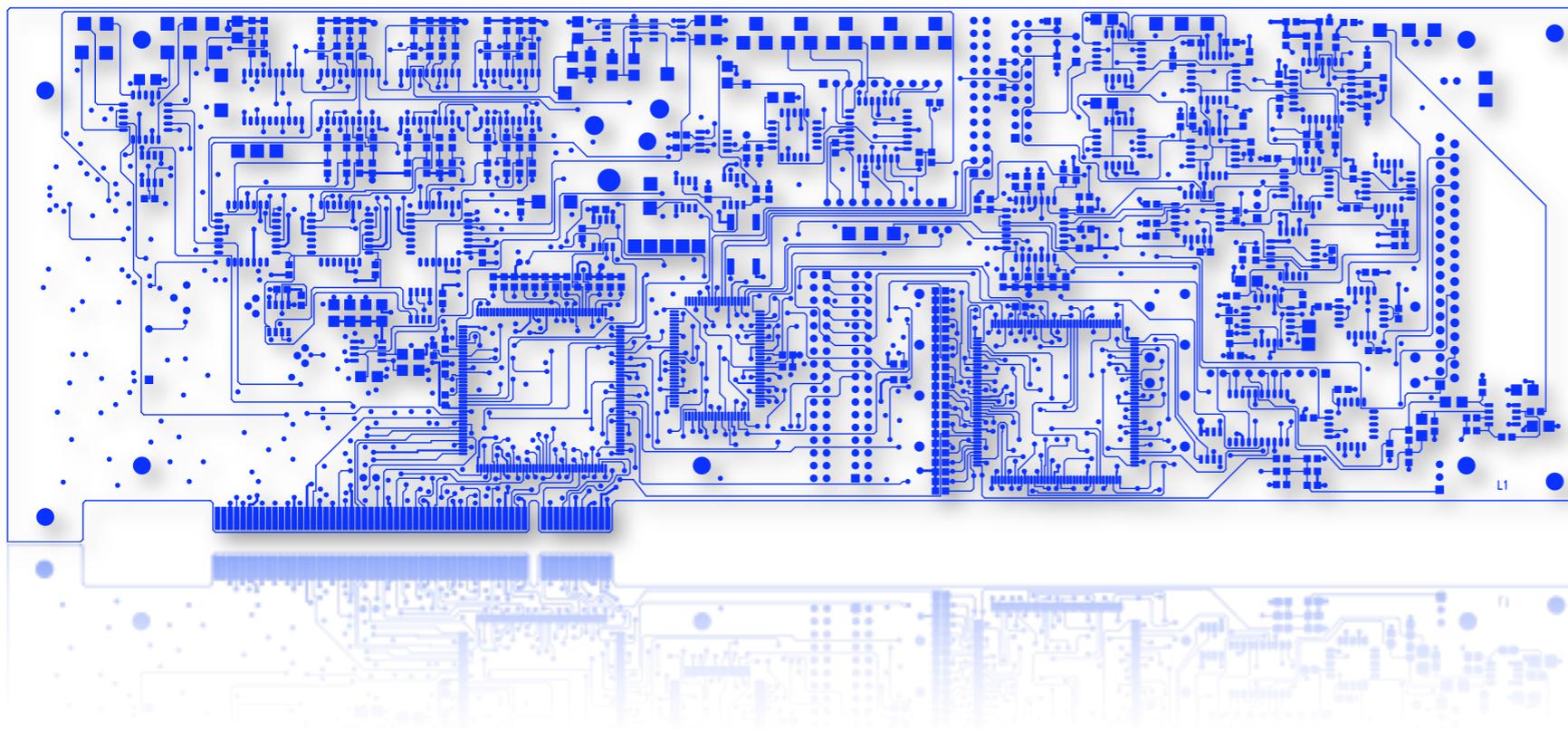# Migrating Legacy Data in the PCB Industry

Matt Aronoff
John Messina
National Institute of Standards and Technology

About NIST

NIST is a national research laboratory that is part of the Department of Commerce. Our mission is to develop standards, technologies, and measurements, all designed to promote trade, enhance productivity, and increase the quality of life.

What's the problem?

- Vast amounts of industry data stored in legacy RS-274 ("Gerber") format

  - Does not convey design intent

    - series of draw instructions

  - No standard dialect for aperture information

  - Not human readable

  - No way to check validity

  - Difficult to maintain or expand

    - When it became necessary to add aperture macros, inline aperture definitions, and small amounts of meta-information, it was necessary to add an entire new dialect (274x) to Gerber.

```
D43*
X1959600Y1349650D02*
X1973900D01*
X1977500Y1353250D02*
Y1404550D01*
X1973900Y1349650D02*
X1974831Y1349772D01*
X1975700Y1350132*
```

What are we trying to do?

- Help industry migrate legacy data forward while reducing risk of adoption

- Speed the adoption of more modern standards like IPC 2581 ("Offspring")

  - design intent and other meta-information available

  - XML-based

    - human readable

    - easy validation

  - Has a clear underlying data model

    - easy to maintain and expand

```
<Package name = "Connector1" type = "CONNECTOR_TH" pinOne = "Left">
    <Outline>
        <Polygon>
            <PolyBegin x = "-10.0" y = "-4.0"/>
            <PolyStepSegment x = "-10.0" y = "4.0"/>
            <PolyStepSegment x = "10.0" y = "4.0"/>
            <PolyStepSegment x = "10.0" y = "-4.0"/>
            <PolyStepSegment x = "-10.0" y = "-4.0"/>
        </Polygon>
        <LineDescRef id = "MediumLine"/>        </Outline>
</Package>
```

GerberTranslator

- A software tool to convert between RS-274 (D and X) "Gerber" files and more modern formats.

- Primarily used as a plugin to the NIST-developed 3D board viewer program known as OffspringViewer

  - The Gerber -> IPC 2581 portion of the tool may be used independently as well.

- Currently focused on Gerber <-> IPC 2581 translation

GerberTranslator

- Translates between Gerber and 2581

- Aims to be accurate and nearly complete rather than complete and nearly accurate

- Does not attempt a perfect conversion due to incompatibilities between formats (addressed in the Challenges section)
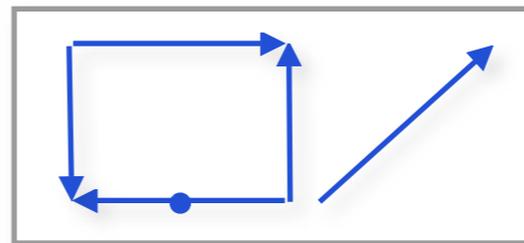
Challenges

- Design intent cannot be easily inferred from Gerber files, so some more advanced features of 2581 can't be used

  - Example: Land Patterns
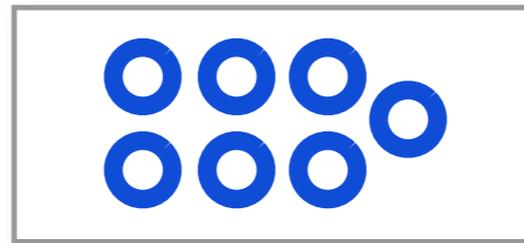
    - Gerber doesn't provide any way to determine whether some number of pads near each other is a land pattern or simply a series of pads.

  - Example: Shape Detection

    - It is difficult to determine programmatically whether a series of lines is intended to be a shape or not, particularly when the lines contain embedded flashes, etc.

Challenges (continued)

- Since Gerber is not object-based, each file is simply a sequence of draw instructions. The following scenario is also possible:

    - Draw half of shape A

    - Move light source to draw a nearby part of shape B

   - Return to draw the second half of shape A
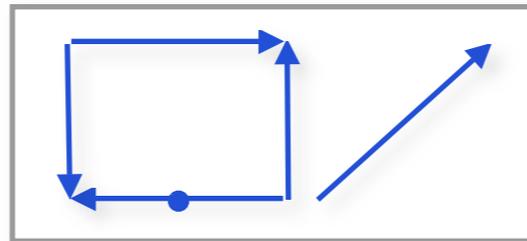
Gerber to 2581

- Converts single file or batch of files in a directory

- Allows user to choose whether or not to include external aperture definition (a.k.a. drill list) files

- Creates a translated file for each input file

Gerber to 2581 (capabilities)

- Line/Arc drawing using linear or circular interpolation

- Polylines and Polygons (containing any combination of linear and arc subsegments)

- Line width detection based on the size and orientation of the aperture used to draw the line

- Line end type (rectangular, round, none)

- Pads
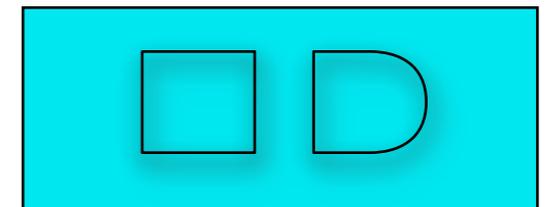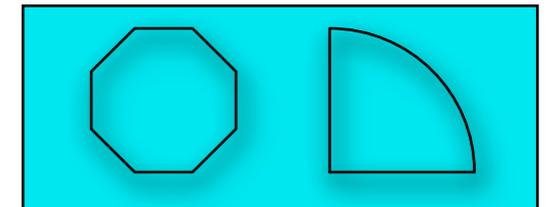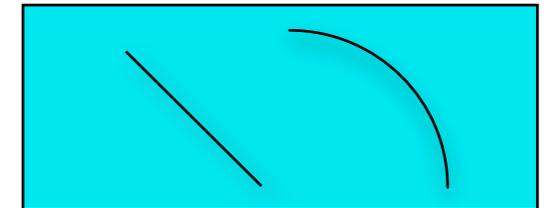
Gerber to 2581
(capabilities continued)

- Apertures and aperture macros

  - Included (274X style) and external (e.g., .des and .rep) aperture definitions

- Layers

- Bounds detection

- All global formatting statements (decimal precision, units, etc.)

- Uses the dictionary-based structure of IPC-2581 to allow reference-based drawing

- Does not require a complete Gerber file -- will extract what information is available

# Reverse Translator: 2581 to Gerber

- Easier and more complete translation

  - Design intent is present in 2581 files

  - *Shape -> series of lines* is a more reliable transformation than *series of lines -> shape*

- This was requested by industry

  - supports communication with companies that have not adopted 2581

Tools used

- Written to be cross-platform

  - Runs on Windows, Linux, and Mac OS X

- Translation code entirely in Ruby (http://www.ruby-lang.org/)

- Uses NIST-developed Pippin framework for XML processing, which itself relies on ReXML (http://www.germane-software.com/software/rexml/)

- Uses the Fox toolkit for windowing (http://fox-toolkit.org/)

Examples: Gerber to 2581
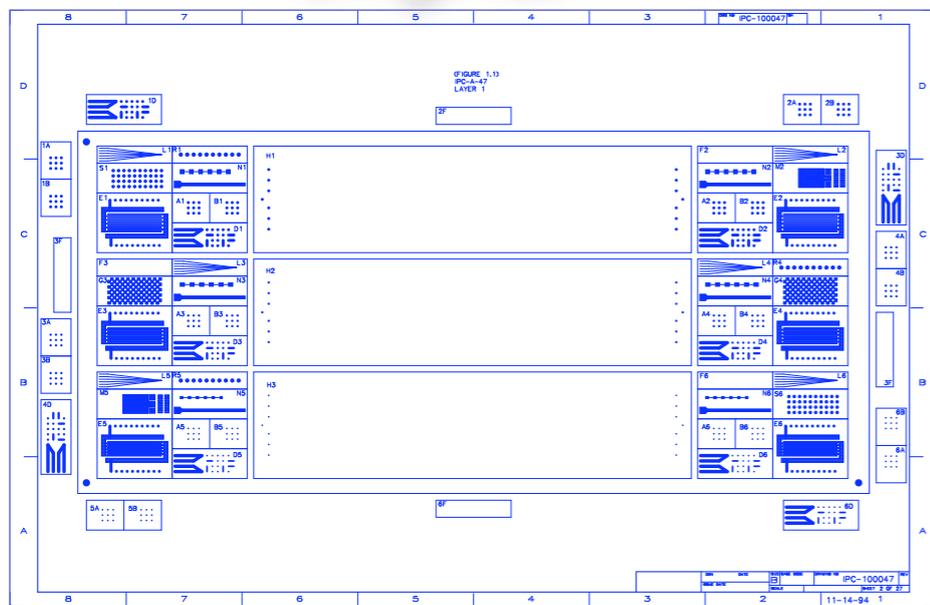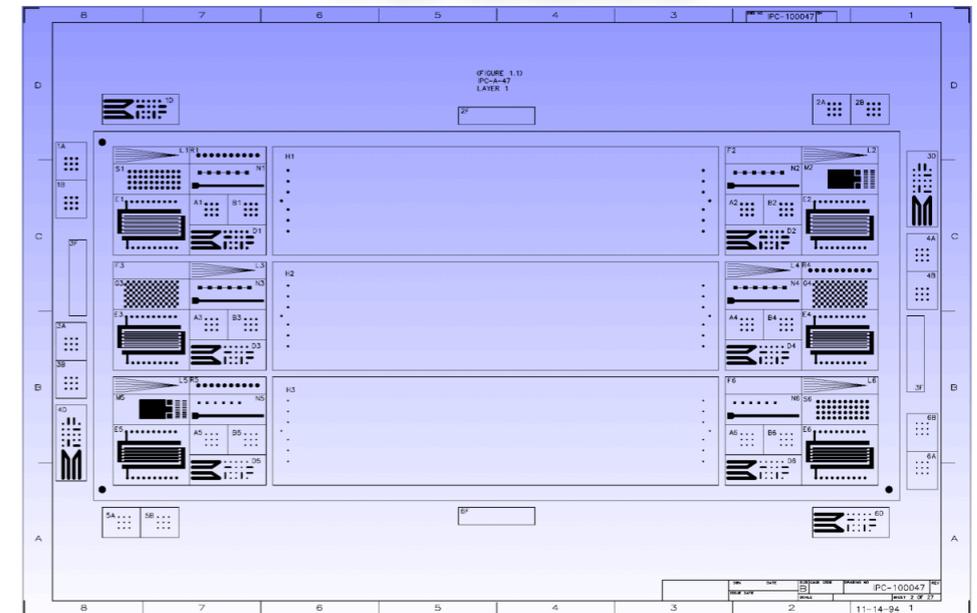
Original
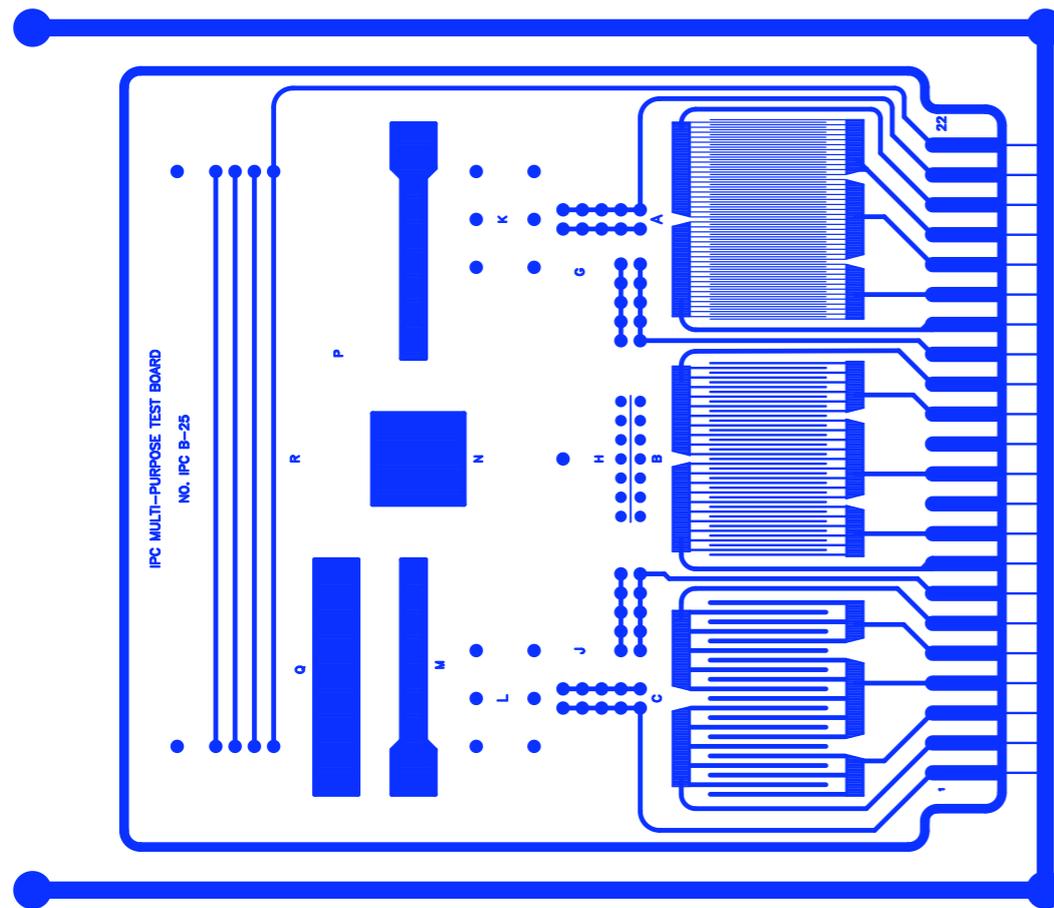
Translated
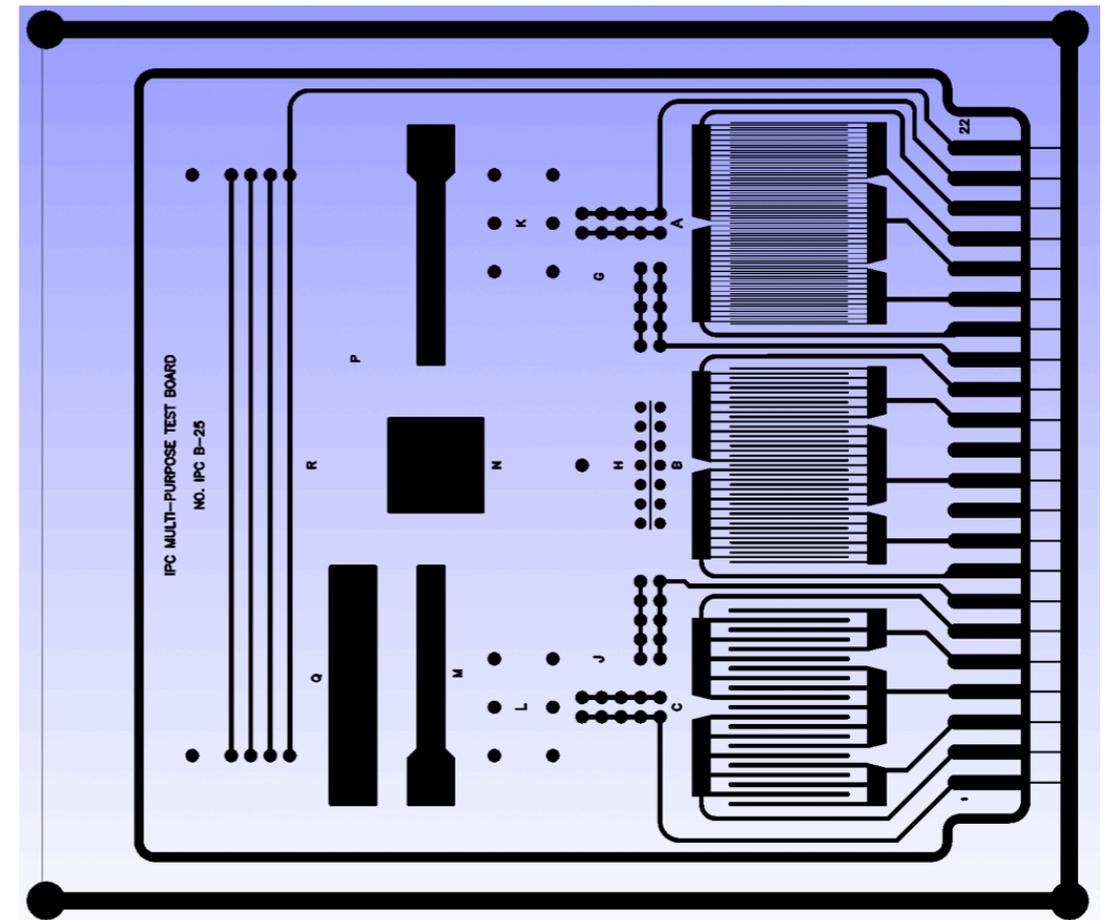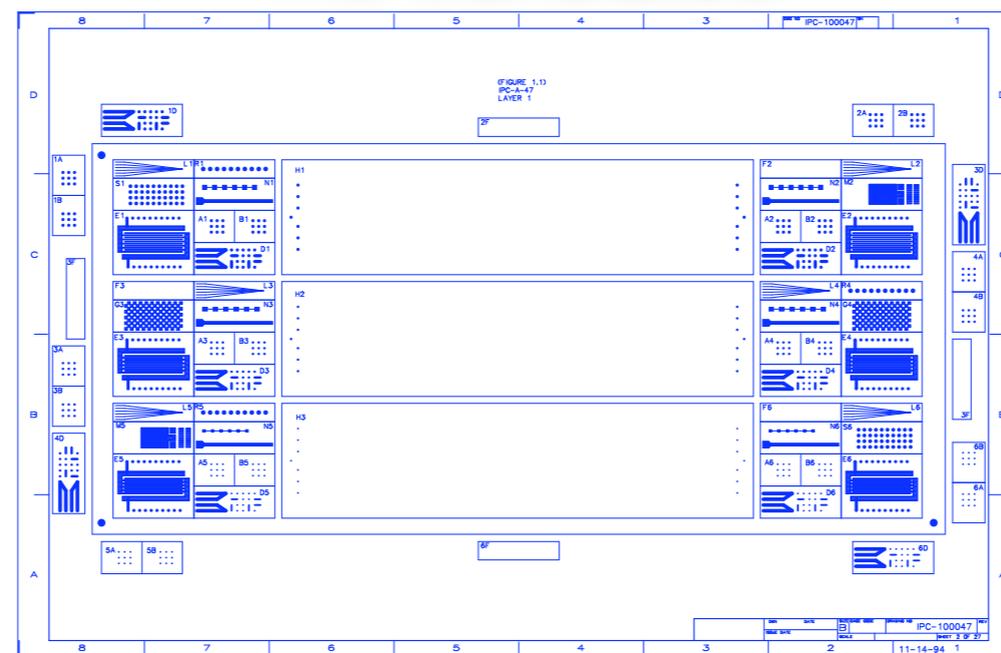
Examples: Round trip

Original

Translated

Re-translated

The future...

- More complete translation

    - e.g., Step-and-repeat

- More inferences available to the user

    - e.g., Shape detection for polygonal line draws

- Speed improvements

    - right now, it can take minutes to translate a large Gerber file

Conclusions

- Allows industry to migrate to newer, more capable standards without losing legacy data

    - Basis to build additional translators to and from both Gerber and 2581

- Will be available on IPC web site (http://www.ipc.org)

Questions?

matthew.aronoff@nist.gov