



HAER Post-Processing Workflows: Analysis of a multi-phased approach

Of the many ongoing projects in our office that utilize laser scanning, one common theme is the increasing reliance on and understanding of the tools (both hardware and software) that we use to process the raw data. The sophistication of the technology in the field seems to pale in comparison to the complexity of the software used in the office. Documentation of OV-103 (Space Shuttle Discovery) was a perfect candidate for laser scanning in many ways. What was unclear, however, was how that information would be translated into a legible, informative and archival line drawing. By experimenting with many different programs, understanding their specific strengths and weaknesses, and identifying stable workflows among them, we were able to establish parameters and precedents for future projects.

TOOLS USED
PROCESS
USEABLE RESULTS

PHASE 1 POINT CLOUD:

WHAT IT IS:
A POINT CLOUD IS A DATA FILE CONSISTING OF POINTS THAT POSSESS UNIQUE X,Y, AND Z COORDINATES.

WHAT IT IS NOT:
A POINT CLOUD IS NOT A COMPLETE 3D MODEL OF THE OBJECT SCANNED.

BENEFITS
HIGH LEVEL OF ACCURACY UNDER RIGHT CONDITIONS, CAN SERVE AS A DIGITAL REFERENCE FOR SOME MEASUREMENTS

DRAWBACKS
LARGE FILE SIZES, HARDWARE/SOFTWARE BARRIERS, UNINTELLIGENT DATA UNTIL MANIPULATED BY THE USER, HIGH COST TO PRODUCE AND PROCESS.

SOFTWARE

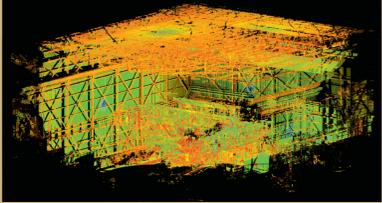
USED
-CYCLONE (REGISTRATION AND EXPORTING)
-POINTTOOLS EDIT PRO (ANIMATION/RENDERINGS)

*NOTE: THIS POSTER ASSUMES YOU HAVE COLLECTED SCAN DATA IN THE FIELD. MOST SCANNING HARDWARE COMES WITH REGISTRATION SOFTWARE WHICH ALLOWS YOU TO COMBINE MULTIPLE SCANS INTO ONE FILE. THE REGISTRATION PROCESS IS NOT COVERED HERE BUT IS AN EXTREMELY IMPORTANT EARLY STEP IN THE OVERALL PROJECT BECAUSE PROBLEMS TEND TO SNOWBALL IN SEVERITY AS YOU PROGRESS.

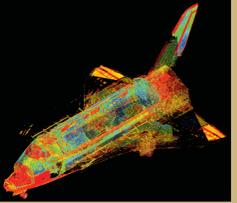
HARDWARE

USED
CPU: 2x INTEL XEON X5660 2.8 GHz (12 CORES)
RAM: 24 GB
OS: 64 BIT WIN 7
GPU: NVIDIA QUADRO FX 4800

RECOMMENDED MINIMUM
CPU: QUAD CORE OR HIGHER
RAM: 16 GB OR MORE
OS: 64 BIT
GPU: DEDICATED (NOT INTEGRATED!)
GEOFORCE GTX 500 SERIES OR HIGHER



REGISTERED POINT CLOUD, IN ALL IT'S GLORY. TRUST ME, THE SHUTTLE IS IN THERE SOMEWHERE...



PORTION OF POINT CLOUD "CROPPED OUT" BY HAND FROM LARGER DATA SET.

POINT CLOUD DATA IS RARELY COMPREHENSIBLE RIGHT AWAY. AFTER A SUCCESSFUL SCAN AND REGISTRATION, THE POINT CLOUD MUST BE MANIPULATED BY THE USER IN ORDER TO EXTRACT ANY USEABLE INFORMATION. TAKING SECTIONS, CROPPING DATA AND 3-D ORBITING ARE THE MOST BASIC METHODS TO BEGIN TO UNDERSTAND WHAT YOU ARE WORKING WITH.



ONCE THE DATA HAS BEEN ISOLATED IN A PRESENTABLE WAY, IMAGES CAN BE PRODUCED AND ANIMATIONS CAN BE SET UP.



ALWAYS REMEMBER THAT BECAUSE THIS IS STILL SCAN DATA, THERE ARE LIKELY AREAS WITH MISSING OR INCOMPLETE DATA. WHILE IT MAY SERVE AS A QUICK AND VISUALLY PLEASING WAY TO SHOWCASE YOUR SCAN, IT MAY NEED TO BE SUPPLEMENTED WITH ADDITIONAL DATA.

TOOLS USED
PROCESS
USEABLE RESULTS

PHASE 2 3D MODELING:

WHAT IS IT?
A 3D MODEL IN THIS CONTEXT IS A DIGITAL REPRESENTATION OF SOME REAL WORLD OBJECT, OR SOME PART OF THAT OBJECT. ONCE GENERATED, THE MODEL CAN BE VIEWED FROM ANY ANGLE AND ANALYZED IN ISOMETRIC AND PERSPECTIVE VIEWS.

WHAT ISN'T IT?
A 3D MODEL IS NOT A UNIVERSAL FILE FORMAT. THERE ARE HUNDREDS OF FILE FORMATS, SOME PROPRIETARY, SOME OPEN. KNOWING WHICH FORMAT CERTAIN PROGRAMS CAN ACCEPT AND PRODUCE IS KEY TO KEEPING MOMENTUM IN A PROJECT. KNOW YOUR IMPORT/EXPORT OPTIONS!

BENEFITS
CAN HELP VISUALIZE COMPONENTS, DEMONSTRATE PROCESSES AND FUNCTIONS, AND VIEW THINGS IN WAYS THAT WOULD OTHERWISE BE IMPOSSIBLE. 3D MODELS ARE ALSO BENEFICIAL BECAUSE OF THEIR POTENTIAL FLEXIBILITY FOR FUTURE USE.

DRAWBACKS
TEND TO DEMAND HIGHER HARDWARE SPECIFICATIONS THAN YOUR TYPICAL HOME AND OFFICE COMPUTER. AS A RESULT, THIS METHOD MAY REQUIRE ADDITIONAL INVESTMENTS THAN INITIALLY THOUGHT. FILES ARE ALSO SUSCEPTIBLE TO CORRUPTION, INCOMPATIBILITY, AND ARE NOT ARCHIVALLY STABLE AS PER THE SECRETARY OF INTERIOR STANDARDS.

SOFTWARE

USED
-RAPIDFORM XOR3
-AUTOCAD 2012
-KUBIT POINTSENSE PLANT FOR AUTOCAD
-RHINO 5 (BETA RELEASE)
-3DS MAX

THERE ARE MANY DIFFERENT 3D MODELING PROGRAMS OUT THERE. SOME ARE EXPENSIVE BUT OFFER SUPPORT AND STABILITY, WHILE OTHERS ARE FREE AND UNPREDICTABLE. SOME ARE BOTH EXPENSIVE AND UNSTABLE, WHICH CAN OFTEN BE THE CASE WHEN WORKING WITH NEWLY RELEASED OR UNTESTED SOFTWARE. THIS IS AN UNFORTUNATE ASPECT OF WORKING WITH NEW TECHNOLOGY. YOU SHOULD ANTICIPATE AND PLAN FOR THE UNEXPECTED. THE BEST WAY TO PROTECT YOURSELF FROM ENCOUNTERING TROUBLE DOWN THE ROAD IS TO KNOW WHAT YOUR END PRODUCT IS. KNOWING THIS FROM THE START WILL HELP YOU TO NARROW YOUR FOCUS RATHER THAN SPREADING PROJECT RESOURCES TOO THIN.

HARDWARE LIMITATIONS CAN ALSO SLOW PRODUCTIVITY, IF NOT HALT IT ALTOGETHER. MAKE SURE YOU DO YOUR HOMEWORK ON MINIMUM HARDWARE REQUIREMENTS BEFORE PURCHASING. FORTUNATELY MOST PROGRAMS OFFER TRIAL VERSIONS WHERE YOU CAN TRY BEFORE YOU BUY. IT SHOULD BE NOTED THAT NOT ALL SOFTWARE CAN TAKE FULL ADVANTAGE OF A HIGH END WORKSTATION, SO SIMPLY THROWING MONEY AT THE HARDWARE ISSUE IS NOT A VIABLE SOLUTION. MAKING SURE YOUR HARDWARE'S DRIVERS ARE UP TO DATE IS ALSO ESSENTIAL TO GETTING THE MOST OUT OF YOUR SOFTWARE.

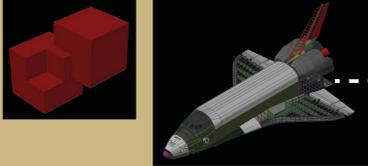
HARDWARE

USED
CPU: 2x INTEL XEON X5660 2.8 GHz (12 CORES)
RAM: 24 GB
OS: 64 BIT WIN 7
GPU: NVIDIA QUADRO FX 4800

RECOMMENDED MINIMUM
CPU: SIX CORE OR HIGHER
RAM: 16 GB OR MORE
OS: 64 BIT
GPU: DEDICATED (NOT INTEGRATED!)
GEOFORCE GTX 500 SERIES OR HIGHER

SOLID MODELING

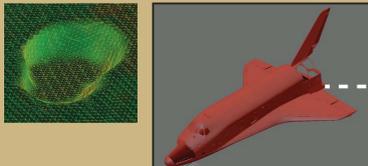
SOLID MODELING ALLOWS YOU TO GENERATE "WATER TIGHT" OBJECTS. THESE OBJECTS MAINTAIN A HIGH FIDELITY WHILE KEEPING FILE SIZE TO A MINIMUM. EASE OF IMPORT/EXPORT FROM MOST 3D MODELING PROGRAMS GIVES GREAT FLEXIBILITY FOR FUTURE USE.



SOLID MODELING IN AUTOCAD OF THE SHUTTLE'S GENERAL STRUCTURE (BASED OFF OF SCAN DATA AND EXISTING DRAWINGS).

MESH SURFACING

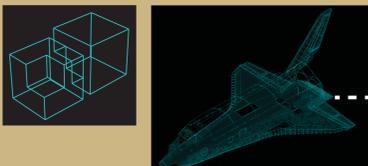
MESH MODELING IS THE APPROXIMATION OF A SURFACE USING POLYGONS. THIS TYPICALLY ALLOWS FOR A HIGH LEVEL OF FIDELITY, ESPECIALLY FOR SURFACES WITH COMPLEX CURVATURE. DUE TO THEIR COMPLEXITY, FILE SIZES TEND TO BE MUCH LARGER THAN OTHER TYPES OF 3D MODELS. GENERATING AND MODIFYING MESH MODELS IS ALSO MORE DEMANDING ON SOFTWARE AND HARDWARE THAN SOLID MODELING.



MESH SURFACE GENERATED IN RAPIDFORM (BASED OFF OF SCAN DATA).

3D POLYLINE/SPLINE

3D POLYLINE MODELING HAS NO SURFACE OR VOLUMETRIC QUALITIES. IT CAN BE USEFUL IN SIMPLIFYING DETAILED INFORMATION, AND CAN BE MANIPULATED USING VERTICES, ENDPOINTS AND CURVATURE HANDLES. WHEN USING 3D POLYLINES, OVERLAPPING INFORMATION CAN BE DIFFICULT TO DECIPHER.



3D POLYLINES EXTRACTED FROM SECTIONS OF THE MESH SURFACE.



COMPOSITE 3D MODEL COMBINING SOLID, MESH AND POLYLINE ENTITIES. (UNRENDERED 3DS MAX SCREENSHOT)

COMBINING VARIOUS 3D ENTITIES INTO ONE FILE CAN BE A TEDIOUS TASK. MAKING SURE THE FILE UNITS AND REFERENCE POINTS ARE IDENTICAL IS CRITICAL TO ALIGNING PROPERLY.

INFORMATIVE AND DYNAMIC ANIMATIONS CAN BE MADE TO HELP VISUALIZE THE OBJECT AND IT'S VARIOUS FUNCTIONS. RENDERING ANIMATIONS DOES TAKE TIME AND SIGNIFICANT PROCESSING POWER, BUT ONCE COMPLETED CAN BE VIEWED ON ALMOST ANY COMPUTER.



TOOLS USED
PROCESS
USEABLE RESULTS

PHASE 3 2D DRAWING:

WHAT IS IT?
IN THIS CONTEXT, IT IS A TANGIBLE, LEGIBLE, AND ARCHIVALLY STABLE DOCUMENT WHICH FOLLOWS THE SECRETARY OF INTERIOR'S STANDARDS (AS AMENDED AND ANNOTATED).

WHAT ISN'T IT?
A 2D DRAWING IS NOT NECESSARILY DONE BY HAND (PEN ON MYLAR). IN FACT MOST ARE PLOTTED FROM CAD APPLICATIONS ON VELLUM.

BENEFITS
ARCHIVALLY STABLE (WHEN PLOTTED ON APPROPRIATE MATERIAL), CLEAR AND LEGIBLE, FREE OF UNNECESSARY INFORMATION. EASILY REPRODUCED AND ACCESSIBLE.

DRAWBACKS
TAKE MORE TIME TO PRODUCE BECAUSE A HUMAN BEING IS NEEDED FOR VERIFICATION AND CLARIFICATION. ALSO, PAPER CUTS.

SOFTWARE

USED
-AUTOCAD 2012
-RHINO 5 (BETA RELEASE)
-ADOBE ILLUSTRATOR CSS (VECTOR)
-ADOBE PHOTOSHOP CSS (RASTER)

*NOTE: THE 3D PROGRAMS ARE USED TO GENERATE THE "FLATTENED" LINEWORK FROM THE 3D MODELS. ONCE LINEWORK HAS BEEN GENERATED, CLEANUP, LAYER ASSIGNMENT AND LINEWEIGHTS CAN BE APPLIED IN A NUMBER OF PROGRAMS.

HARDWARE

USED
CPU: 2x INTEL XEON X5660 2.8 GHz (12 CORES)
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GPU: NVIDIA QUADRO FX 4800

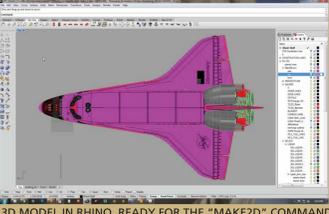
SUGGESTED MINIMUM
CPU: QUAD CORE OR HIGHER
RAM: 16 GB OR MORE
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"FLATTENING" THE 3D MODEL

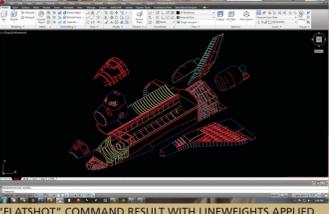
THE PROCESS OF FLATTENING A 3D MODEL TO A 2D IMAGE OR GRAPHIC MAY SEEM BACKWARDS TO SOME. BOTH DOCUMENTS CONTAIN VALUABLE INFORMATION. HOWEVER, UNTIL A 3D MODEL CAN LAST 500 YEARS IN IT'S DIGITAL FORMAT AND STILL BE EASILY OPENED, READ, AND REPRODUCED, THE DRAWING WILL ALWAYS BE MORE STABLE.

THERE ARE VARIOUS WAYS TO FLATTEN A 3D MODEL TO OBTAIN A SET OF LINES. THE LINES REPRESENT PROFILE EDGES, SILHOUETTES/OUTLINES, AND CAN EVEN INCLUDE OBSCURED LINES. THE LINEWORK PRODUCED IS STILL A "FLAT" LOOKING GRAPHIC AND REQUIRES A DRAFTER TO APPLY LINEWEIGHTS TO ADD DEPTH AND CLARITY.

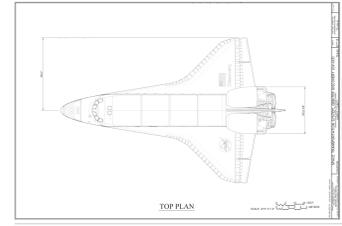
IT IS ALSO IMPORTANT TO NOTE THAT THESE FLAT LINE DRAWINGS ARE VECTOR, NOT RASTER. RASTER IMAGES HAVE A PRESET RESOLUTION AND THEREFORE CANNOT BE EASILY REPRODUCED LEGIBLY.



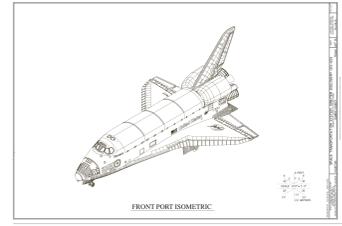
3D MODEL IN RHINO, READY FOR THE "MAKE2D" COMMAND.



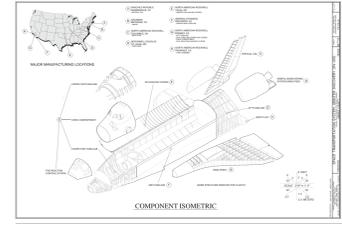
"FLATSHOT" COMMAND RESULT WITH LINEWEIGHTS APPLIED.



TOP PLAN



FRONT PURE ISOMETRIC



COMPONENT ISOMETRIC

TO SEE THOUSANDS OF OTHER PROJECTS (ALL PUBLIC DOMAIN AND FREE TO DOWNLOAD) VISIT US ONLINE AND CLICK ON THE "SEARCH COLLECTIONS" LINK.



<http://www.nps.gov/history/hdp>