NPS NRP Executive Summary and Final Report

Title: X3D Model Data Strategy for Navy Additive Manufacturing Digital Thread
Report Date: 28 November 2018, Project Number (IREF ID): NPS-18-N380-A
Naval Postgraduate School (NPS), Modeling Virtual Environments and Simulation (MOVES)

NAVAL RESEARCH PROGRAM
NAVAL POSTGRADUATE SCHOOL

MONTEREY, CALIFORNIA

X3D MODEL DATA STRATEGY FOR NAVY ADDITIVE MANUFACTURING (AM) DIGITAL THREAD

Report Type: Executive Summary and Final Report
Period of Performance: 10/1/2017 – 9/30/2018

Project PI: Dr. Donald P. Brutzman, Modeling Virtual Environments Simulation, Naval Postgraduate School (NPS)
Additional Authors: Dr. Edward Rockower, J. Michael Bailey, and Rebecca Law, Naval Postgraduate School (NPS)
Student Participation: Capt Matt Friedell USMC, other NPS students and staff using 3D printing

Prepared for: OPNAV N415, USMC, NAVFAC, EXWC
Topic Sponsor: OPNAV N415
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Research POC Contact Information: James.Pluta.crt@navy.mil, 703-695-5825

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EXECUTIVE SUMMARY

Project Summary

NPS has applied and integrated a wide range of open-source open-standards capabilities to support Navy and Marine Makers who are learning and applying 3D printing, also known as Additive Manufacturing (AM). Building on the work of the National Institutes of Health (NIH) 3D Print Exchange (3dprint.nih.gov), the X3D Model Exchange (ModelExchange.nps.edu) enables Navy and Marine Makers to learn how to find, share, produce, and print 3D models that impact the future of Navy and Marine operations. Whereas the NIH site is built using Drupal 7 with a "pipeline" for processing uploaded models, the Navy's X3D Model Exchange is developed with the latest version of the Drupal 8 Content Management System (CMS). This public-facing portal leverages the highly evolved NPS version-control repository (GitLab.nps.edu/ModelExchangeGroup) using best practices for agile developer operations (DevOps) to encourage broad partnerships and re-use. Security requirements are met through account management and Common Access Card (CAC) authentication of users. Version control ensures that all changes and incremental improvements are trackable, repeatable and fixable (if ever needed). Access control for administrators, developers, makers and the public ensures that models remain uncorrupted and only available to the appropriate community of users. This project reports on follow-on continuation of the design phase performed by preceding Naval Research Program (NRP) project NPS-17-244-A.

Keywords: *3D printing, additive manufacturing, community, digital thread, X3D graphics, Web3D*

Background

Additive Manufacturing (AM), 3D printing and CAD export are critical for Navy maintenance. Rapid change continues to occur across the design, engineering, manufacturing, and production process - many products can now be fabricated using AM methods. Iterative design processes require close collaboration of all entities involved from design to production; with AM, the lines between these previously stove-piped steps become blurred. A need to design, test and adopt different maintenance workflow becomes a necessity in cases of preventive and corrective maintenance of mechanical components on Navy ships and aircrafts where such operations have major impact on operational readiness.

This project proposed to study and test elements that are identified as critical for effective deployment of AM in Navy operations, with specific emphasis on maintenance operations, while remaining sensitive to other Navy domains and activities where the use of AM can bring significant value. The overarching goal was to provide a comprehensive approach that would lead towards reduction of energy costs, mitigation of risks, as well as reduction of materials and human resources engaged in that process.

Inspired and aided by the open-source NIH Model Exchange project this project has developed a model exchange website and backend capabilities to enable secure contribution and sharing of AM models using the latest open source software. Related research work includes partnered efforts by Dr. Amela Sadagic on diffusion of innovation across Navy and Marine Corps. This tandem work has guided corresponding implementation of numerous specific aspects in Model Exchange (MX) design with respect to deployment, scalability, access, repeatability, and user value. Continued work appears fully feasible and is expected to provide fundamental long-term value.

Findings and Conclusions

PHASE ONE: MODEL EXCHANGE PORTAL DESIGN

Year one of this project (from FY2017 NRP project NPS-17-N244-A) laid the basis for design and initial implementation. Despite personnel challenges, our group has persisted and continued evolving sophisticated work to develop and deliver key capabilities. Such work was essential and has included direct involvement in multiple Extensible 3D (X3D) Graphics Working Groups as part of membership in the Web3D Consortium. The royalty-free Extensible 3D (X3D) Graphics International Standard was shown to have fundamental value by mapping well to diverse commercial formats and by adding integrated features for metadata provenance, visualization, Web viewability and model composition. X3D Working Groups in the non-profit Web3D Consortium provided continuing further value. Early February 2018 included a well-attended project review at NPS that reviewed plans and developed detailed strategies. We have followed that collaborative plan closely, to good effect. The findings and conclusions of this project follow the three phases identified there: design, developers beta testing, and soft launch testing as part of current work.

PHASE TWO: DEVELOPER'S BETA TESTING

The ability to find printable models by category, community and metadata tags is currently in developer's beta. Presently, GitLab-based automation for processing and preparation is found in the Model Exchange Staging Area (MXSA). Procedures continue to be refined using automated and manually performed processing, resulting in steadily increasing automation capabilities. The GitLab repository supports the X3D Model Exchange portal by hosting developer assets. All contributions are unclassified open source, with either public or For Official Use Only (FOUO) access. Membership is strictly controlled to block hackers and ensure professional progress.

The *ModelExchangeStagingArea (MXSA)* repository serves as a staging area, holding 3D model assets for the X3D Model Exchange. Here, developers can add any assets of interest into a project. These assets include but are not limited to 3D models, data, metadata and videos. Developer participation is by government personnel, or designated contractors in a support role.

ModelExchange7 and ModelExchange8 are two further repositories supporting code and configuration files deployed as part of the X3D Model Exchange portal. Developed using Drupal 8 code and other open-source assets, and extending the Drupal 7 predecessor open-source 3D Print Exchange developed by the National Institutes of Health (NIH), the resulting X3D Model Exchange is online at https://ModelExchange.nps.edu with public-facing support.

PHASE THREE: SOFT LAUNCH TESTING AND CURRENT WORK

Soft launch testing began in summer 2018 by inviting our first Navy and Marine Makers. Early users first verify that they have a 3D model saved to any format and identify the appropriate level of access applicable to the model, i.e. For Official Use Only (FOUO) or unrestricted. The model title, author information and hash tags are then used to upload the model to GitLab's Model Exchange Staging Area. Makers then provide the details in a description of their open source model. These details may include drawings, plans, photos and videos. Uploaded user models are then acknowledged by Model Exchange administrators and then further tested and prepared by partner developers in the Model Exchange Staging Area (MXSA) using NPS GitLab version control. When ready, the new model assets are placed into the Navy X3D Model Exchange and published according to their administrator-confirmed level of access. We are publishing models on a weekly basis.

With the Drupal 8 update complete, 3D model upload/download testing continues. Current work includes providing tutorials for end users who are learning the system, creating FAQ's and

other help files, development of community forums, and improving the taxonomy of metadata vocabularies. Models are accepted each week with ongoing incremental processing improvements.

Community building and engagement remains a critical component for growing the X3D Model Exchange. The primary resource for Navy and Marine Makers on the Model Exchange site is the community-driven discussion forums. Here, Makers can contribute to various partner forums, site development forums, and share lessons learned on how to make something new. Additionally, the administrators provide reports on Model Exchange site progress to community members. The X3D Model Exchange also maintains a social media presence on both YouTube NavyMakers and Twitter@NavyMakers where highlights and developments within the broader additive manufacturing community can be shared. Weekly teleconferences with Seabee users continue guiding this work, and further activity is expected with MarineMakers. Much continued future work is expected in direct support of NPS Strategic Plan and multiple external partners.

Recommendations for Further Research

This report provides only a small slice of the many activities being integrated and enabled. Interested users are invited to explore the portal to learn much more. Interested developers are welcome to contact us and learn about collaboration opportunities.

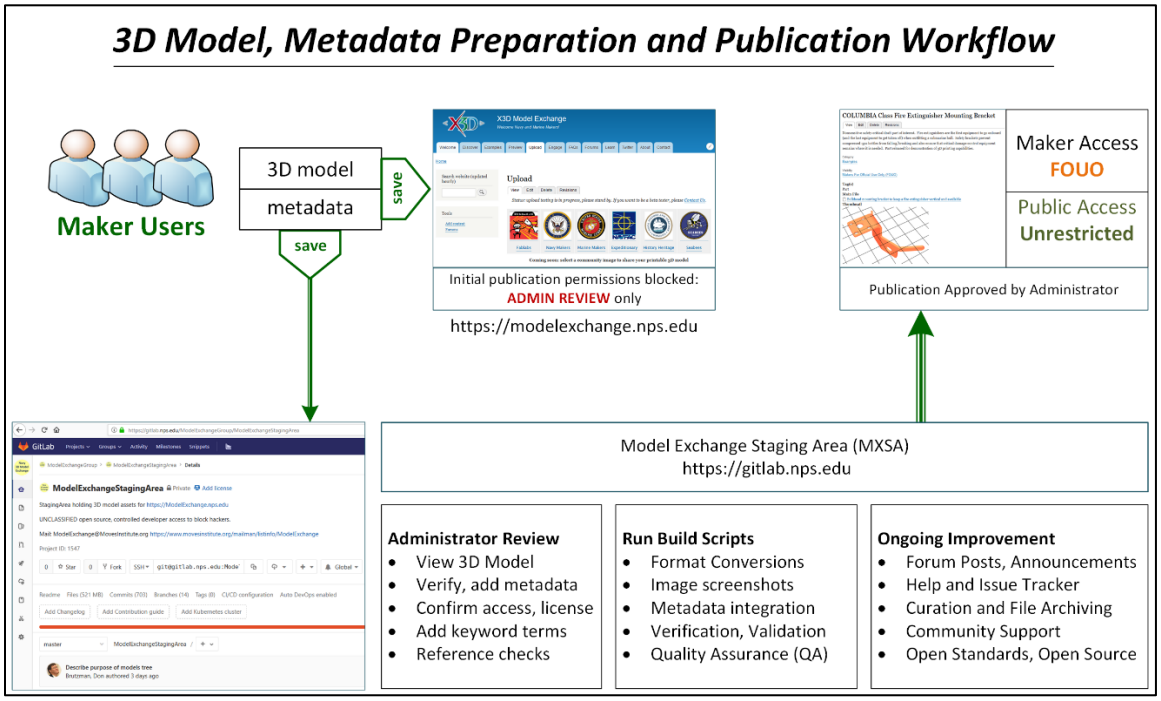
- Continue development and maintenance of the Drupal 8 website with shared issue tracking.
- Finish integration Capcha and CAC controls directly into the ModelExchange.nps.edu website.
- Further automate the integration of backups and newly added models & metadata with the NPS GitLab repository and its processing functionality. See attached figures for functional summary.
- Support multiple maker communities: Navy, Marine, Expeditionary and History/Heritage.
- Collect longitudinal metrics and statistics to measure usage and indicate areas for growth.
- Continue participating in Web3D Consortium X3D Working Groups to extend standards support for 3D printing, scanning and visualization in support of DoD Digital Engineering efforts.
- Share models with NAVFAC SPIDERS3D Virtual Environment, build “sand table” capability.
- Tighten website processing with data-centric security to ensure models remain uncompromised.
- Continue to build community through social media and other means of communication.
- Continue to “tell the story” of developers and users through interviews and video.

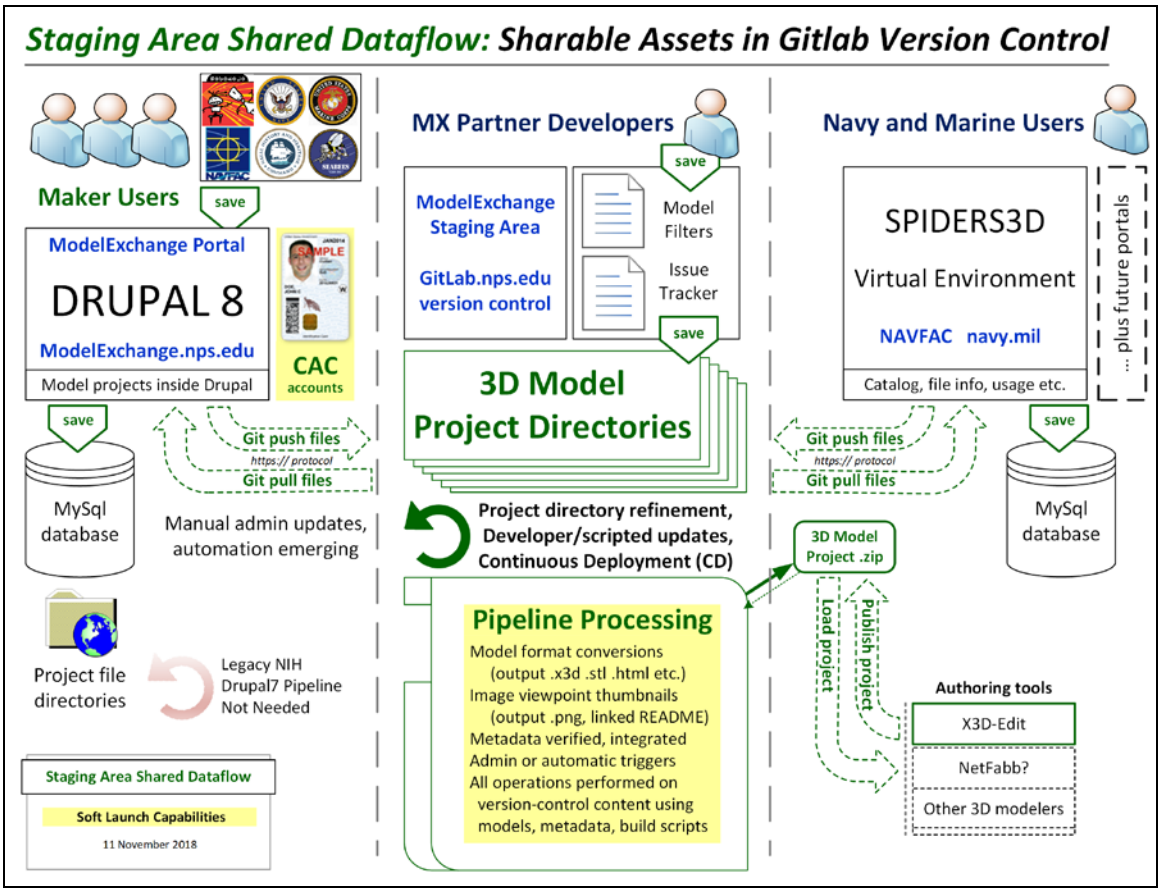
References

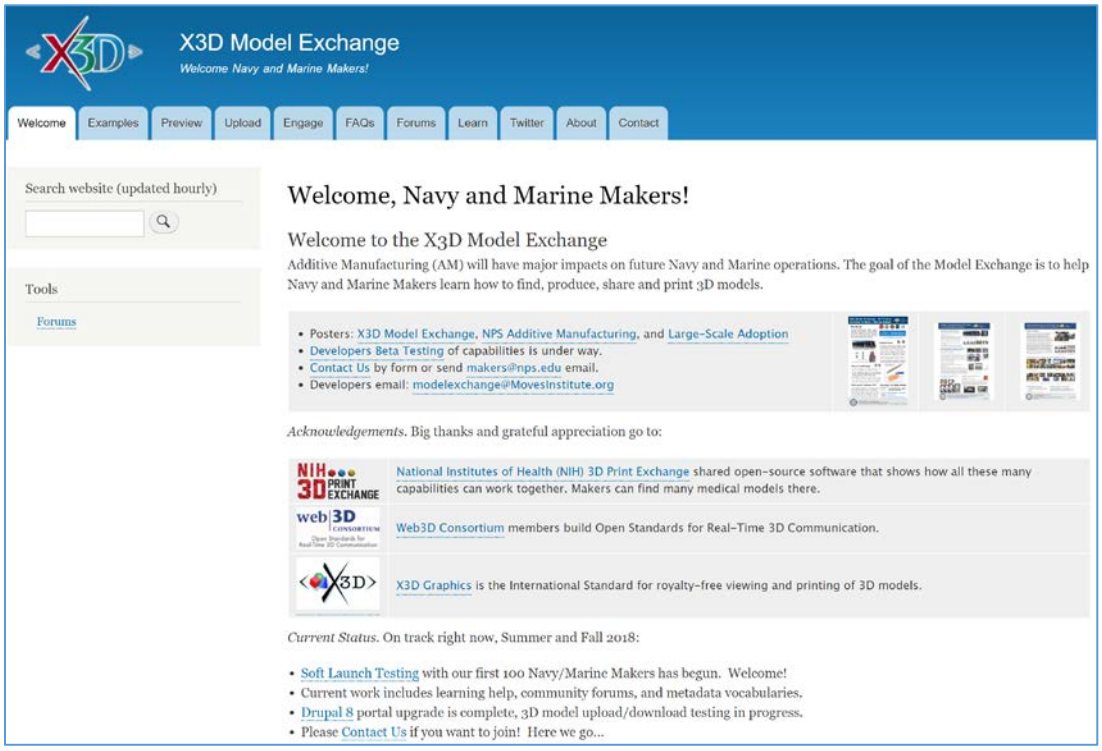
- X3D Model Exchange for Navy and Marine Makers, https://ModelExchange.nps.edu
- Model Exchange Staging Area (MXSA), https://gitlab.nps.edu/ModelExchangeGroup
- National Institutes of Health (NIH) 3D Print Exchange, https://3dprint.nih.gov
- Web 3D Consortium, https://www.web3d.org
- X3D Graphics, https://www.web3d.org/x3d/what-x3d
- Drupal 8, https://www.drupal.org/8
- Naval Postgraduate School, https://www.nps.edu
- NPS Robodojo, https://my.nps.edu/web/robodojo
- NPS Additive Manufacturing, https://wiki.nps.edu/display/ADDM/Additive+Manufacturing
- Naval Facilities Engineering Command (NAVFAC), https://www.navfac.navy.mil
- Engineering and Expeditionary Warfare Center (EXWC), https://www.navfac.navy.mil/navfac_worldwide/specialty_centers/exwc.html

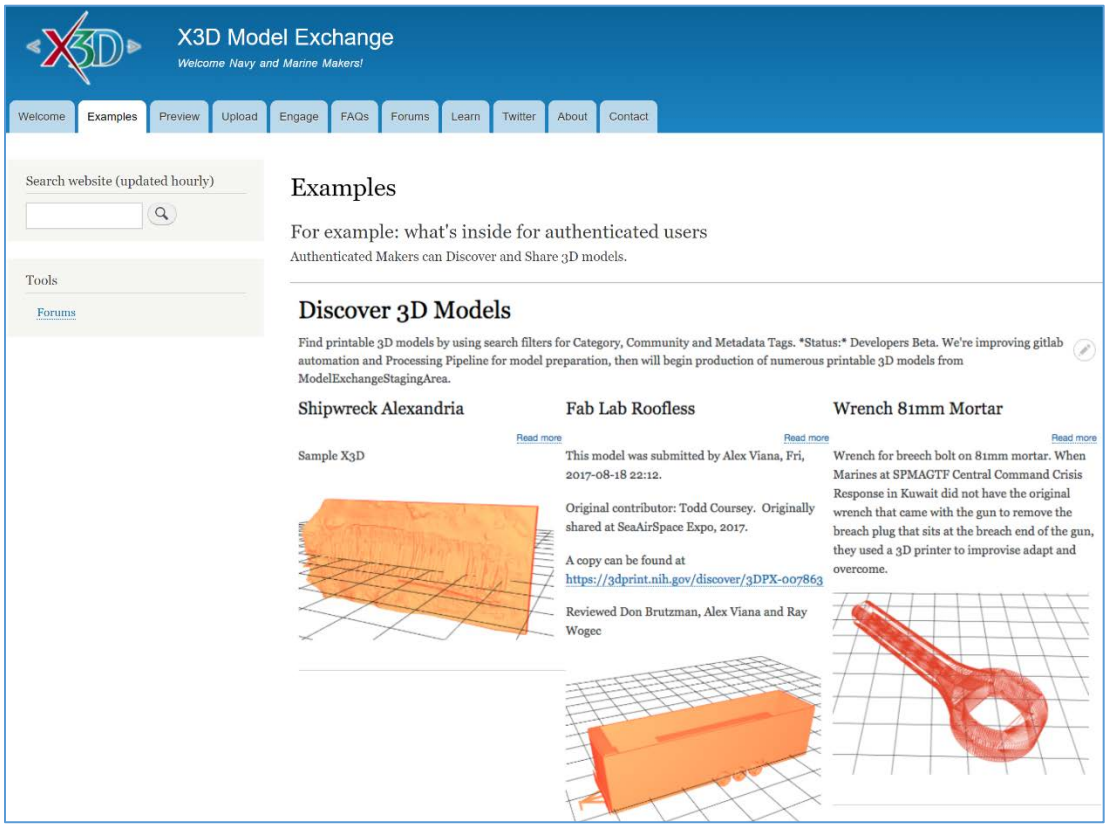
Acronyms

- AM Additive Manufacturing
- CAC Common Access Card, i.e. military/government ID card
- CAD Computer-Aided Design
- CAPCHA Completely Automated Public Turing test to tell Computers and Humans Apart
- CMS Content Management System
- DevOps Agile-software Development Operations progress
- Drupal Name of open-source portal software and CMS
- EXWC Engineering and Expeditionary Warfighting Command
- FAQ Frequently Answered Questions
- FOUO For Official Use Only
- Git Version-control protocol for agile software development
- Makers Users who use tools to design, build, scan, 3D print for AM, etc.
- ModelExchange7 Drupal 7 version of Model Exchange
- ModelExchange8 Drupal 8 version of Model Exchange
- GitLab Open-source server environment for Git version control
- MOVES NPS Modeling, Virtual Environments, Simulation Institute
- MX X3D Model Exchange for Navy and Marine Makers, https://modelexchange.nps.edu
- MXC Model Exchange Contributions, part of https://gitlab.nps.edu/ModelExchangeGroup
- MXSA ModelExchange Staging Area
- NAVFAC Naval Facilities Engineering Command
- NIH National Institutes of Health
- Robodojo NPS Maker Lab, https://robodojo.nps.edu
- SecDevOps Secure agile-software Development Operations progress
- SPIDERS3D NAVFAC's Web-based visualization of ports and facilities using X3D
- X3D Extensible 3D Graphics International Standard
- Web3D Web3D Consortium
- 3D Three-dimensional, three dimensions


3D Model, Metadata Preparation and Publication Workflow
Maker Users
3D model
metadata
save
save
X3D Model Exchange
Upload
Initial publication permissions blocked:
ADMIN REVIEW only
https://modelexchange.nps.edu
Maker Access
FOUO
Public Access
Unrestricted
Publication Approved by Administrator
Model Exchange Staging Area (MXSA)
https://gitlab.nps.edu
Administrator Review
View 3D Model
Verify, add metadata
Confirm access, license
Add keyword terms
Reference checks
Run Build Scripts
Format Conversions
Image screenshots
Metadata integration
Verification, Validation
Quality Assurance (QA)
Ongoing Improvement
Forum Posts, Announcements
Help and Issue Tracker
Curation and File Archiving
Community Support
Open Standards, Open Source


Staging Area Shared Dataflow: Sharable Assets in Gitlab Version Control
Maker Users
save
ModelExchange Portal
DRUPAL 8
ModelExchange.nps.edu
Model projects inside Drupal
CAC
accounts
save
MySql
database
Git push files
https:// protocol
Git pull files
Manual admin updates,
automation emerging
Project file
directories
Legacy NIH
Drupal7 Pipeline
Not Needed
Staging Area Shared Dataflow
Soft Launch Capabilities
11 November 2018
MX Partner Developers
save
ModelExchange
Staging Area
GitLab.nps.edu
version control
Model
Filters
Issue
Tracker
save
3D Model
Project Directories
Project directory refinement,
Developer/scripted updates,
Continuous Deployment (CD)
Pipeline Processing
Model format conversions
(output .x3d .stl .html etc.)
Image viewpoint thumbnails
(output .png, linked README)
Metadata verified, integrated
Admin or automatic triggers
All operations performed on
version-control content using
models, metadata, build scripts
Navy and Marine Users
SPIDERS3D
Virtual Environment
NAVFAC navy.mil
Catalog, file info, usage etc.
... plus future portals
save
Git push files
https:// protocol
Git pull files
MySql
database
3D Model
Project .zip
Load project
Publish project
Authoring tools
X3D-Edit
NetFabb?
Other 3D modelers


X3D Model Exchange
Welcome Navy and Marine Makers!
Welcome
Examples
Preview
Upload
Engage
FAQs
Forums
Learn
Twitter
About
Contact
Search website (updated hourly)
Tools
Forums
Welcome, Navy and Marine Makers!
Welcome to the X3D Model Exchange
Additive Manufacturing (AM) will have major impacts on future Navy and Marine operations. The goal of the Model Exchange is to help Navy and Marine Makers learn how to find, produce, share and print 3D models.
• Posters: X3D Model Exchange, NPS Additive Manufacturing, and Large-Scale Adoption
• Developers Beta Testing of capabilities is under way.
• Contact Us by form or send makers@nps.edu email.
• Developers email: modelexchange@MovesInstitute.org
Acknowledgements. Big thanks and grateful appreciation go to:
National Institutes of Health (NIH) 3D Print Exchange shared open-source software that shows how all these many capabilities can work together. Makers can find many medical models there.
Web3D Consortium members build Open Standards for Real-Time 3D Communication.
X3D Graphics is the International Standard for royalty-free viewing and printing of 3D models.
Current Status. On track right now, Summer and Fall 2018:
• Soft Launch Testing with our first 100 Navy/Marine Makers has begun. Welcome!
• Current work includes learning help, community forums, and metadata vocabularies.
• Drupal 8 portal upgrade is complete, 3D model upload/download testing in progress.
• Please Contact Us if you want to join! Here we go...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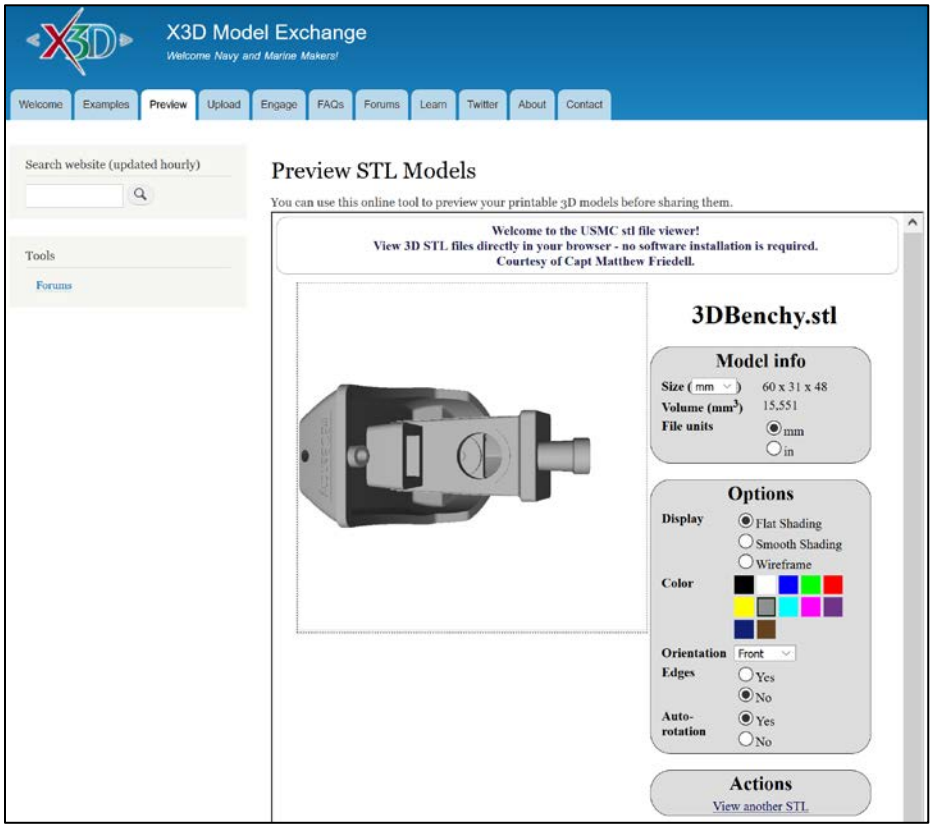
Examples
For example: what's inside for authenticated users
Authenticated Makers can Discover and Share 3D models.
Discover 3D Models
Find printable 3D models by using search filters for Category, Community and Metadata Tags. *Status:* Developers Beta. We're improving gitlab automation and Processing Pipeline for model preparation, then will begin production of numerous printable 3D models from ModelExchangeStagingArea.
Shipwreck Alexandria
Read more
Sample X3D
Fab Lab Roofless
Read more
This model was submitted by Alex Viana, Fri, 2017-08-18 22:12.
Original contributor: Todd Coursey. Originally shared at SeaAirSpace Expo, 2017.
A copy can be found at https://3dprint.nih.gov/discover/3DPX-007863
Reviewed Don Brutzman, Alex Viana and Ray Wogec
Wrench 81mm Mortar
Read more
Wrench for breech bolt on 81mm mortar. When Marines at SPMAGTF Central Command Crisis Response in Kuwait did not have the original wrench that came with the gun to remove the breach plug that sits at the breach end of the gun, they used a 3D printer to improvise adapt and overcome.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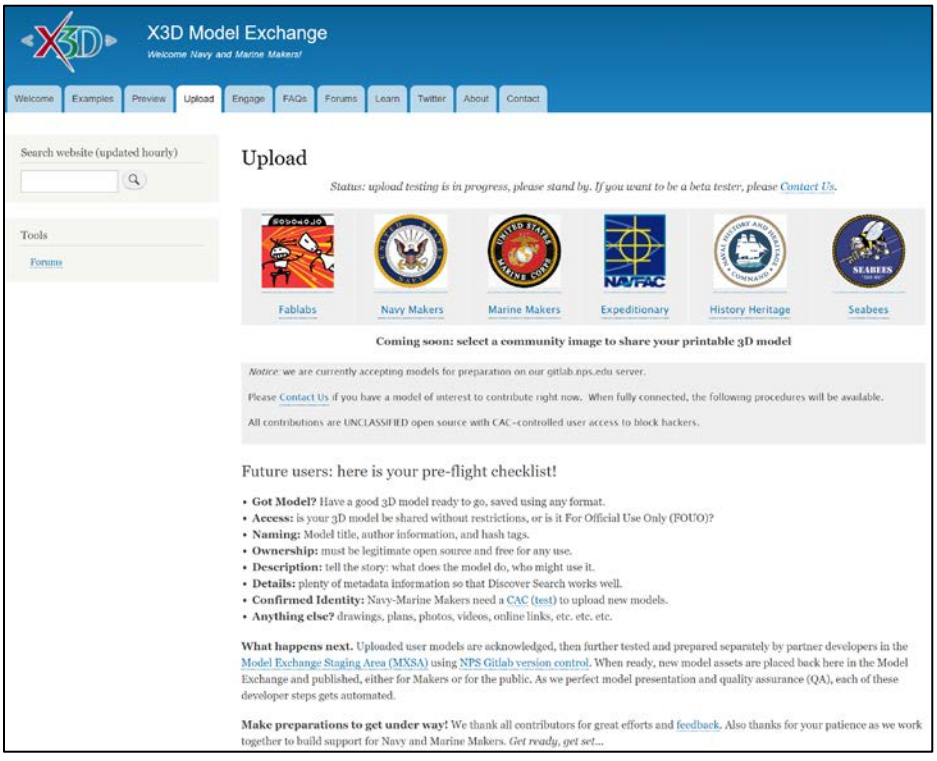
Search website (updated hourly)
Tools
Forums
Preview STL Models
You can use this online tool to preview your printable 3D models before sharing them.
Welcome to the USMC stl file viewer!
View 3D STL files directly in your browser - no software installation is required.
Courtesy of Capt Matthew Friedell.
3DBenchy.stl
Model info
Size (mm)
60 x 31 x 48
Volume (mm3)
15,551
File units
mm
in
Options
Display
Flat Shading
Smooth Shading
Wireframe
Color
Orientation
Front
Edges
Yes
No
Auto-rotation
Yes
No
Actions
View another STL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Search website (updated hourly)
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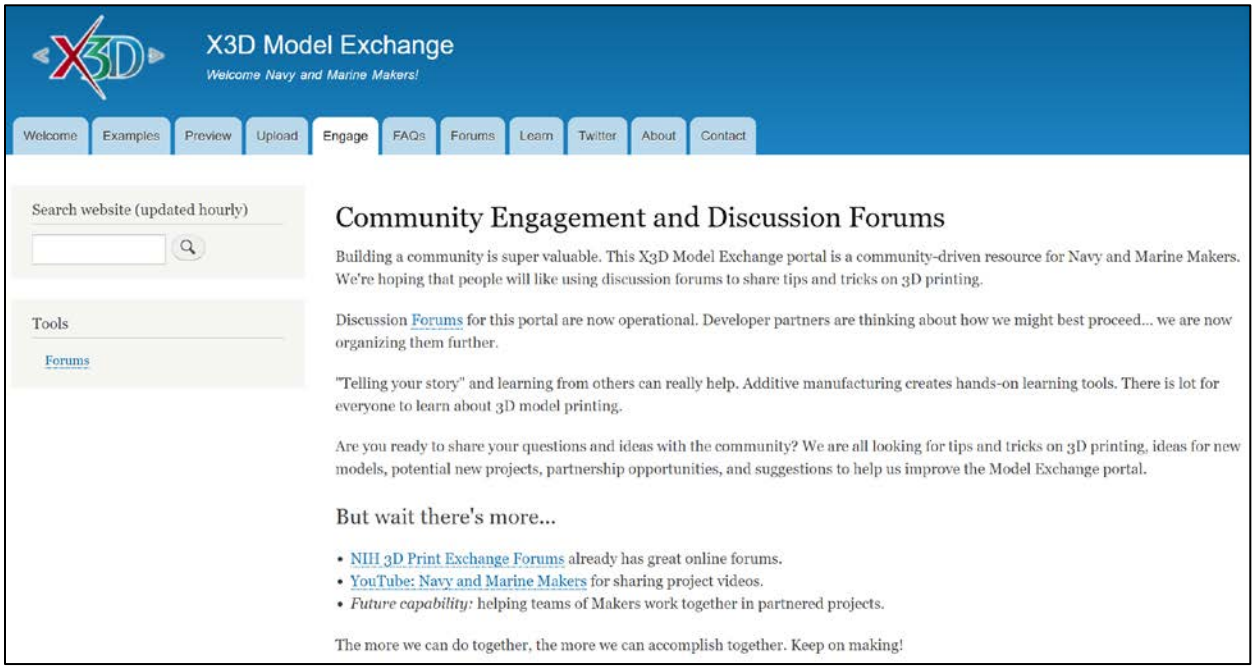
Forums
Upload
Status: upload testing is in progress, please stand by. If you want to be a beta tester, please Contact Us.
Fablabs
Navy Makers
Marine Makers
Expeditionary
History Heritage
Seabees
Coming soon: select a community image to share your printable 3D model
Notice: we are currently accepting models for preparation on our gitlab.nps.edu server.
Please Contact Us if you have a model of interest to contribute right now. When fully connected, the following procedures will be available.
All contributions are UNCLASSIFIED open source with CAC-controlled user access to block hackers.
Future users: here is your pre-flight checklist!
Got Model? Have a good 3D model ready to go, saved using any format.
Access: is your 3D model be shared without restrictions, or is it For Official Use Only (FOUO)?
Naming: Model title, author information, and hash tags.
Ownership: must be legitimate open source and free for any use.
Description: tell the story: what does the model do, who might use it.
Details: plenty of metadata information so that Discover Search works well.
Confirmed Identity: Navy-Marine Makers need a CAC (test) to upload new models.
Anything else? drawings, plans, photos, videos, online links, etc. etc. etc.
What happens next. Uploaded user models are acknowledged, then further tested and prepared separately by partner developers in the Model Exchange Staging Area (MXSA) using NPS Gitlab version control. When ready, new model assets are placed back here in the Model Exchange and published, either for Makers or for the public. As we perfect model presentation and quality assurance (QA), each of these developer steps gets automated.
Make preparations to get under way! We thank all contributors for great efforts and feedback. Also thanks for your patience as we work together to build support for Navy and Marine Makers. Get ready, get set...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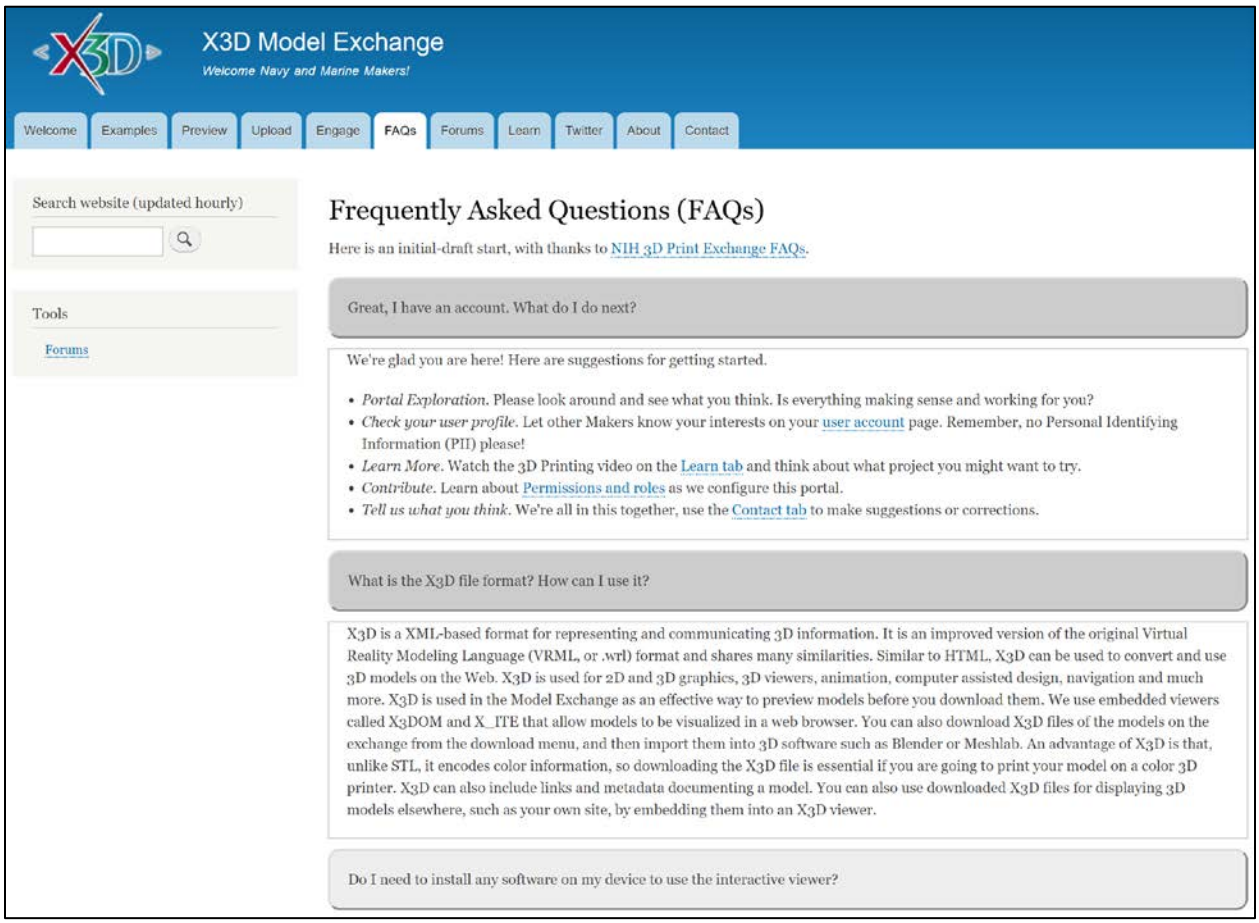
Search website (updated hourly)
Tools
Forums
Community Engagement and Discussion Forums
Building a community is super valuable. This X3D Model Exchange portal is a community-driven resource for Navy and Marine Makers. We're hoping that people will like using discussion forums to share tips and tricks on 3D printing.
Discussion Forums for this portal are now operational. Developer partners are thinking about how we might best proceed... we are now organizing them further.
"Telling your story" and learning from others can really help. Additive manufacturing creates hands-on learning tools. There is lot for everyone to learn about 3D model printing.
Are you ready to share your questions and ideas with the community? We are all looking for tips and tricks on 3D printing, ideas for new models, potential new projects, partnership opportunities, and suggestions to help us improve the Model Exchange portal.
But wait there's more...
NIH 3D Print Exchange Forums already has great online forums.
YouTube: Navy and Marine Makers for sharing project videos.
Future capability: helping teams of Makers work together in partnered projects.
The more we can do together, the more we can accomplish together. Keep on making!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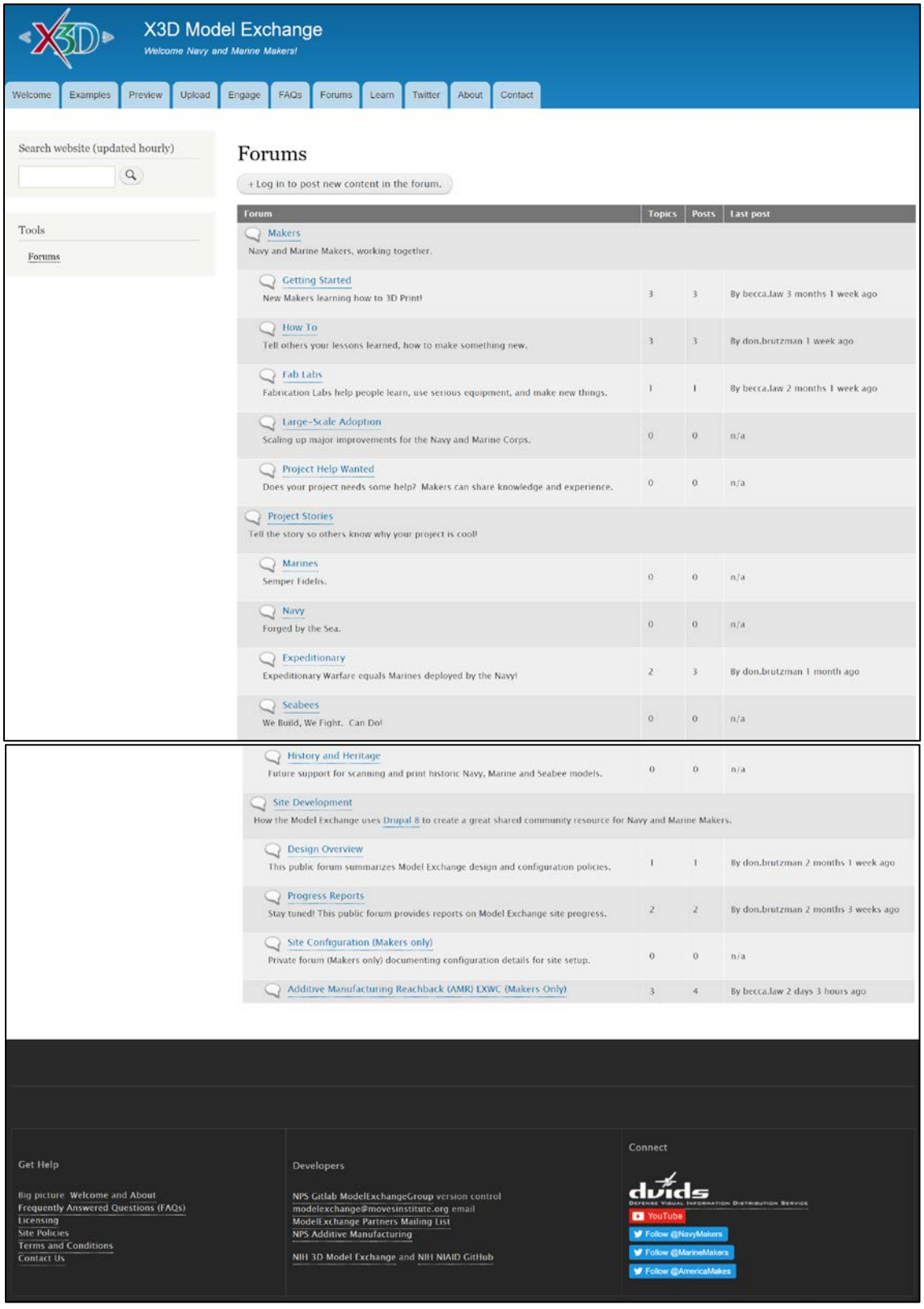
Frequently Asked Questions (FAQs)
Here is an initial-draft start, with thanks to NIH 3D Print Exchange FAQs.
Great, I have an account. What do I do next?
We're glad you are here! Here are suggestions for getting started.
Portal Exploration. Please look around and see what you think. Is everything making sense and working for you?
Check your user profile. Let other Makers know your interests on your user account page. Remember, no Personal Identifying Information (PII) please!
Learn More. Watch the 3D Printing video on the Learn tab and think about what project you might want to try.
Contribute. Learn about Permissions and roles as we configure this portal.
Tell us what you think. We're all in this together, use the Contact tab to make suggestions or corrections.
What is the X3D file format? How can I use it?
X3D is a XML-based format for representing and communicating 3D information. It is an improved version of the original Virtual Reality Modeling Language (VRML, or .wrl) format and shares many similarities. Similar to HTML, X3D can be used to convert and use 3D models on the Web. X3D is used for 2D and 3D graphics, 3D viewers, animation, computer assisted design, navigation and much more. X3D is used in the Model Exchange as an effective way to preview models before you download them. We use embedded viewers called X3DOM and X_ITE that allow models to be visualized in a web browser. You can also download X3D files of the models on the exchange from the download menu, and then import them into 3D software such as Blender or Meshlab. An advantage of X3D is that, unlike STL, it encodes color information, so downloading the X3D file is essential if you are going to print your model on a color 3D printer. X3D can also include links and metadata documenting a model. You can also use downloaded X3D files for displaying 3D models elsewhere, such as your own site, by embedding them into an X3D viewer.
Do I need to install any software on my device to use the interactive viewer?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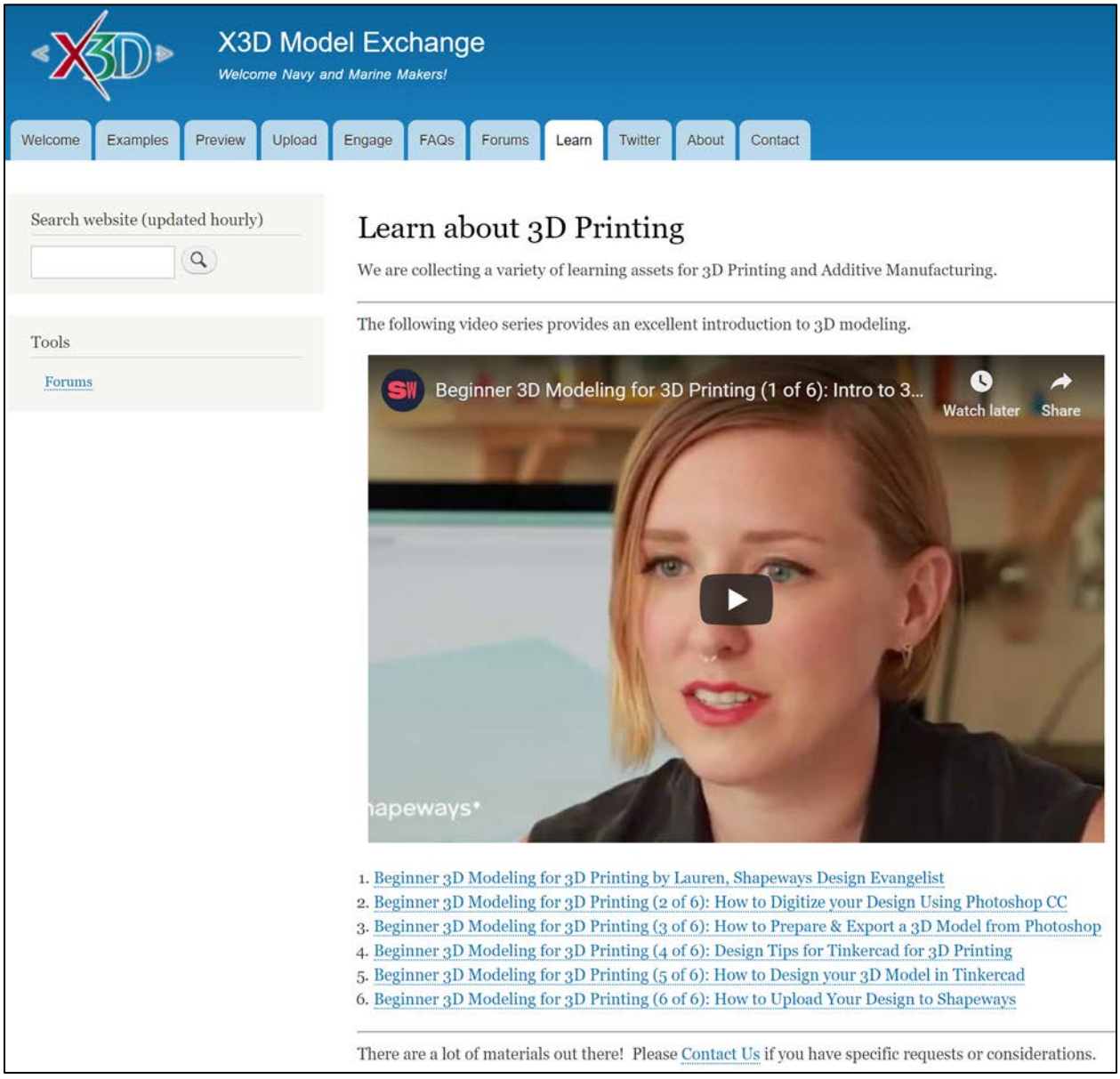
Forums
Forums
+ Log in to post new content in the forum.
Forum
Topics
Posts
Last post
Makers
Navy and Marine Makers, working together.
Getting Started
New Makers learning how to 3D Print!
3
3
By becca.law 3 months 1 week ago
How To
Tell others your lessons learned, how to make something new.
3
3
By don.brutzman 1 week ago
Fab Labs
Fabrication Labs help people learn, use serious equipment, and make new things.
1
1
By becca.law 2 months 1 week ago
Large-Scale Adoption
Scaling up major improvements for the Navy and Marine Corps.
0
0
n/a
Project Help Wanted
Does your project needs some help? Makers can share knowledge and experience.
0
0
n/a
Project Stories
Tell the story so others know why your project is cool!
Marines
Semper Fidelis.
0
0
n/a
Navy
Forged by the Sea.
0
0
n/a
Expeditionary
Expeditionary Warfare equals Marines deployed by the Navy!
2
3
By don.brutzman 1 month ago
Seabees
We Build, We Fight. Can Do!
0
0
n/a
History and Heritage
Future support for scanning and print historic Navy, Marine and Seabee models.
0
0
n/a
Site Development
How the Model Exchange uses Drupal 8 to create a great shared community resource for Navy and Marine Makers.
Design Overview
This public forum summarizes Model Exchange design and configuration policies.
1
1
By don.brutzman 2 months 1 week ago
Progress Reports
Stay tuned! This public forum provides reports on Model Exchange site progress.
2
2
By don.brutzman 2 months 3 weeks ago
Site Configuration (Makers only)
Private forum (Makers only) documenting configuration details for site setup.
0
0
n/a
Additive Manufacturing Reachback (AMR) EXWC (Makers Only)
3
4
By becca.law 2 days 3 hours ago
Get Help
Big picture: Welcome and About
Frequently Answered Questions (FAQs)
Licensing
Site Policies
Terms and Conditions
Contact Us
Developers
NPS Gitlab ModelExchangeGroup version control
modelexchange@movesinstitute.org email
ModelExchange Partners Mailing List
NPS Additive Manufacturing
NIH 3D Model Exchange and NIH NIAID GitHub
Connect
dvids
YouTube
Follow @NavyMakers
Follow @MarineMakers
Follow @AmericaMakes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Welcome Navy and Marine Makers!
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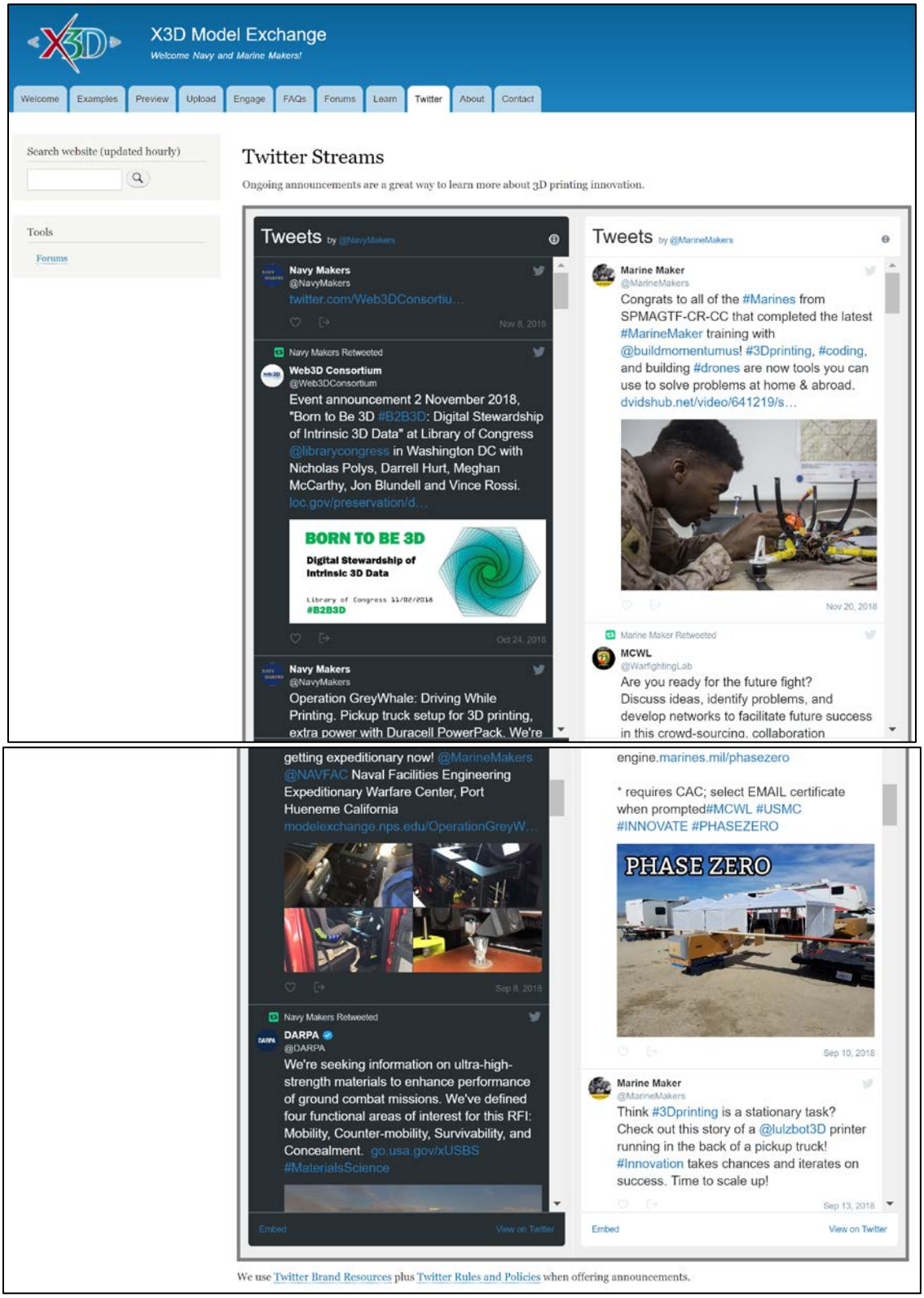
Search website (updated hourly)
Tools
Forums
Learn about 3D Printing
We are collecting a variety of learning assets for 3D Printing and Additive Manufacturing.
The following video series provides an excellent introduction to 3D modeling.
Beginner 3D Modeling for 3D Printing (1 of 6): Intro to 3...
Watch later
Share
1. Beginner 3D Modeling for 3D Printing by Lauren, Shapeways Design Evangelist
2. Beginner 3D Modeling for 3D Printing (2 of 6): How to Digitize your Design Using Photoshop CC
3. Beginner 3D Modeling for 3D Printing (3 of 6): How to Prepare & Export a 3D Model from Photoshop
4. Beginner 3D Modeling for 3D Printing (4 of 6): Design Tips for Tinkercad for 3D Printing
5. Beginner 3D Modeling for 3D Printing (5 of 6): How to Design your 3D Model in Tinkercad
6. Beginner 3D Modeling for 3D Printing (6 of 6): How to Upload Your Design to Shapeways
There are a lot of materials out there! Please Contact Us if you have specific requests or considerations.


X3D Model Exchange
Welcome Navy and Marine Makers!
Welcome
Examples
Preview
Upload
Engage
FAQs
Forums
Learn
Twitter
About
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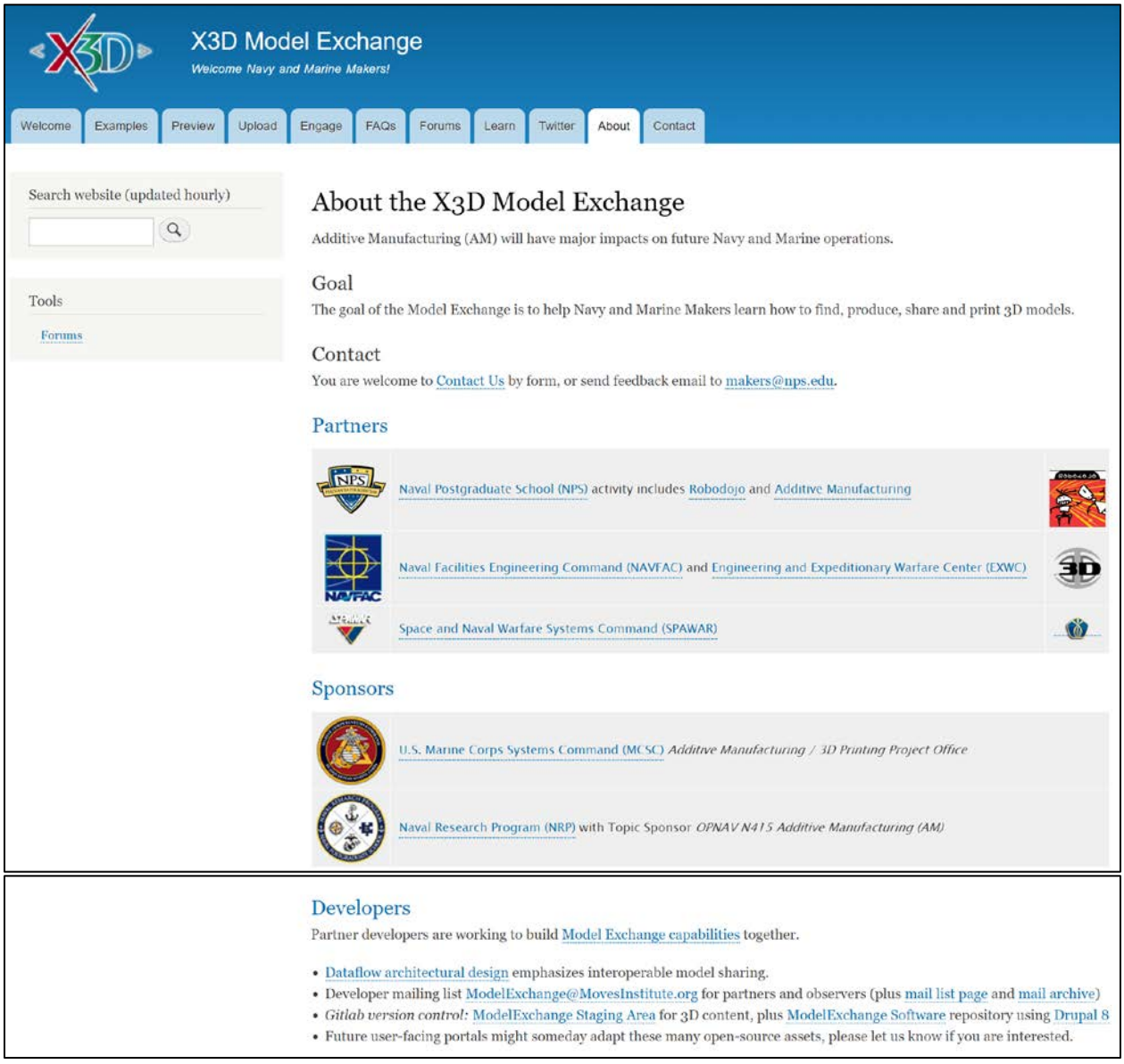
Search website (updated hourly)
Tools
Forums
Twitter Streams
Ongoing announcements are a great way to learn more about 3D printing innovation.
Tweets by @NavyMakers
Navy Makers
@NavyMakers
twitter.com/Web3DConsortiu...
Nov 8, 2018
Navy Makers Retweeted
Web3D Consortium
@Web3DConsortium
Event announcement 2 November 2018, "Born to Be 3D #B2B3D: Digital Stewardship of Intrinsic 3D Data" at Library of Congress @librarycongress in Washington DC with Nicholas Polys, Darrell Hurt, Meghan McCarthy, Jon Blundell and Vince Rossi. loc.gov/preservation/d...
BORN TO BE 3D
Digital Stewardship of Intrinsic 3D Data
Library of Congress 11/02/2018
#B2B3D
Oct 24, 2018
Navy Makers
@NavyMakers
Operation GreyWhale: Driving While Printing. Pickup truck setup for 3D printing, extra power with Duracell PowerPack. We're
Tweets by @MarineMakers
Marine Maker
@MarineMakers
Congrats to all of the #Marines from SPMAGTF-CR-CC that completed the latest #MarineMaker training with @buildmomentumus! #3Dprinting, #coding, and building #drones are now tools you can use to solve problems at home & abroad. dvidshub.net/video/641219/s...
Nov 20, 2018
Marine Maker Retweeted
MCWL
@WarfightingLab
Are you ready for the future fight? Discuss ideas, identify problems, and develop networks to facilitate future success in this crowd-sourcing, collaboration
getting expeditionary now! @MarineMakers @NAVFAC Naval Facilities Engineering Expeditionary Warfare Center, Port Hueneme California modelexchange.nps.edu/OperationGreyW...
Sep 8, 2018
Navy Makers Retweeted
DARPA
@DARPA
We're seeking information on ultra-high-strength materials to enhance performance of ground combat missions. We've defined four functional areas of interest for this RFI: Mobility, Counter-mobility, Survivability, and Concealment. go.usa.gov/xUSBS #MaterialsScience
Embed
View on Twitter
engine.marines.mil/phasezero
* requires CAC; select EMAIL certificate when prompted#MCWL #USMC #INNOVATE #PHASEZERO
PHASE ZERO
Sep 10, 2018
Marine Maker
@MarineMakers
Think #3Dprinting is a stationary task? Check out this story of a @lulzbot3D printer running in the back of a pickup truck! #Innovation takes chances and iterates on success. Time to scale up!
Sep 13, 2018
Embed
View on Twitter
We use Twitter Brand Resources plus Twitter Rules and Policies when offering announcements.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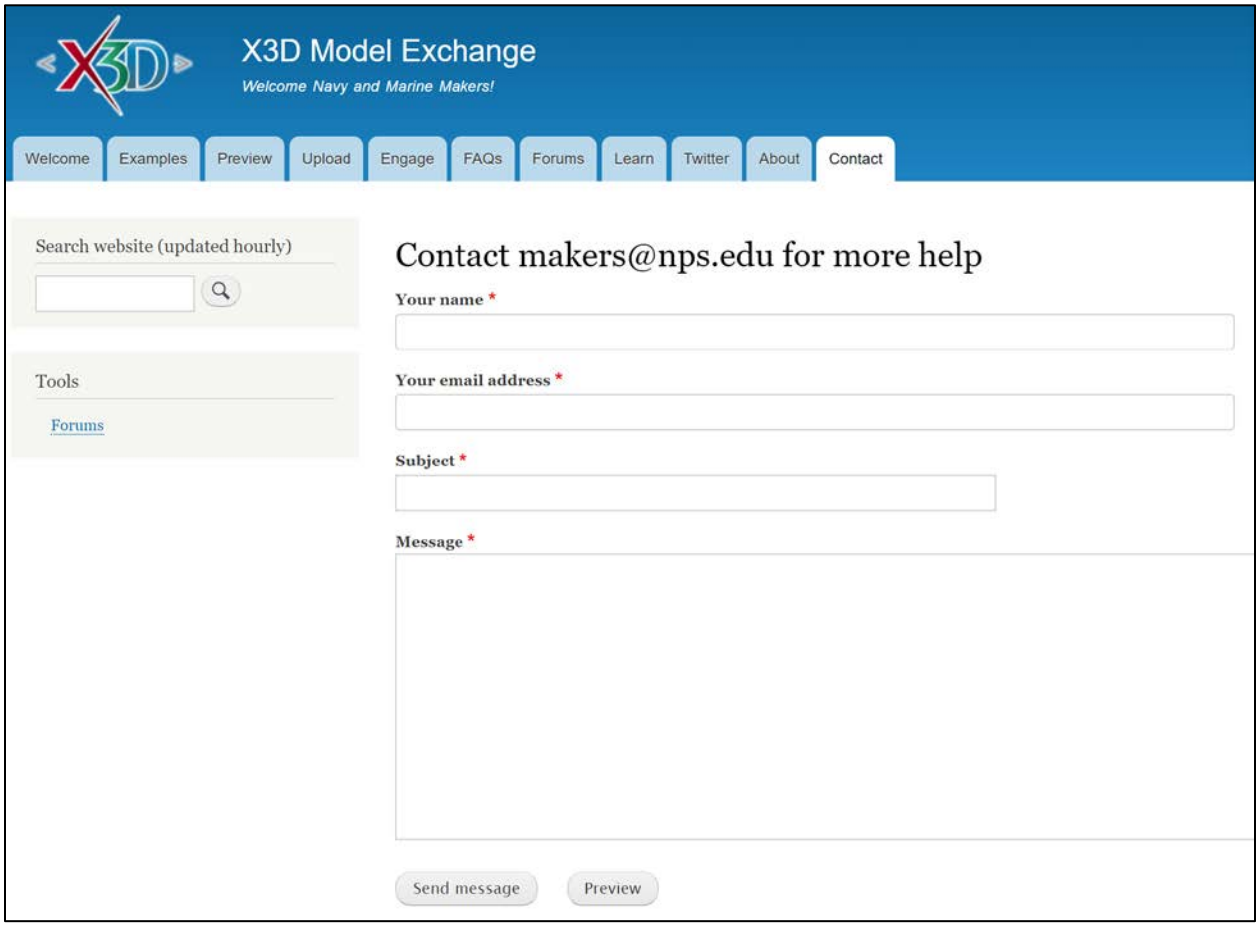
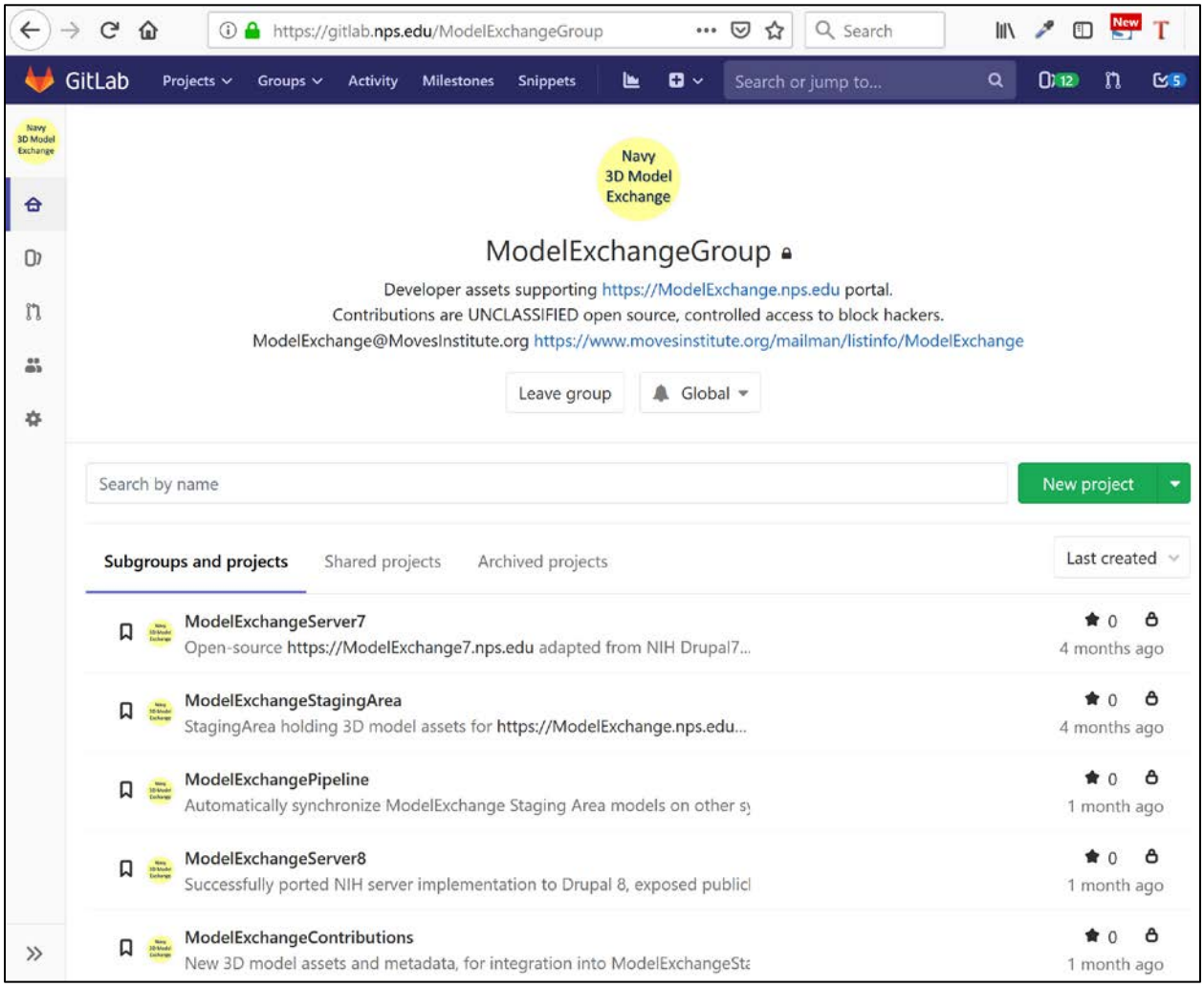
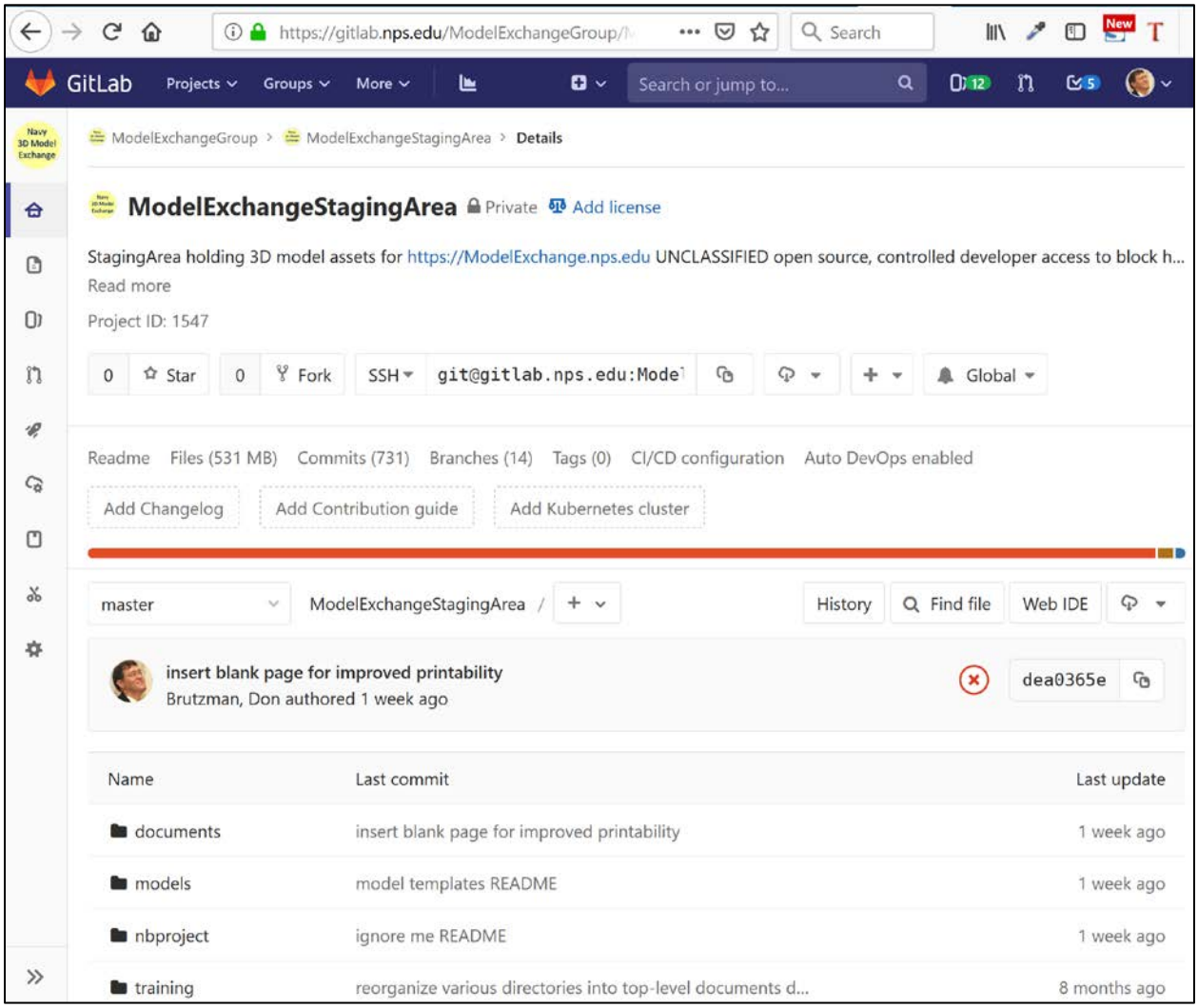
About the X3D Model Exchange
Additive Manufacturing (AM) will have major impacts on future Navy and Marine operations.
Goal
The goal of the Model Exchange is to help Navy and Marine Makers learn how to find, produce, share and print 3D models.
Contact
You are welcome to Contact Us by form, or send feedback email to makers@nps.edu.
Partners
Naval Postgraduate School (NPS) activity includes Robodojo and Additive Manufacturing
Naval Facilities Engineering Command (NAVFAC) and Engineering and Expeditionary Warfare Center (EXWC)
Space and Naval Warfare Systems Command (SPAWAR)
Sponsors
U.S. Marine Corps Systems Command (MCSC) Additive Manufacturing / 3D Printing Project Office
Naval Research Program (NRP) with Topic Sponsor OPNAV N415 Additive Manufacturing (AM)
Developers
Partner developers are working to build Model Exchange capabilities together.
Dataflow architectural design emphasizes interoperable model sharing.
Developer mailing list ModelExchange@MovesInstitute.org for partners and observers (plus mail list page and mail archive)
Gitlab version control: ModelExchange Staging Area for 3D content, plus ModelExchange Software repository using Drupal 8
Future user-facing portals might someday adapt these many open-source assets, please let us know if you are interested.



Mail is delivered to ModelExchange administrators email makers@nps.edu



Version control accounts available on request, FOUO access at
https://gitlab.nps.edu/ModelExchangeGroup



Putting all models into version control allows tracking of initial versions, modifications and improvements by multiple developers and multiple systems.

Account requests: makers@nps.edu

Access: https://gitlab.nps.edu/ModelExchangeGroup/ModelExchangeStagingArea