3D Printing

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Topics

- Standards
    - File formats
    - Metadata
    - Protocols
- Gaps
    - Spooling/monitoring/standard UI
    - Content creation

Standards: File Formats

- STL is still the defacto standard 3D format for makers

  - An updated version of STL that eventually became known as AMF is now available as a non-free ISO standard, although its future in the ISO isn't clear

- G-Code is still the defacto standard layer format for makers

  - The Printer Working Group (PWG) defined a standard subset ("PWG Safe G-Code") to enable interoperability and some level of safety

  - https://ftp.pwg.org/pub/pwg/informational/bp-pwgsafegcode10-20190604-5199.7.pdf

- 3MF is a free and open alternative format that fixes the problems in STL, supports multiple materials and color/texture information, and can include metadata and layer information; many applications and vendors support 3MF today

- PDF is a non-free ISO standard that has two approved 3D object formats (U3D and PRC) and a third in development (STEP-NC)

  - STEP-NC looks to be the "professional" additive manufacturing format that combines the best of AMF and the worse of G-Code

  - U3D is a free standard from ECMA, PRC and STEP-NC are also non-free ISO standards

Standards: Metadata

- 3MF includes Microsoft's standard print job ticket metadata:

  - https://www.3mf.io

- The PWG 3D Print Job Ticket and Associated Capabilities v1.0 (PJT3D) defines an XML schema for job and printer metadata that can be embedded in 3MF or PDF files:

  - https://ftp.pwg.org/pub/pwg/informational/bp-smpjt3d10-20170818.pdf

- ISO is working on a 3D metadata format

  - The PWG hopes this will be based on the PWG 3D Print Job Ticket

Standards: Protocols

- The IPP 3D Printing Extensions v1.1 (PWG 5100.21-2019) define extensions to the Internet Printing Protocol for 3D Printing:

  - https://ftp.pwg.org/pub/pwg/candidates/cs-ipp3d11-20190329-5100.21.pdf

- IPP 3D has been prototyped in the PWG's IPP sample code project:

  - https://github.com/istopwg/ippsample

  - Supports common USB + G-Code printers

Gaps: Spooler/Monitoring/Standard UI

- There is no equivalent to CUPS for 3D Printing

- Ideally, it should be possible to configure system-wide (or per-user) queues for 3D printers and print services like Shapeways

- Aside from the obvious differences in options and print preview:

  - 3D print jobs take a lot longer than 2D print jobs

  - Progress monitoring is more important

  - Video monitoring is somewhat common and could be used to detect common printing errors

  - Printing through external print services is more common - would be ideal to support job submission (ordering) through the standard UI

Gaps: Content Creation

- Current applications used to create 3D content are limiting

  - Traditional CAD applications have a steep learning curve

  - Modeling applications used for animation/etc. lack the precision needed in many situations

  - Multiple material support is lacking

- Ideally there should be common libraries for manipulating 3D content, in particular generation of printable 3MF (or other) format files

  - 3D print your game avatar, etc.

- Plenty of room for "application-specific" software, e.g., custom LEGO brick creation, candy bar design, etc.

Q&A

Resources (1/2)

- Formats:

  - 3MF File Format: https://www.3mf.io

  - ECMA-363: Universal 3D File Format: https://www.ecma-international.org/publications/standards/Ecma-363.htm

  - ISO 10303-238:2007 Industrial automation systems and integration — Product data representation and exchange — Part 238: Application protocol: Application interpreted model for computerized numerical controllers: https://www.iso.org/standard/38036.html

  - ISO 14739-1:2014, Document management — 3D use of Product Representation Compact (PRC) format — Part 1: PRC 10001: https://www.iso.org/standard/54948.html

  - PWG 5199.7-2019: PWG Safe G-Code Subset for 3D Printing v1.0: https://ftp.pwg.org/pub/pwg/informational/bp-pwgsafegcode10-20190604-5199.7.pdf

  - The Stl Format - Standard Data Format for Fabbers: http://www.fabbers.com/tech/STL_Format

Resources (2/2)

- Metadata:
  - PWG 3D Print Job Ticket and Associated Capabilities v1.0 (PJT3D): https://ftp.pwg.org/pub/pwg/informational/bp-smpjt3d10-20170818.pdf

- Protocols:
  - PWG 5100.21-2019: IPP 3D Printing Extensions v1.1: https://ftp.pwg.org/pub/pwg/candidates/cs-ipp3d11-20190329-5100.21.pdf

- Software:
  - IPP Sample Code: https://github.com/istopwg/ippsample

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