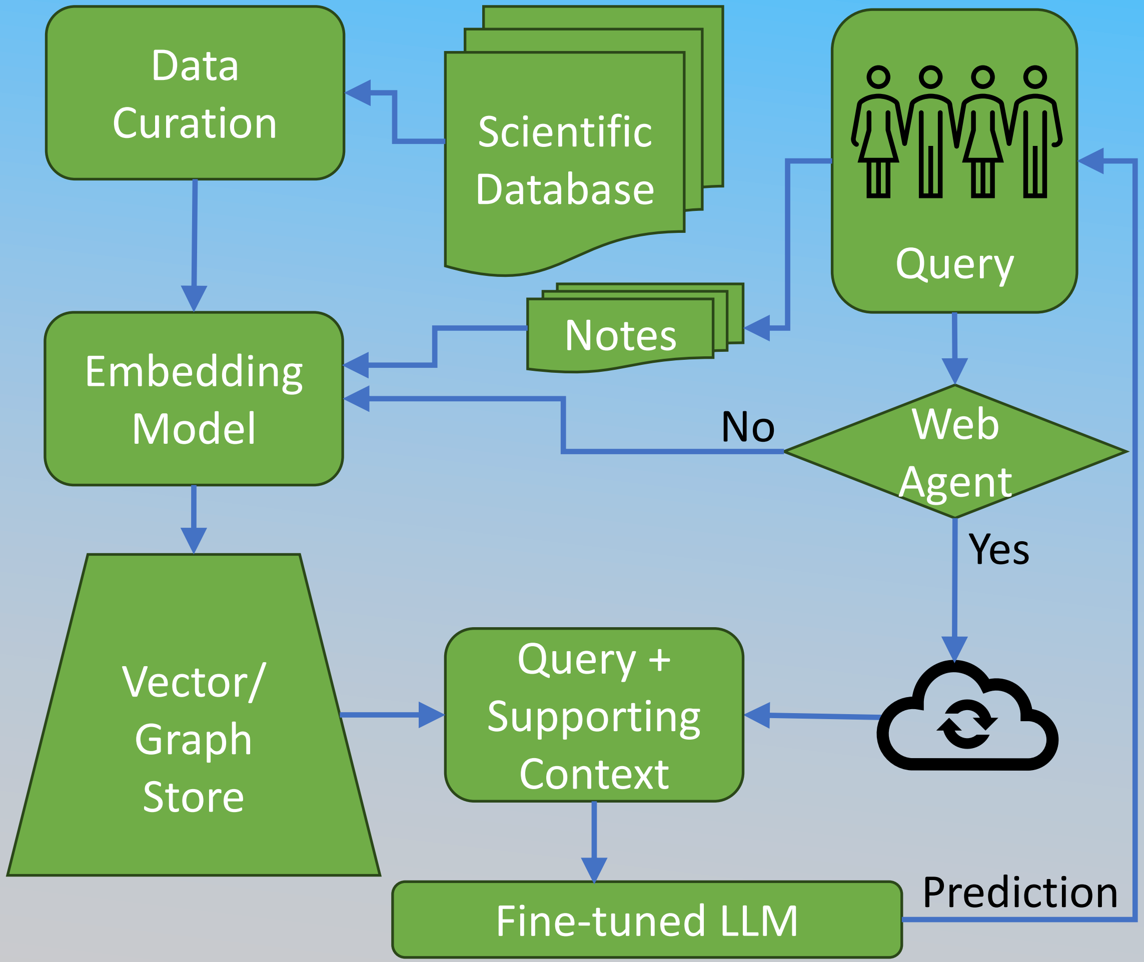
- Observe → Interpret → Decide
- Issue → Evidence → Action
- Functional Expressive Aesthetic tagging
- Test → Refine → Retest loops

Inputs(Formatted per enterprise database): Wear tests; user feedback; body context; product and size

Outputs: Comparable fit records; traceable decisions; design and sizing insights

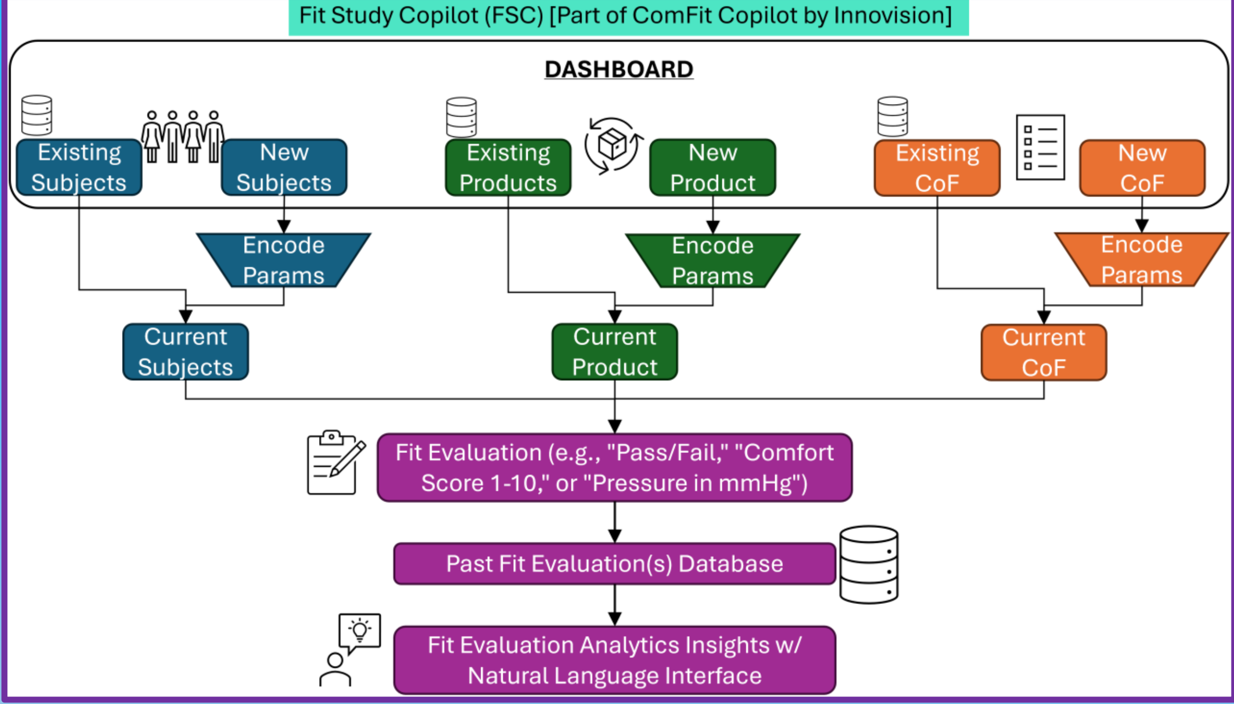
System Value: preserves expert judgment > enterprise ready intelligence

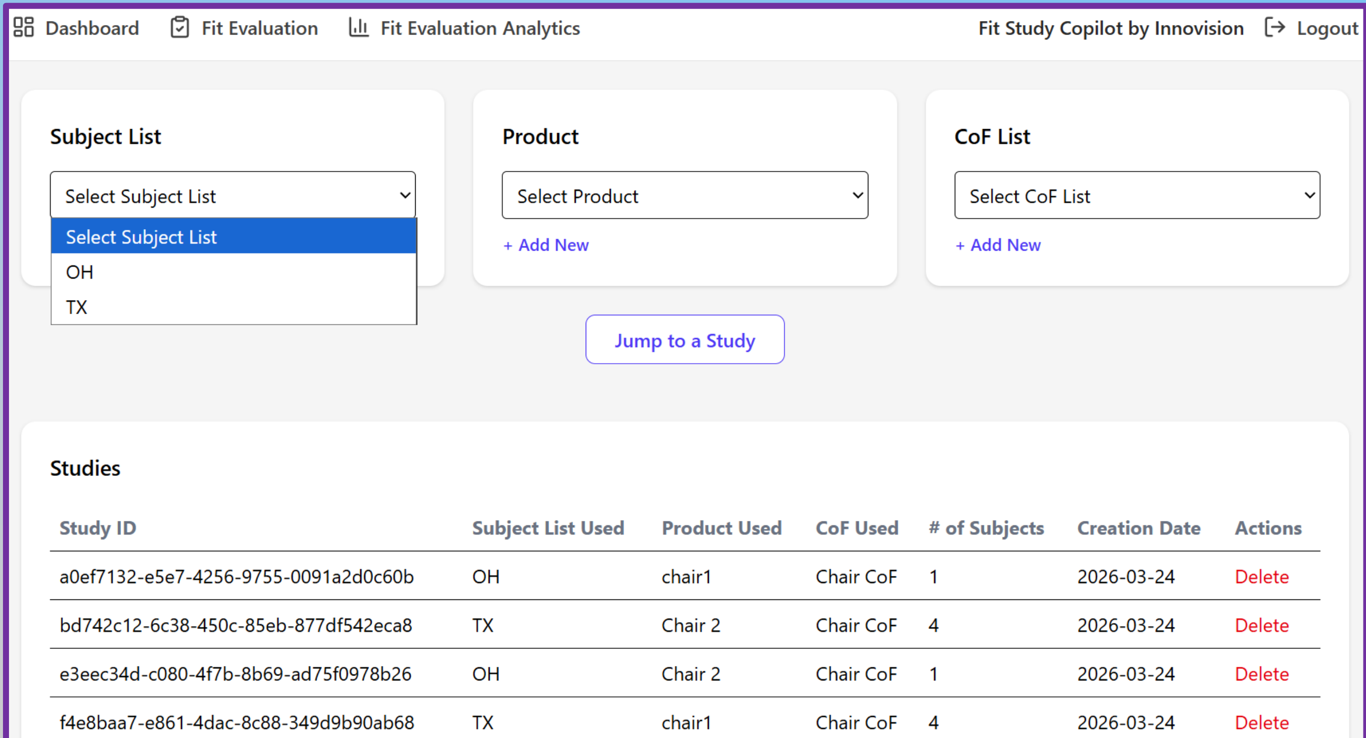




Fit Study Copilot (FSC)

- Manage reusable records for Subjects, Products, and Concepts of Fit (CoFs)
- Launch studies from a dashboard with one product, one subject list, and one CoF list
- Capture investigator assessments such as pass or fail and comfort scores
- Store completed studies in a searchable evaluation database
- Query past studies in natural language with cited study level traceability





3D Virtual Fit

- Parametric 3D human model generation from user body measurements
- Automated integration of equipment (helmet, armor, footwear)
- In browser CAD style manipulation (translate, scale, rotate)
- Multi axis camera tracking with orthographic views for precise spatial validation

Video Demos

INNOVISION

Thank you | Questions

Welcome to Visit Our Booth

Free Access to ComFit CoPilot

https://huggingface.co/spaces/Innovision/ComFit-Copilot