Examining the Use of Lightweight 3D Formats on Mobile Devices

Nathan Hartman, Ronald Glotzbach, Kyle Sigo, Christopher Rice

Department of Computer Graphics Technology, Purdue University, West Lafayette, IN

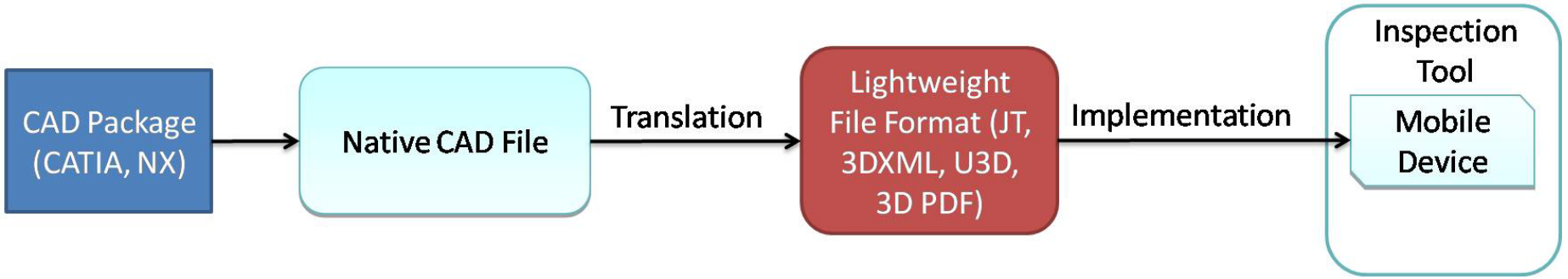
Mobile CAD Overview

- Given the geographically dispersed product design and manufacturing scenarios that are commonplace in industry today, companies are grappling with decisions regarding the use of specific formats and mechanisms to promote communication and collaboration processes.
- Current communication solutions tend to center on “lightweight” file formats as one of the enabling technologies that support this distributed collaboration.
- An emerging application area for lightweight formats is in need of study – the use of this data on mobile devices.

Methodology Overview

•Develop a pipeline and interface for creating, transporting, displaying and manipulating lightweight CAD files on a number of mobile devices.

•A use case study around “Hangar of the Future”



Current Data Path

- Siemens' PLM Vis
  - Component technology that enables rapid development of collaborative applications through:
    - Development of applications that produce graphics from complex data
    - Create customized views of data not possible with off-the-shelf applications
    - Develop applications that work across the Internet and from within a Web browser

PLM Vis

- Recently used to successfully develop application on a mobile device
- PLM Vis components are ActiveX/Java beans that enable the development of applications
- Java compatibility means potentially widespread use on mobile devices equipped with Java

Hangar of the Future Lab

Lead research faculty:

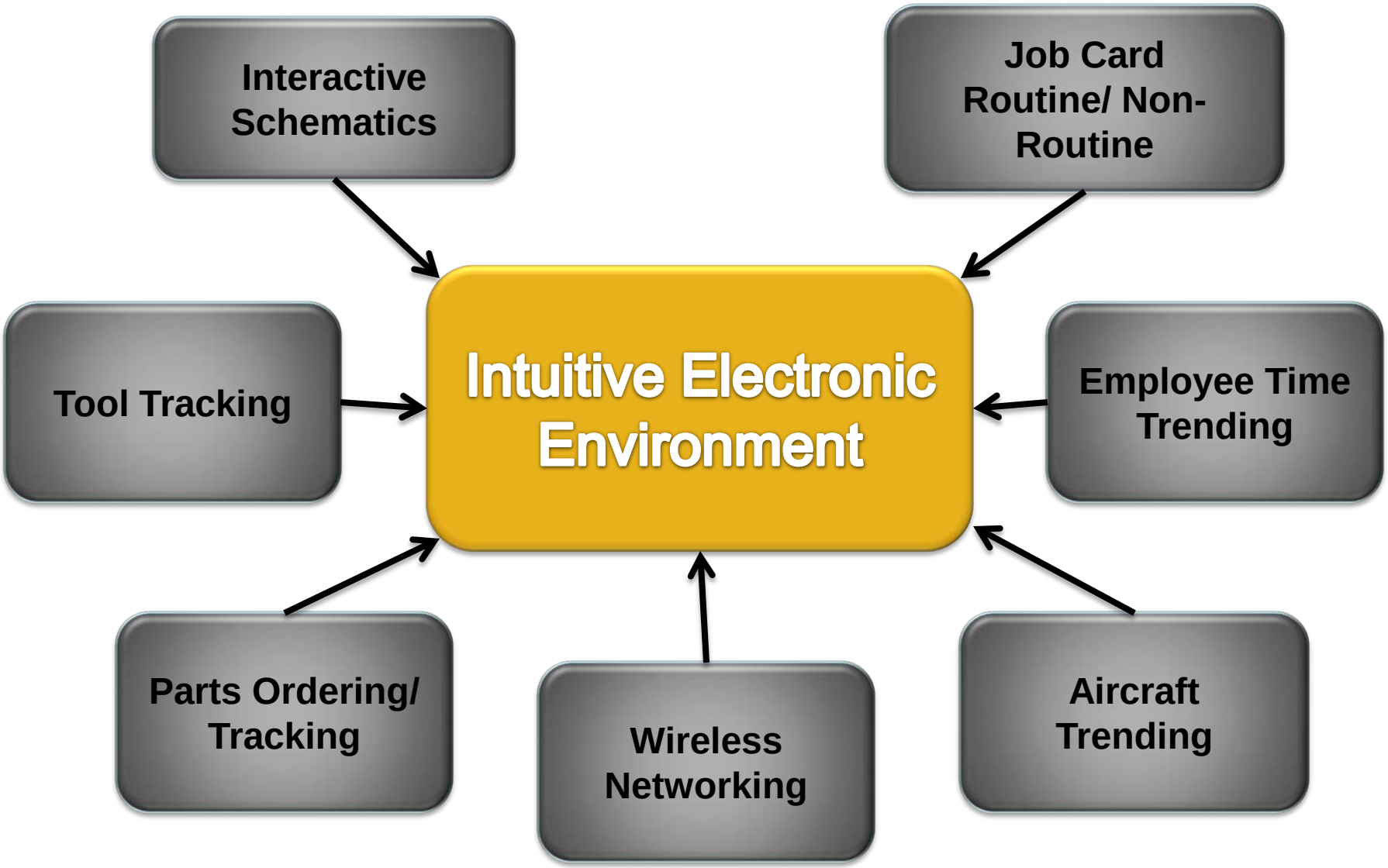
Professor Tim Ropp-PI

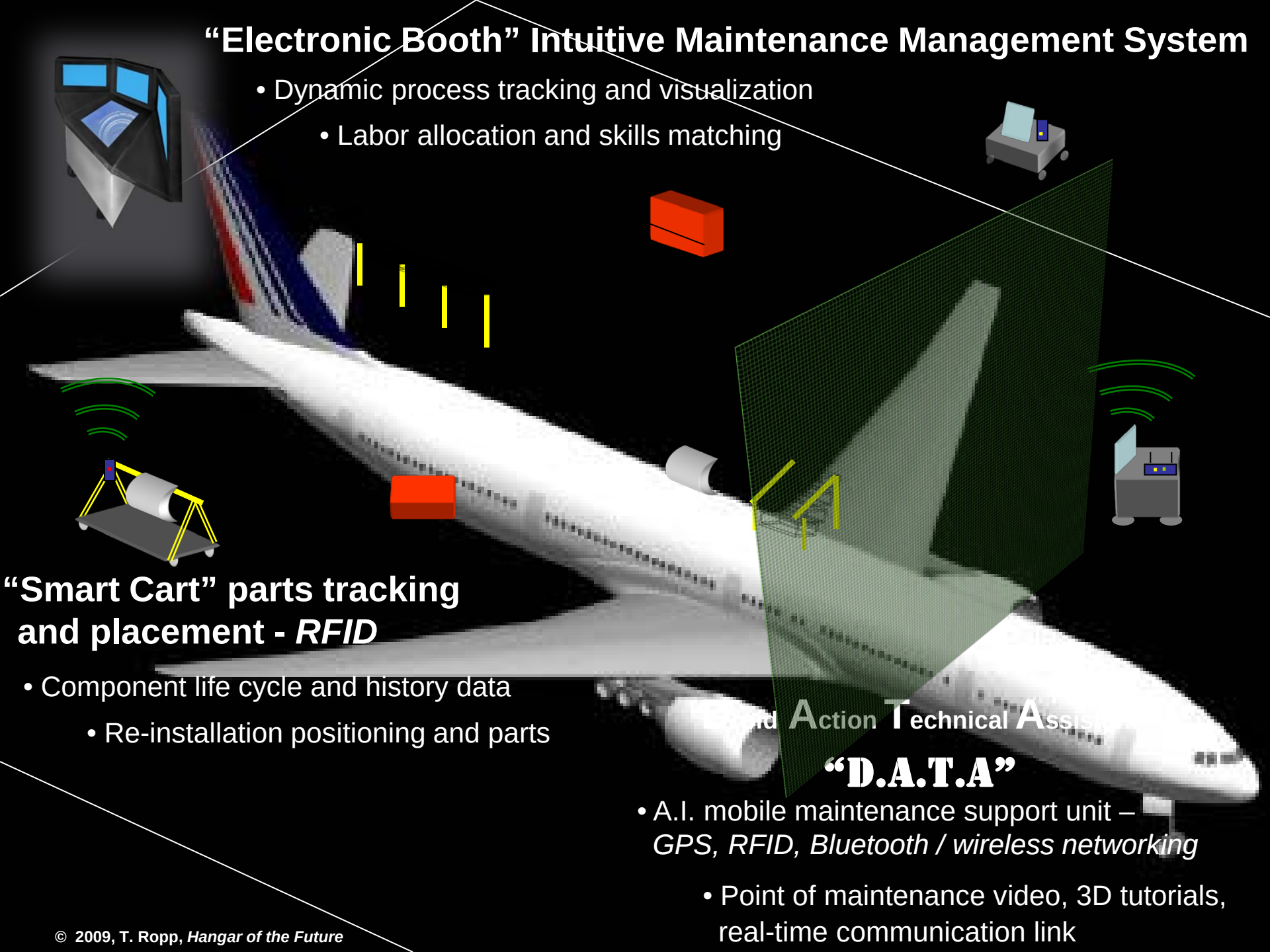
Professor Denver Lopp

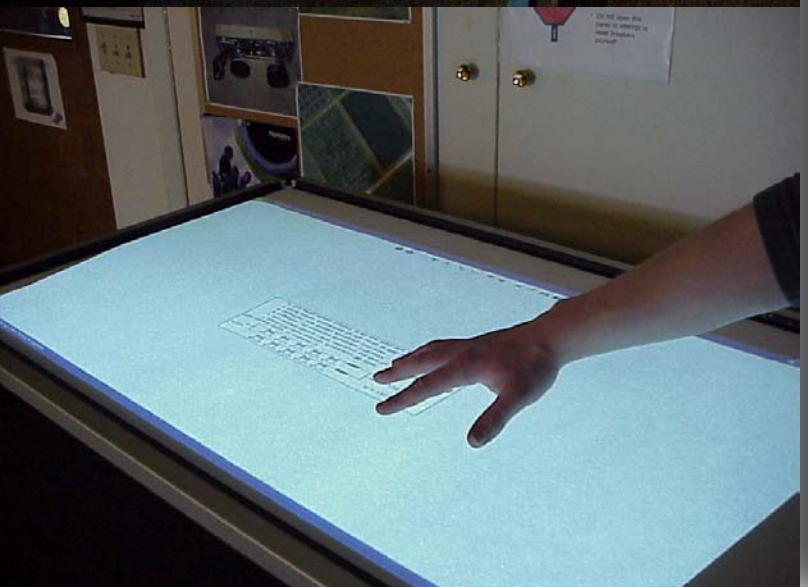
Professor Mary Johnson

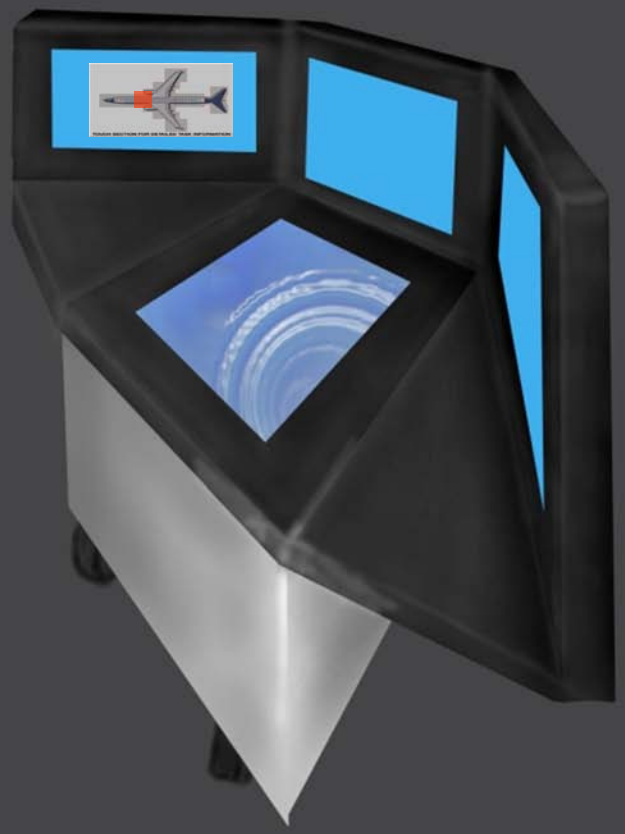
Professor Sergey Dubikovsky

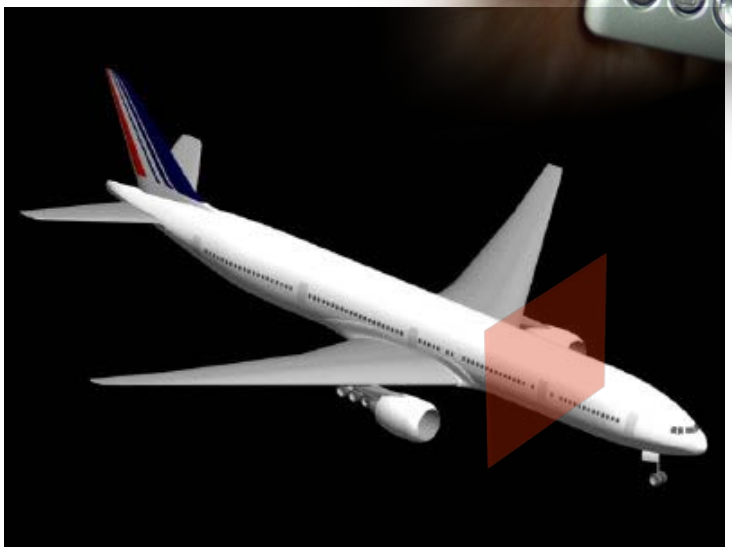
HANGAR OF THE FUTURE












Alert!
Task 9065 ready for final sign-off inspection

Testing the Effectiveness of 3D Models versus Static Illustrations in Aircraft Maintenance Manuals

Computer Graphics Technology

CGT411 Senior Group Project

The Project

•Put product maintenance manuals in a format that can utilize data rich 3D models and can be accessed in the field

•Originally for handheld mobile devices

•Due to time constraints, changed to mobile devices excluding smart phones and PDAs

•Met with students and professors in the Aviation Technology Department to find out about existing parts and manuals

•Asked questions regarding their knowledge of 3D software and experience with maintenance of aviation parts

Problem Statement

•In aircraft maintenance situations, traditional 2D methods for viewing models are often cumbersome, out of date, and inaccurate.

Research Question

•Can a lightweight 3D model carry the same information as a 2D reference manual and enable students to complete aircraft maintenance operations faster and more accurately?

Hypotheses

1.Product maintenance technicians will perform assembly tasks faster when using a manual with dynamic 3D models than when using the original manual with static 2D illustrations.

2.Individuals will experience less workload when using a dynamic 3D model as a visual aid than when using a static 2D exploded view.

N=22 (mixture of CGT and AT students)

Problems:

•Product maintenance manuals are often out of date.

•Design changes have been implemented, but the manuals have not changed.

•Illustrations are cluttered and hard to understand.

Our Example:

Marvel Schebler Model MA-4-5 aviation carburetor maintenance and overhaul manual

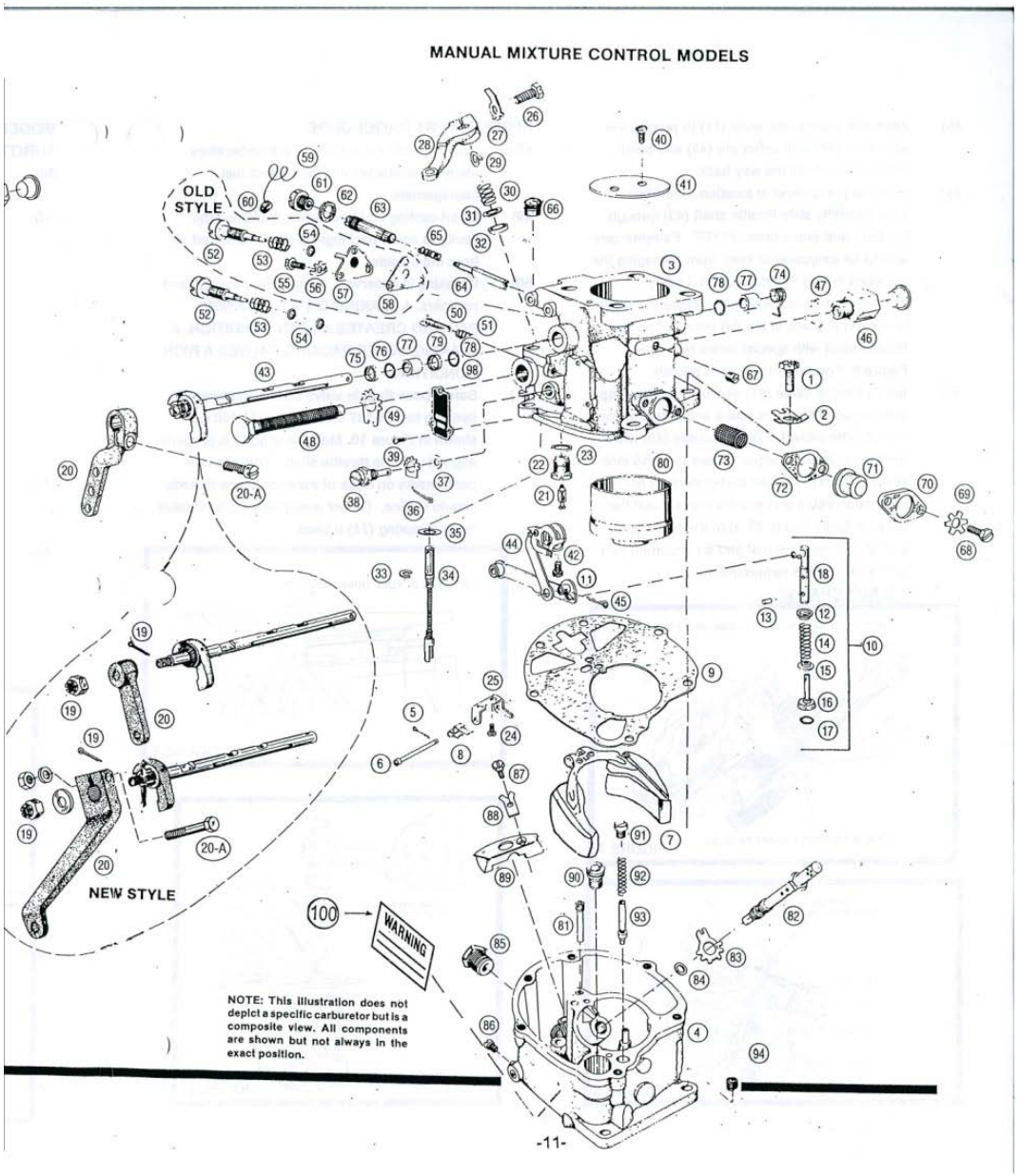
Source:

Purdue Aviation Technology

Issues:

•Illustrations are inaccurate due to design changes

•Exploded view is cluttered and oversaturated with information making it hard to read



Possible solution: Manuals with 3D models

•3D CAD models already exist for current products, so 3D data is readily available.

•CAD data is not included in product manuals for the most part.

•Purdue's Aviation Technology department stores manuals as PDF documents.

•Using Adobe Acrobat 9 Pro Extended, one can import native CAD formats and include 3D models in the PDF document.

•It is easy to leverage existing CAD data to make maintenance operations faster with this method.

Our experiment will attempt to determine if manuals which include 3D models will reduce the time required to perform maintenance operations.

Experiment Design:

•Subjects will be asked to assemble the model MA-4-5 carburetor.

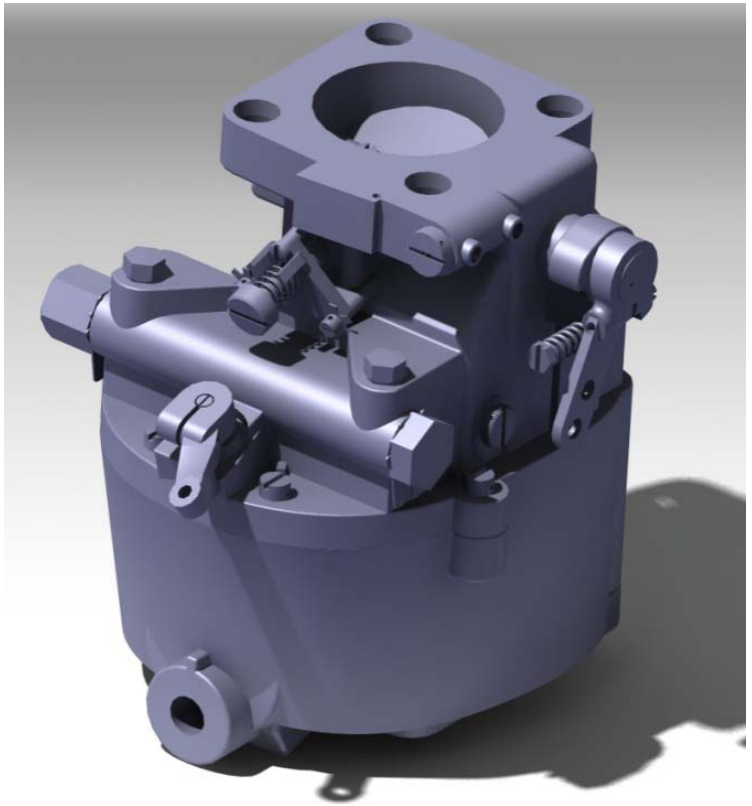
•The control group will use the original maintenance manual.

•The experimental group will use a manual with 3D models.

•Subjects were assigned to a group based on the order they came in, odd numbers used the experimental manuals, even numbers used the control manuals.

•Subjects were timed, and afterwards they were asked to complete the NASA Task Load Index (TLX) survey.

•To create the 3D PDF manual, we needed a CAD model.
•We re-modeled the carburetor and made the models and assembly in CATIA V5 R18.
•Then we imported the CATProduct assembly file into Adobe Acrobat 9.
•Using Adobe, the models were colored and animated to show the steps of assembly.
•To make our manual we combined the models with the original PDF manual.



•**Incidental Advantages:**
    - •Easy updating for design change
    - •Multiple configurations can be stored to accommodate mass customization

Our Manual

For steps 45-57 use Figure 1 as reference

45) Assemble pump idler lever (11) to pump lever assembly (44) with cotter pin (45) and bend cotter pin ends all the way back.

46) Hold the pump lever in location. See Figure 8. Very carefully slide throttle shaft (43) through the bore and pump lever. NOTE: Extreme care should be exercised to keep from damaging the packings during this installation. Lightly lubricating the shaft will help. Secure the pump lever (44) in place in the flat provided on the throttle shaft with special screw (42). See Figure 9. Torque to 10-12 inch pounds.

47) Install throttle valve (41) with screws (40). Tap throttle valve lightly to seat it accurately in bore with throttle closed. Tighten screws (40) while throttle is closed. Torque screws to 10-15 inch pounds. NOTE: Certain carburetors do not use a wide open valve and you may notice that the valve is limited up to 8^0 from the fully open position. This is normal and an important part of the full throttle requirements. DO NOT CHANGE.

SPECIAL TEST PROCEDURE

48) Leaking packings can upset the carburetors metering characteristics and affect fuel management.

~~49) Invert casting and pour a test liquid into the cavity to cover packings. Blow compressed air from the outside.~~

~~50) If leaking is observed, replace the packings and retainers. A LEAKING OR WORN INNER PACKING CREATES A LEAN CONDITION. A LEAKING OUTER PACKING CAUSES A RICH CONDITION.~~

~~51) Safety peen throttle valve screws in place with peening tool M-107 on arbor tool M-100 as shown in Figure 10. Make sure arbor is properly aligned with the throttle shaft. Three to four peen marks on edge of exposed screw threads should suffice. Do not over peen.~~ Install throttle opening spring (74) if used.

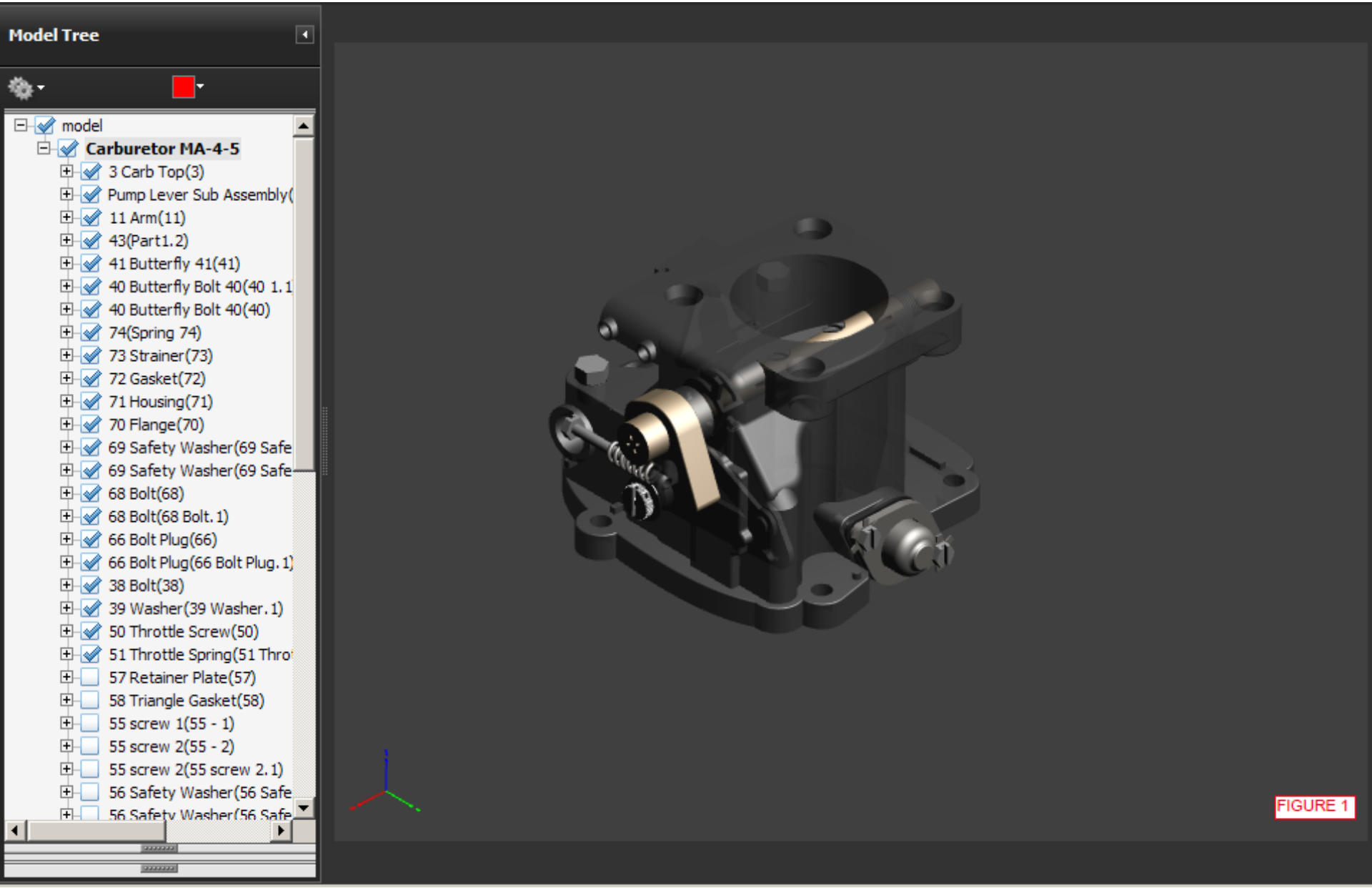
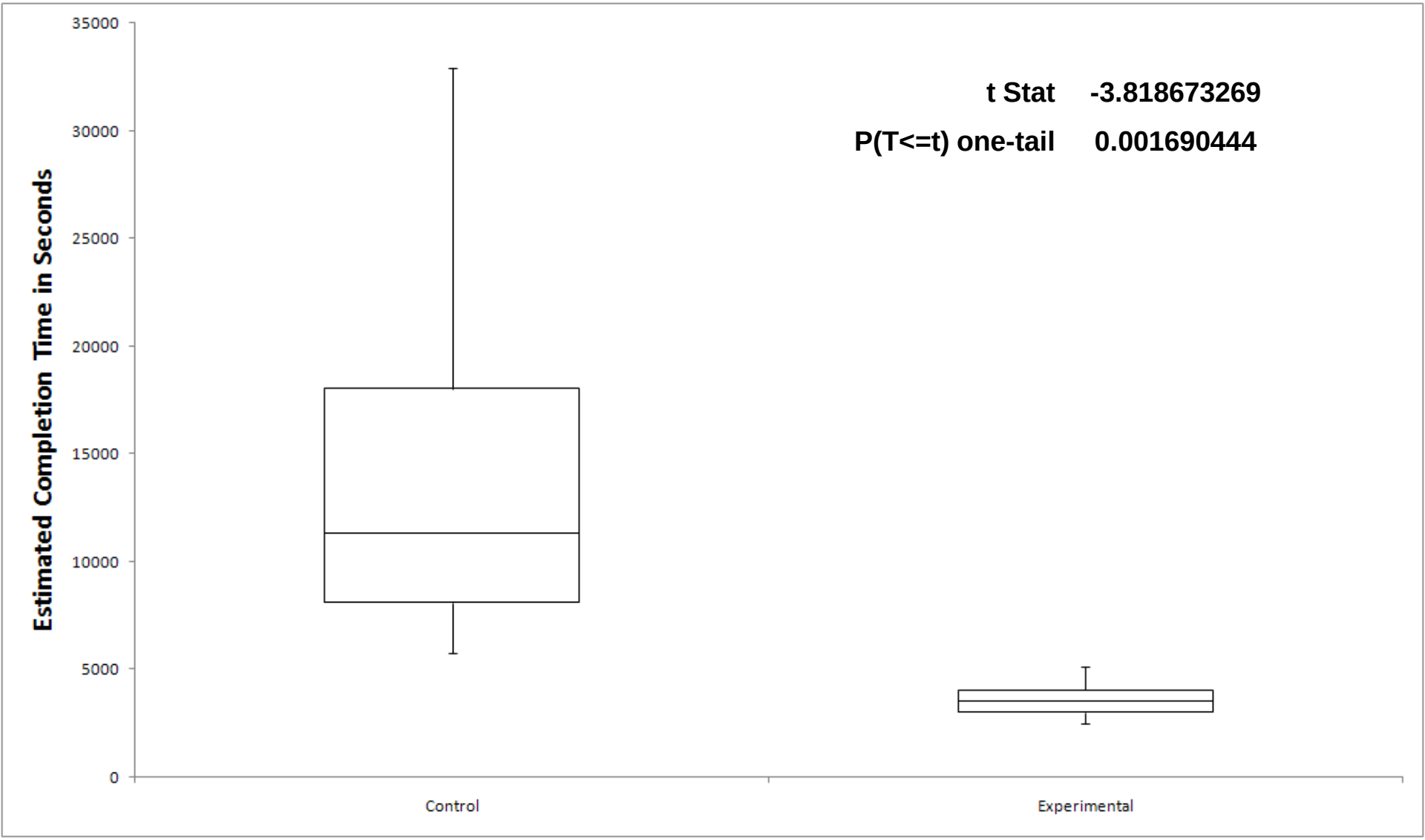
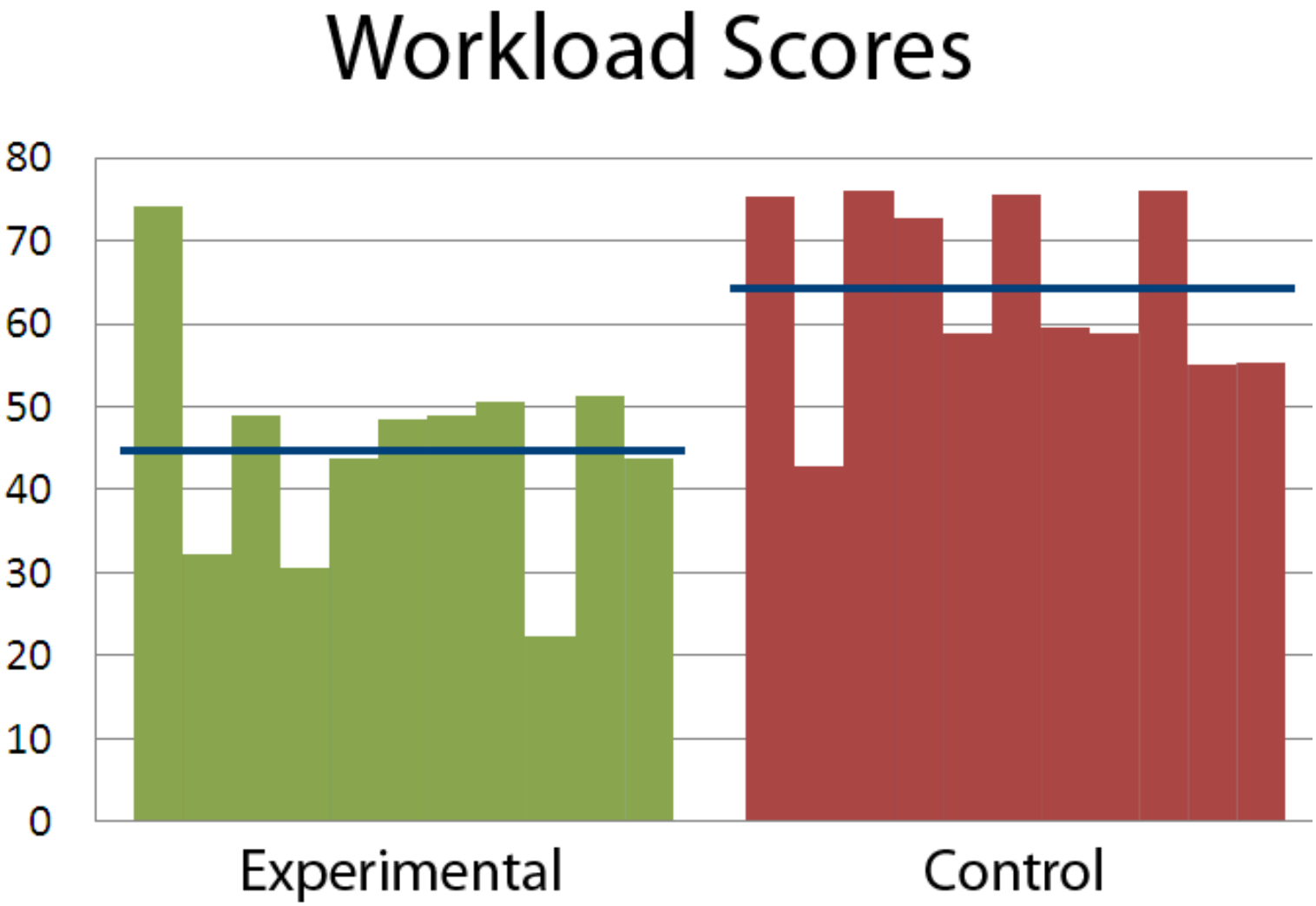

Model Tree
model
Carburetor MA-4-5
3 Carb Top(3)
Pump Lever Sub Assembly(
11 Arm(11)
43(Part1.2)
41 Butterfly 41(41)
40 Butterfly Bolt 40(40 1.1
40 Butterfly Bolt 40(40)
74(Spring 74)
73 Strainer(73)
72 Gasket(72)
71 Housing(71)
70 Flange(70)
69 Safety Washer(69 Safe
69 Safety Washer(69 Safe
68 Bolt(68)
68 Bolt(68 Bolt.1)
66 Bolt Plug(66)
66 Bolt Plug(66 Bolt Plug.1)
38 Bolt(38)
39 Washer(39 Washer.1)
50 Throttle Screw(50)
51 Throttle Spring(51 Thro
57 Retainer Plate(57)
58 Triangle Gasket(58)
55 screw 1(55 - 1)
55 screw 2(55 - 2)
55 screw 2(55 screw 2.1)
56 Safety Washer(56 Safe
56 Safety Washer(56 Safe

FIGURE 1

Estimated Completion Time



TLX Workload Scores



The experimental group's TLX scores were on average 14 points lower than those for the control group

P-value = .00179

What Does This Mean?

•Overall, times and workloads were better for the new experimental manual.

•So not only were they able to perform the task quicker, on the whole, participants found the new manual easier to use.

•There is a much shorter learning curve for people with little to no prior knowledge about the operation.

In the Future (this summer)

•Application to handheld mobile devices

•Finalize technical pipeline: JT, 3D PDF, 3DXML

•Test a target population from the intended context of application; experienced mechanics.