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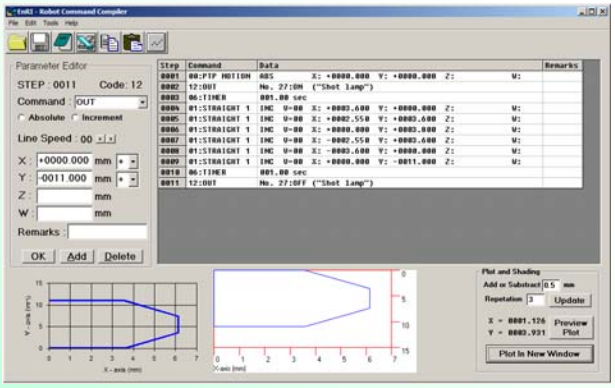
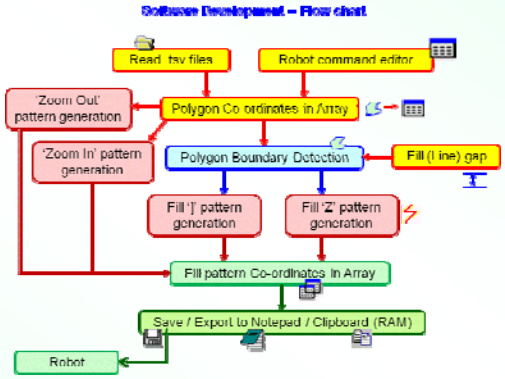
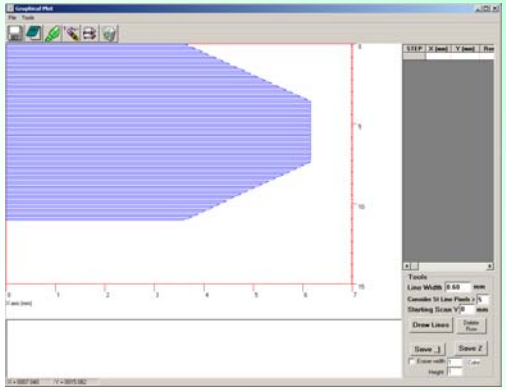
Development of Direct Write Technology for complex filled pattern using 3-Axis Desktop Robot and pneumatic system







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Overview of Presentation

1. Introduction
2. Application / Requirement of Printable Explosives
3. Different Printing Technology for Energetic Materials
   a) Ink Jet Technology
   b) Screen Printing
   c) Pneumatic Dispensing Technology
4. **Software Development**
5. Result and Discussion
6. Conclusion

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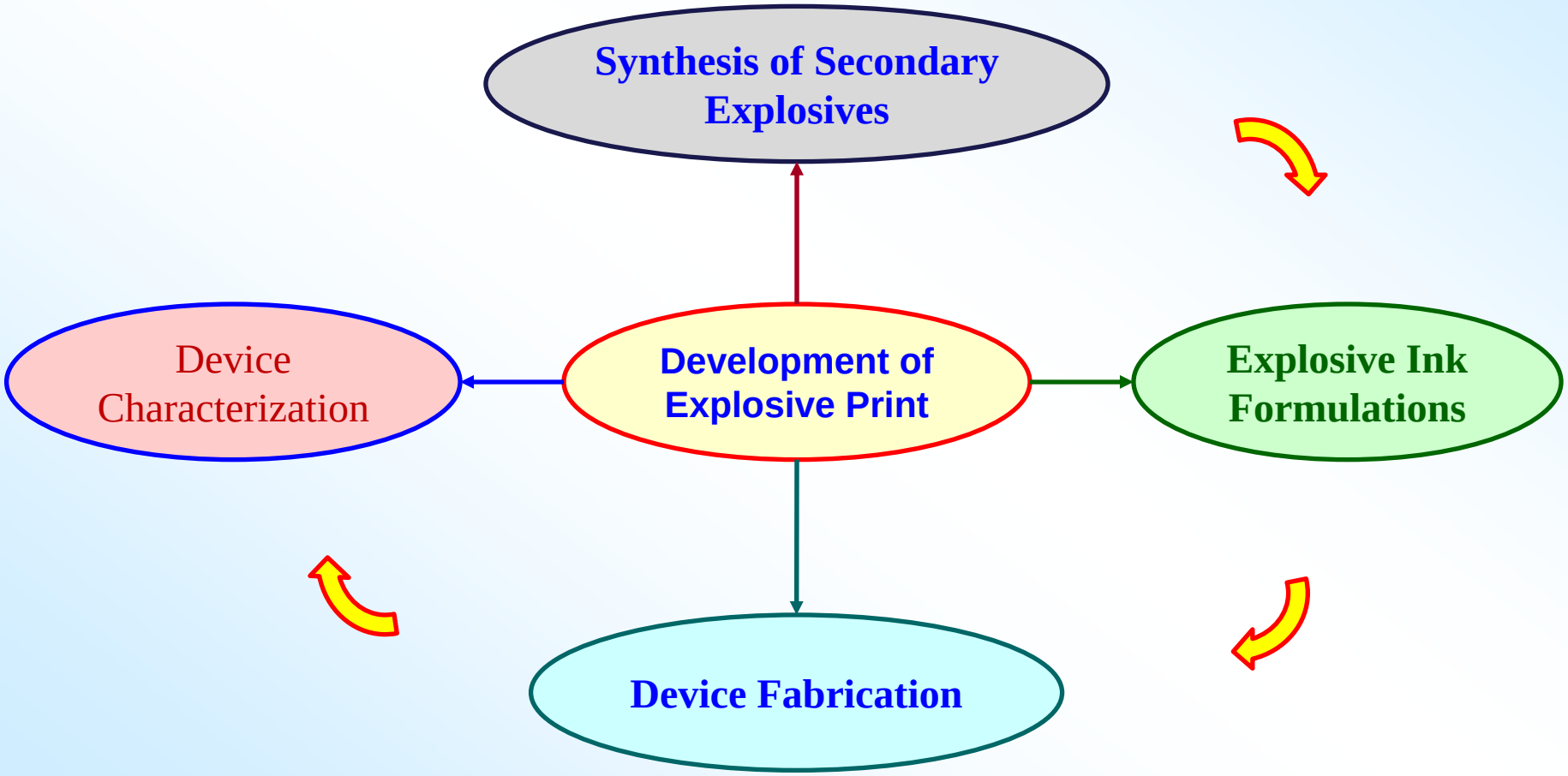
Development of High Precision Technology on Explosive Print

Sub-systems



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Development of High Precision Technology on Explosive Print

Key Tasks:

- Synthesis of secondary explosive
- Synthesis and characterization of energetic ink formulations
- Software for Robot command generation for printing of energetic materials for specific pattern
- Device fabrication and electrical characterization
- Characterization using High Speed Imaging and other methods

Ultimate End Goal :

- Technology development of Printable Energetic Materials, which is part of MEMS initiator as well as pyro-MEMS for fuze applications.
- To achieve the recent approach of “lighten up the heavy forces and heavy up the capabilities of the light force”, requiring systems to be deployable, be 70% lighter, and 50% smaller than current systems, while maintaining equivalent lethality and survivability [Reference: J.L. Zunino et al (ARDEC), "Inkjet Printed Devices for Armament Applications", NSTI-Nanotech 2010].
- Also the technology of high precision printable energetic materials is useful in manufacturing the calibration standards for IMS analyzers (approximately 10,000 IMS analyzers are in use in USA airports

Miniature Aerial vehicles - Unmanned Aerial Vehicles (UAV)

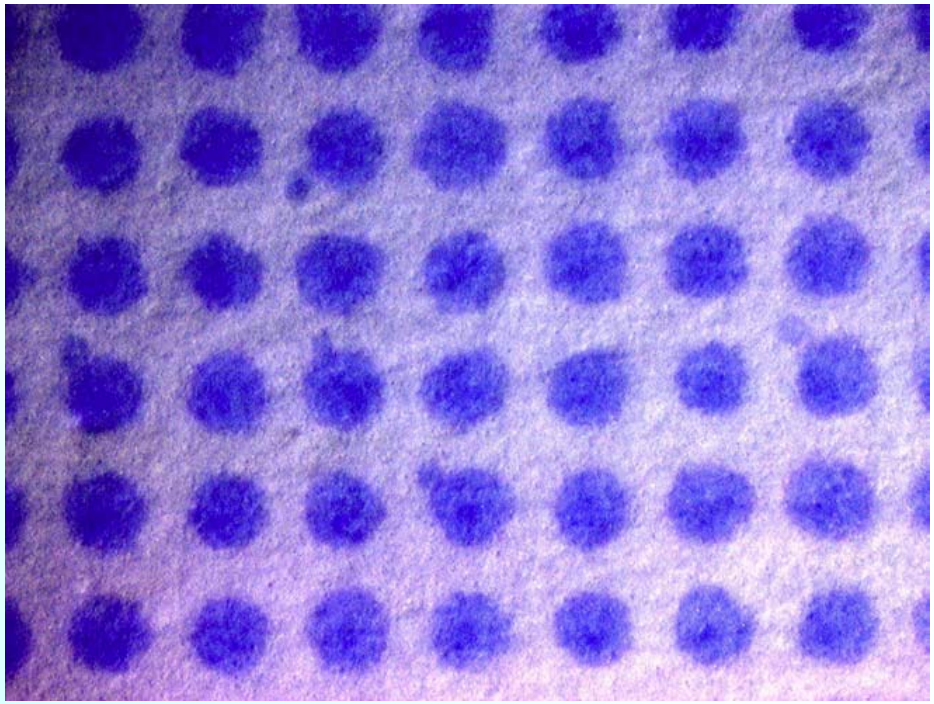
Micro aerial vehicle (MAV) describes a category of aircraft with dimensions roughly comparable to small birds.

As the smallest, powered aircraft, MAVs can carry various sensors as payload to support such civil and **military missions as traffic monitoring, weather observation, and enemy surveillance during military conflicts**.

Much faster and cheaper than conventional reconnaissance aircraft, a MAV equipped with a miniaturized video camera could reconnoiter nearby **enemy troop positions** or, outfitted with highly sensitive sensors, **could locate chemical weapons**

Advanced Inkjet Printing Technology for Trace Explosive Standards

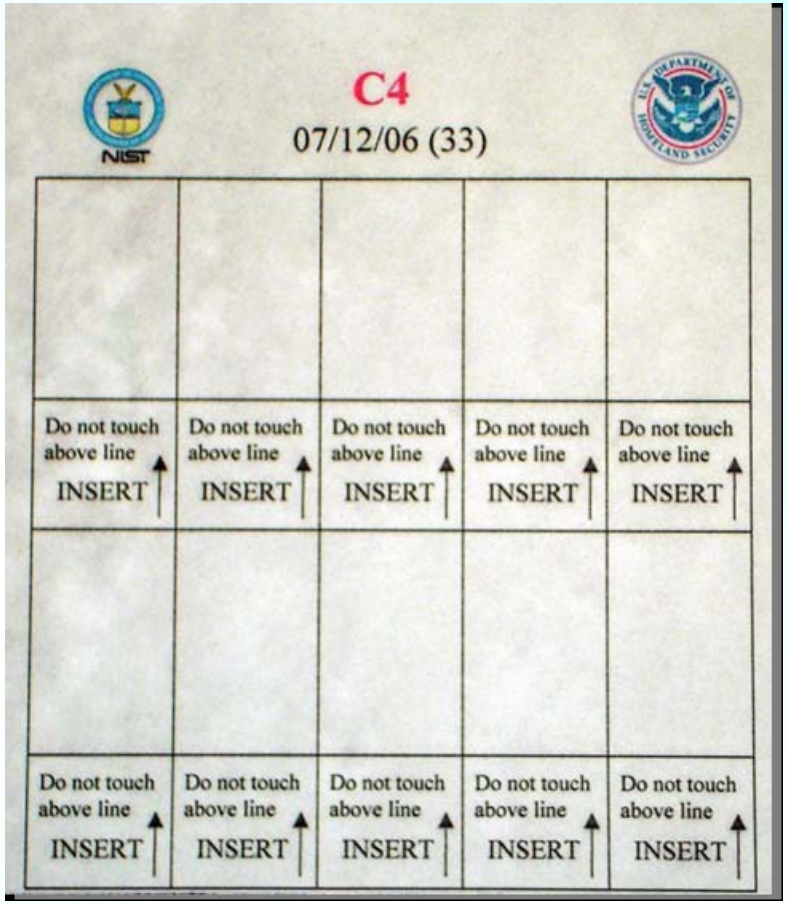
100 μg/ml of PETN Array with Ink



Quality Control of Standards

For routine observation of correct printer function, visual observation of droplet arrays using fluorescent or optical dyes is useful. This approach allows us to verify printheadmisfires, satellite drop formation, tip plugging. Localizing deposit for anlalysts

IMS Intercomparison Reference Material



Reference: Greg Gillen et al, Advanced Inkjet Printing Technology for Trace Explosive Standards, NIST

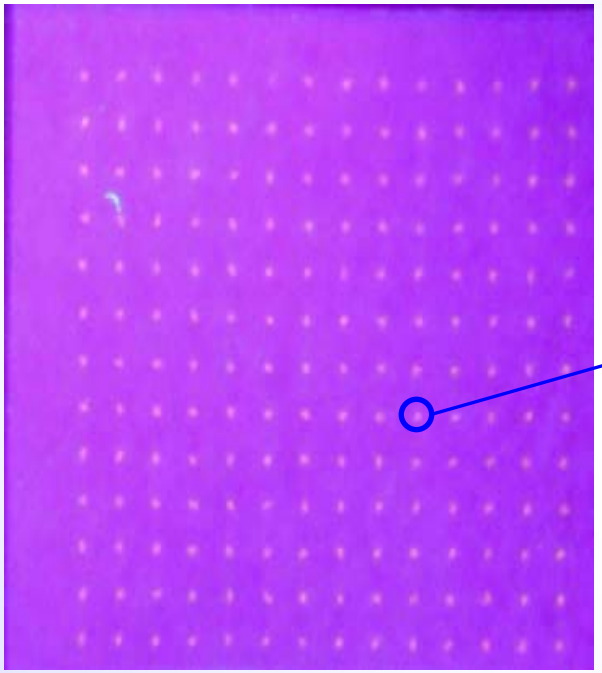
Advanced Inkjet Printing Technology for Trace Explosive Standards

- TNT Arrays containing trace levels of TNT and fluorescent dyes were jetted onto a variety of test surfaces using various solvents
- Arrays characterized by optical and fluorescence microscopy and advanced surface analysis tools available
- Inkjet printing of explosives is feasible. Appropriate solvent and substrate selection critical

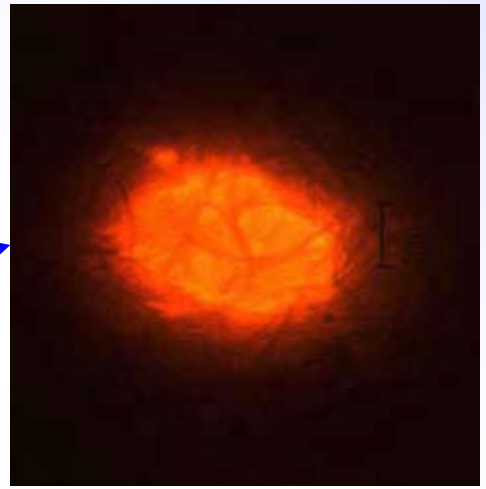
Fluorescein + TNT

2.5 cm

Rhodamine + TNT



2.5 cm



Reference: Greg Gillen et al, Advanced Inkjet Printing Technology for Trace Explosive Standards, NIST

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Printing of Energetic Materials

Ink-Jet Technology

Ditmatix Materials Printer

Cost : ~ S$ 100 K

Availability at sg
NTU : 2 quantity
NUS : 1 quantity

Screen Printing

Pneumatic Dispensing

Cost : ~ S$ 70 K

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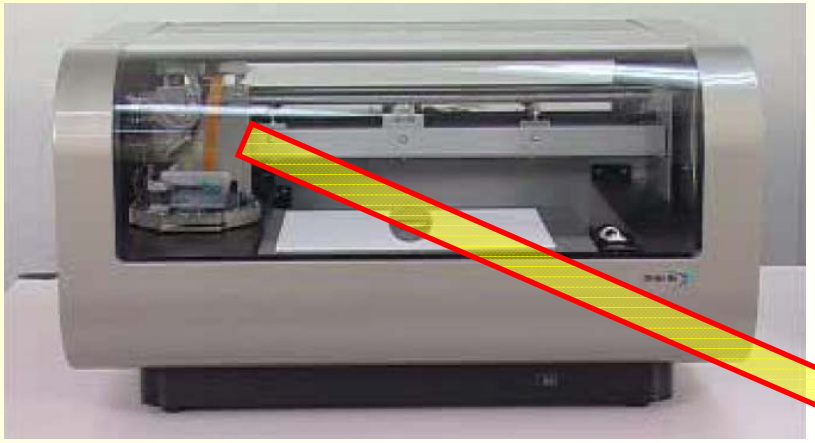
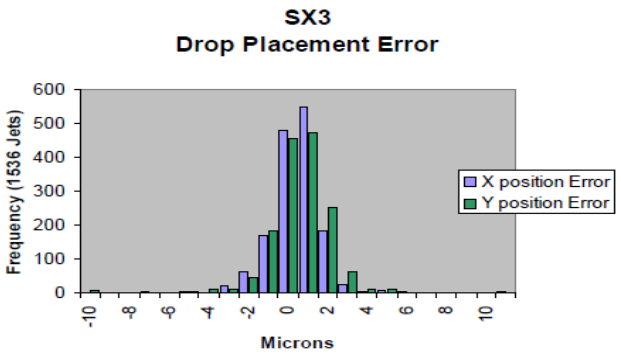
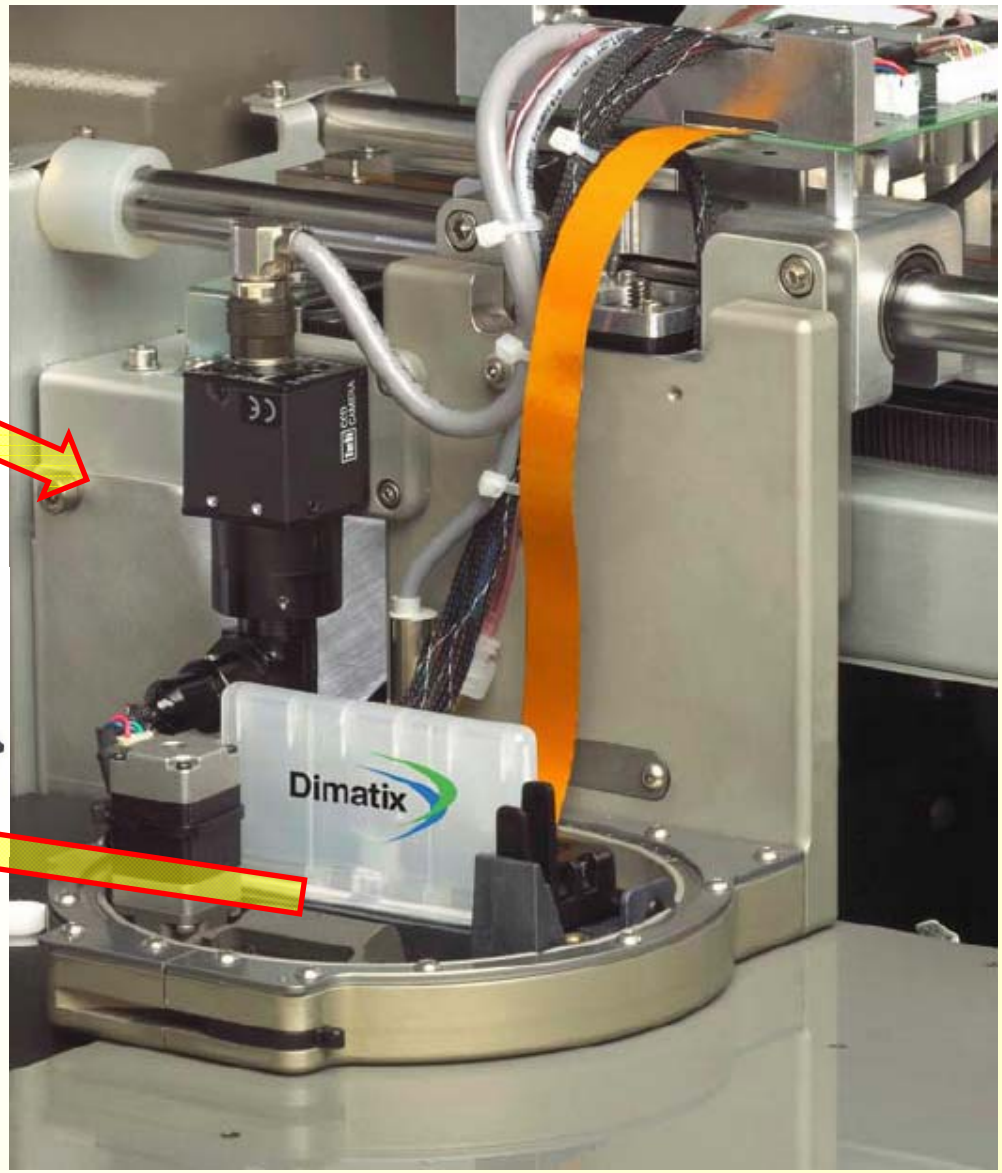
Ink-Jet Technology



Dimatix Materials Printer DMP-2800

Ink-Jet Cartridge





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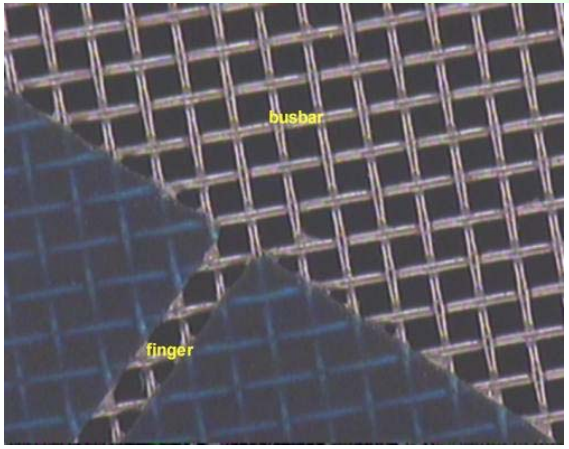
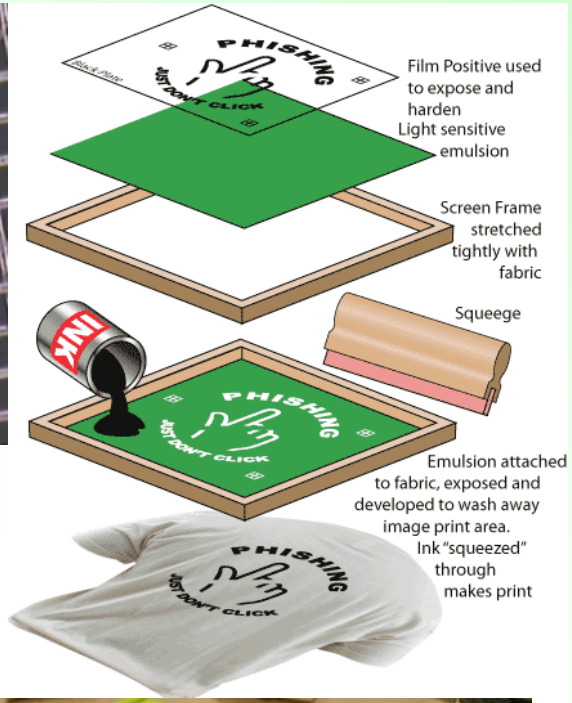
Screen Printing

Automated 3 Color Screen Printing



Screen Printing Mess

Screen Printing on T-shirts



Semi – Automated Screen Printing

Screen Printing of a Image

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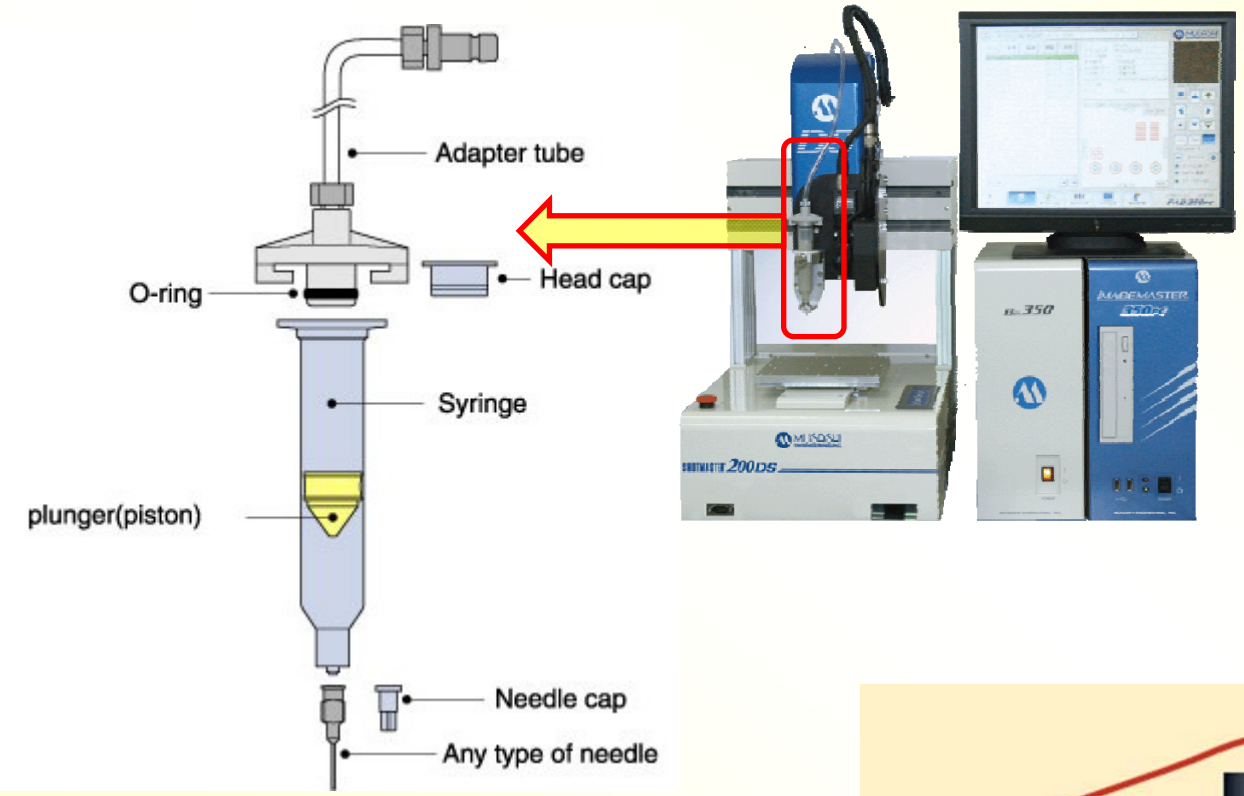
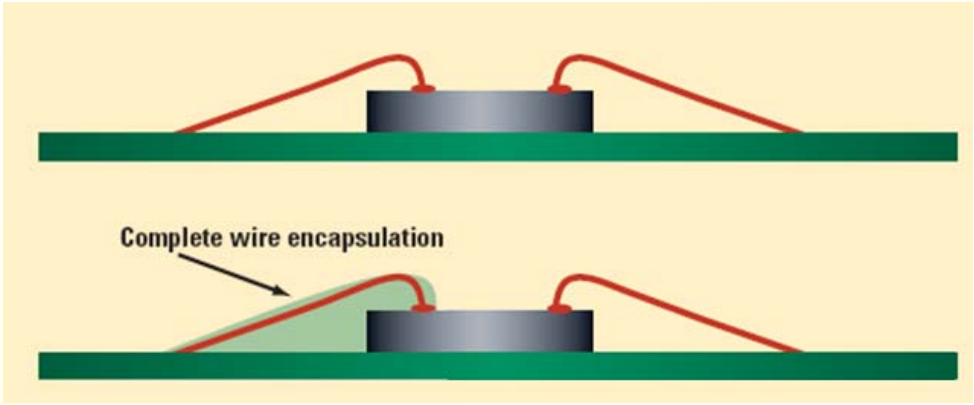
Pneumatic Dispensing Technique



Syringe and accessories Diagram

Precise Die bonding Application



Wire Encapsulation to withstand shock

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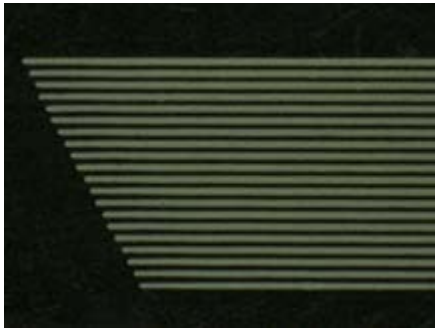
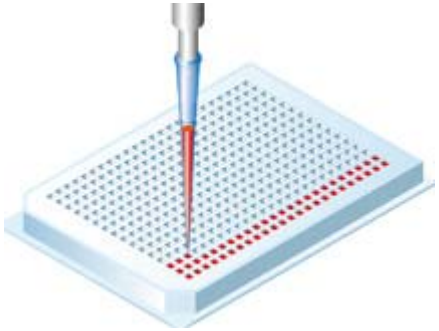
Pneumatic Dispensing Technique Applications

Die bonding to lead frame

Electrode line dispensing

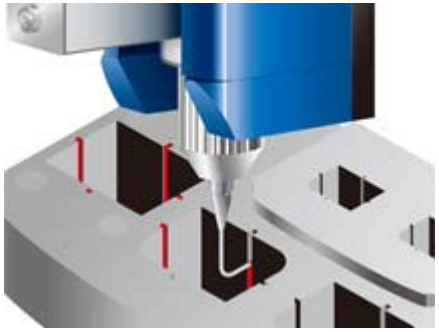


Divided injection to micro-plates



Soldering to in-vehicle substrate

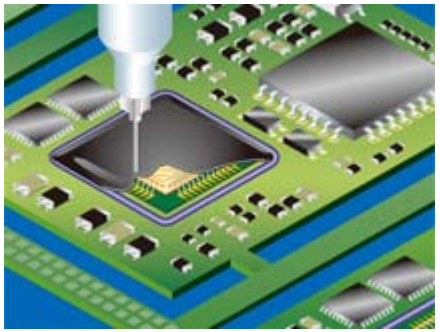
Grease injection to interior panel



Filling to sample goods

Filling to Vials

Encapsulation to PCB



Liquid-type gasket seal-dispensing to cylinder head

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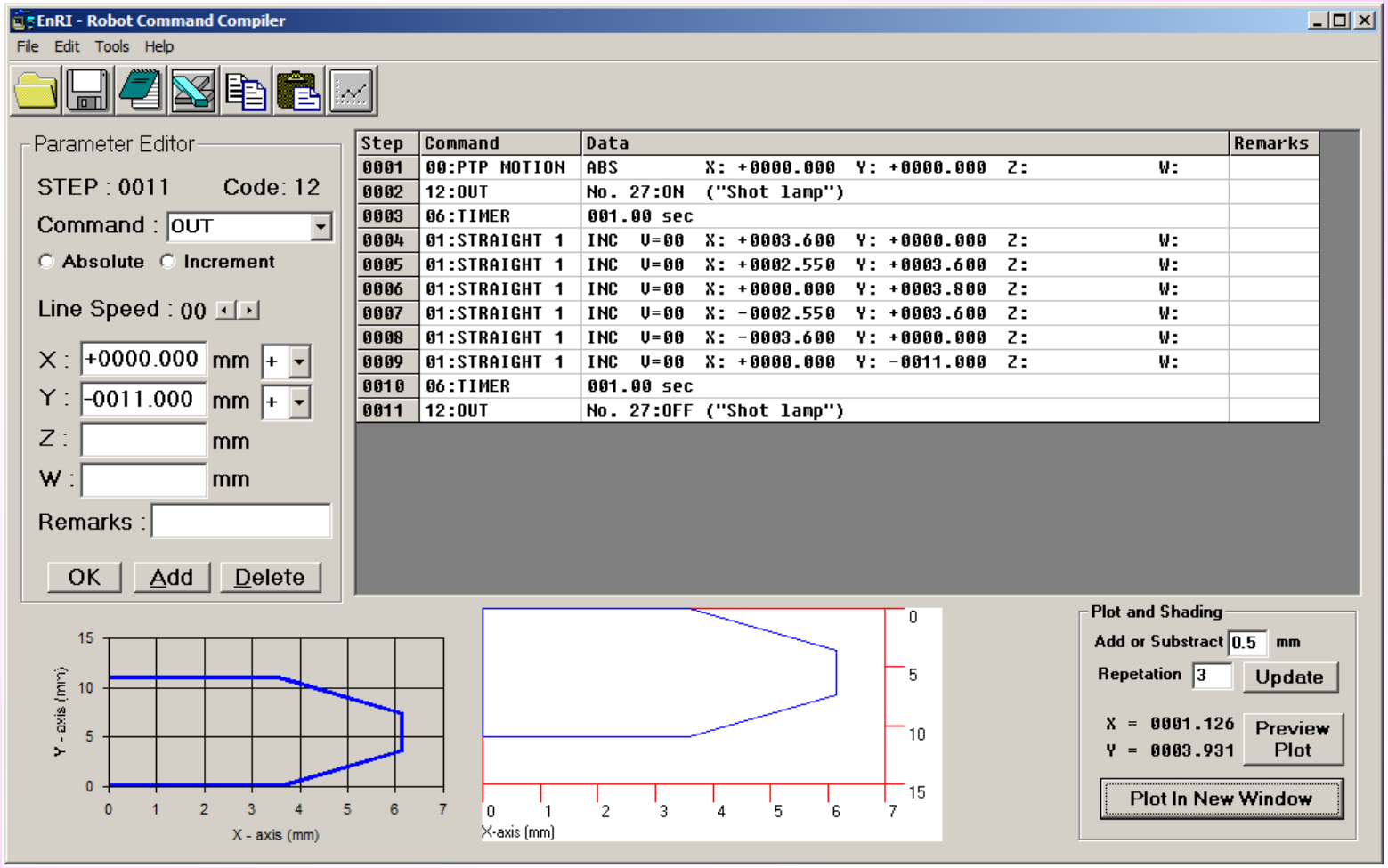
Main Screen – Loading and Design Polygon

Software developed by our Team



- Add New Robot commands
- Save the commands
- Open previously stored command sets
- View graphically

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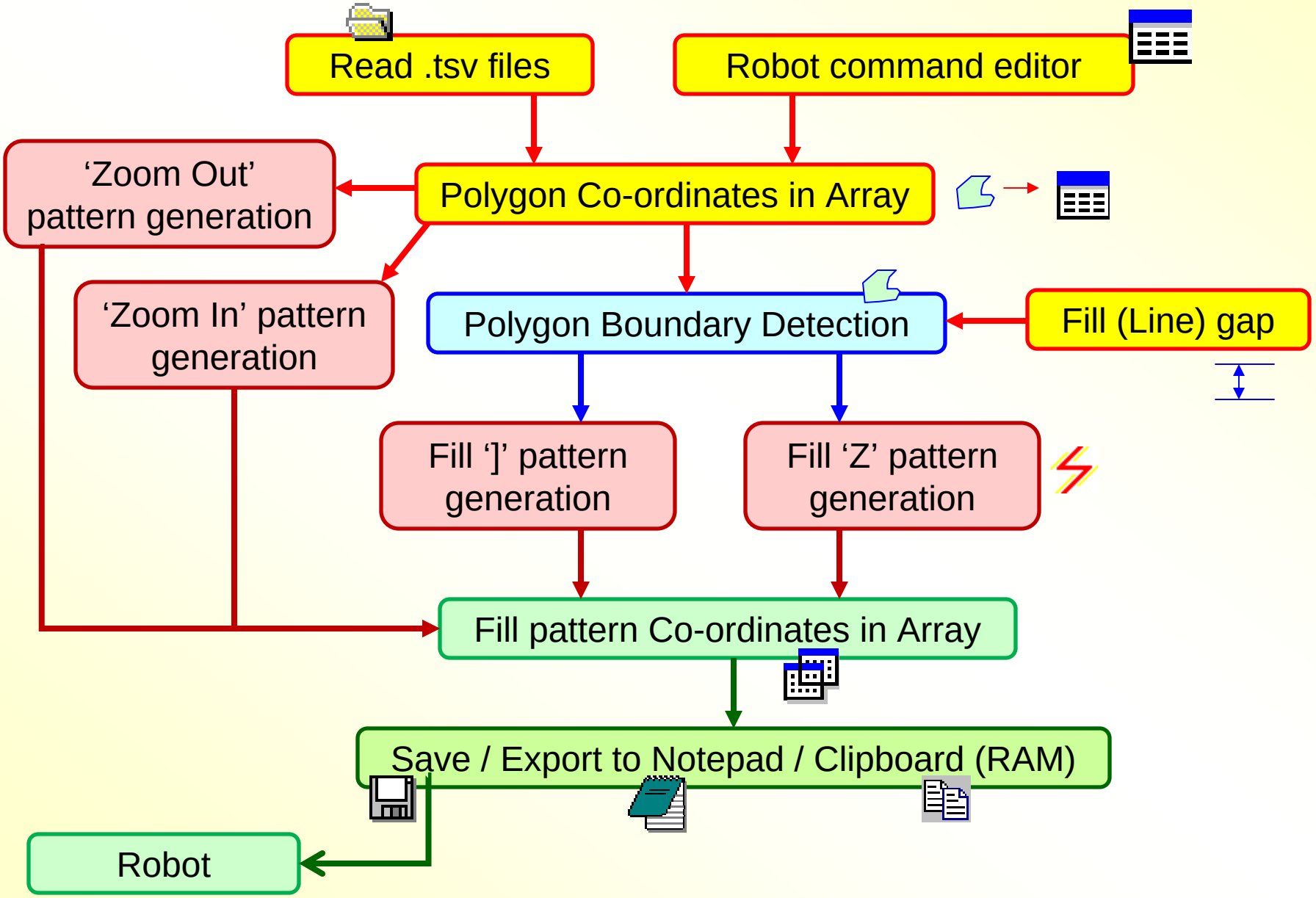
Software Development – Flow chart



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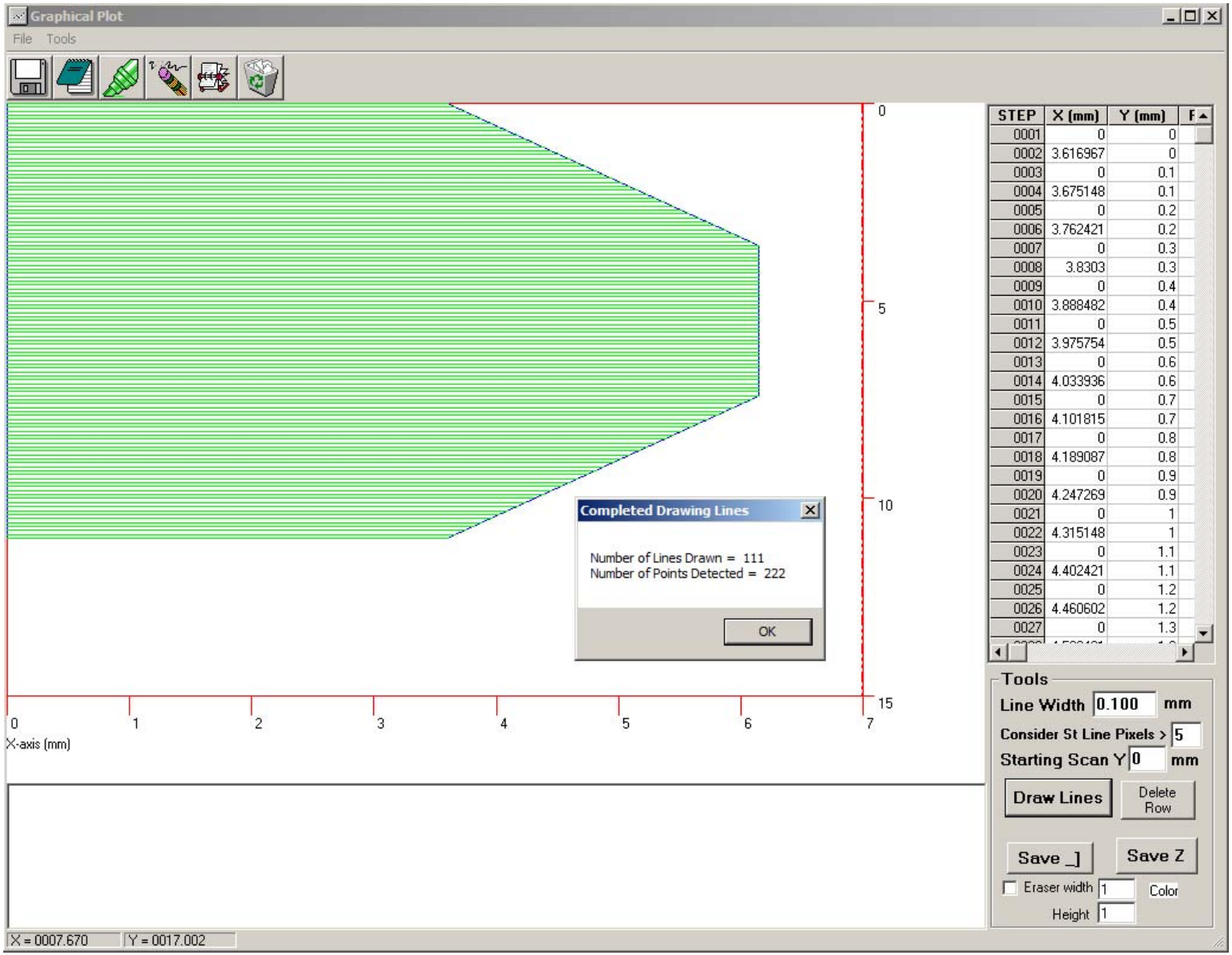
Pattern Filling Options



100 micron line width requires 222 co-ordinates and 111 lines for pattern filling

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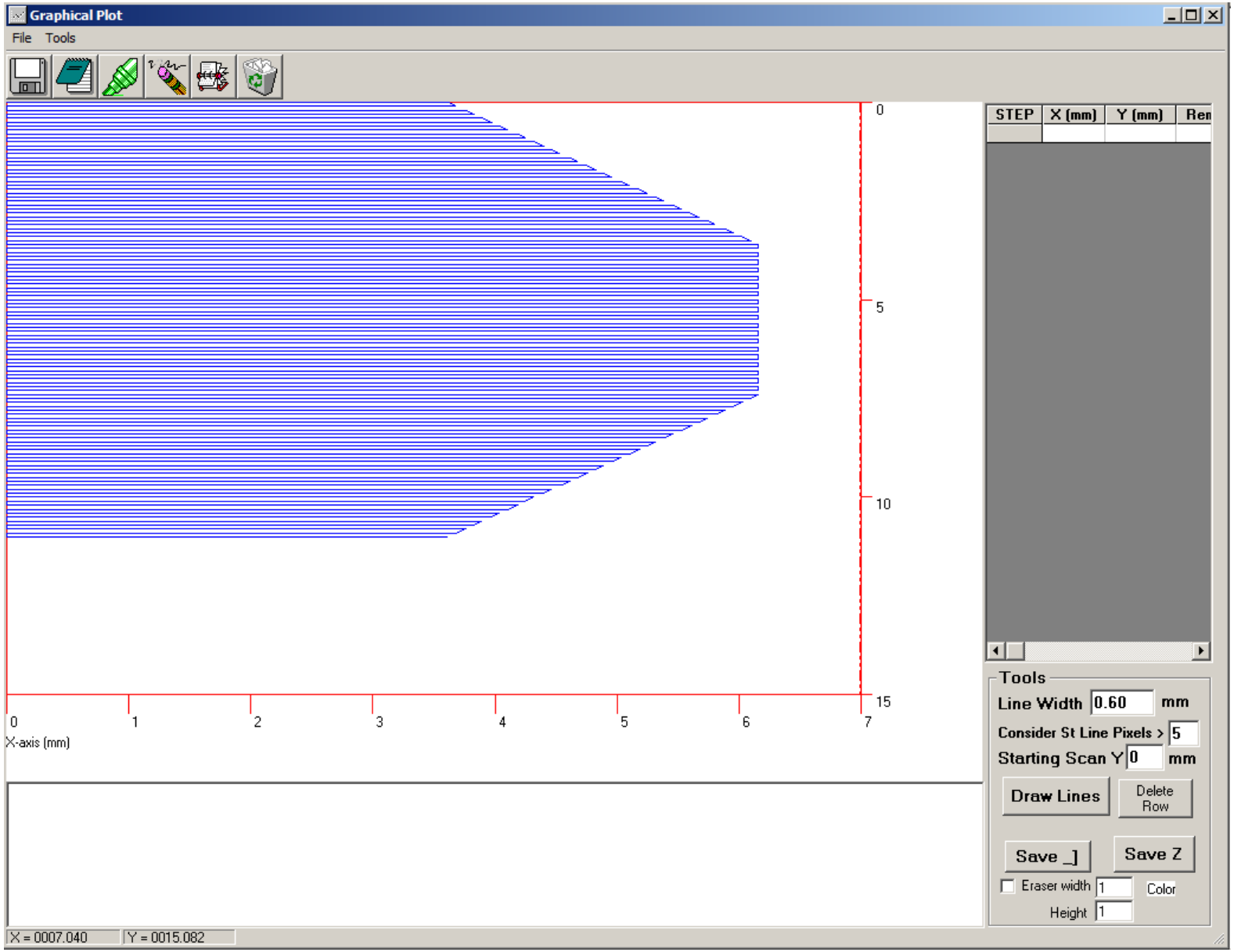
Pattern Filling with] shape



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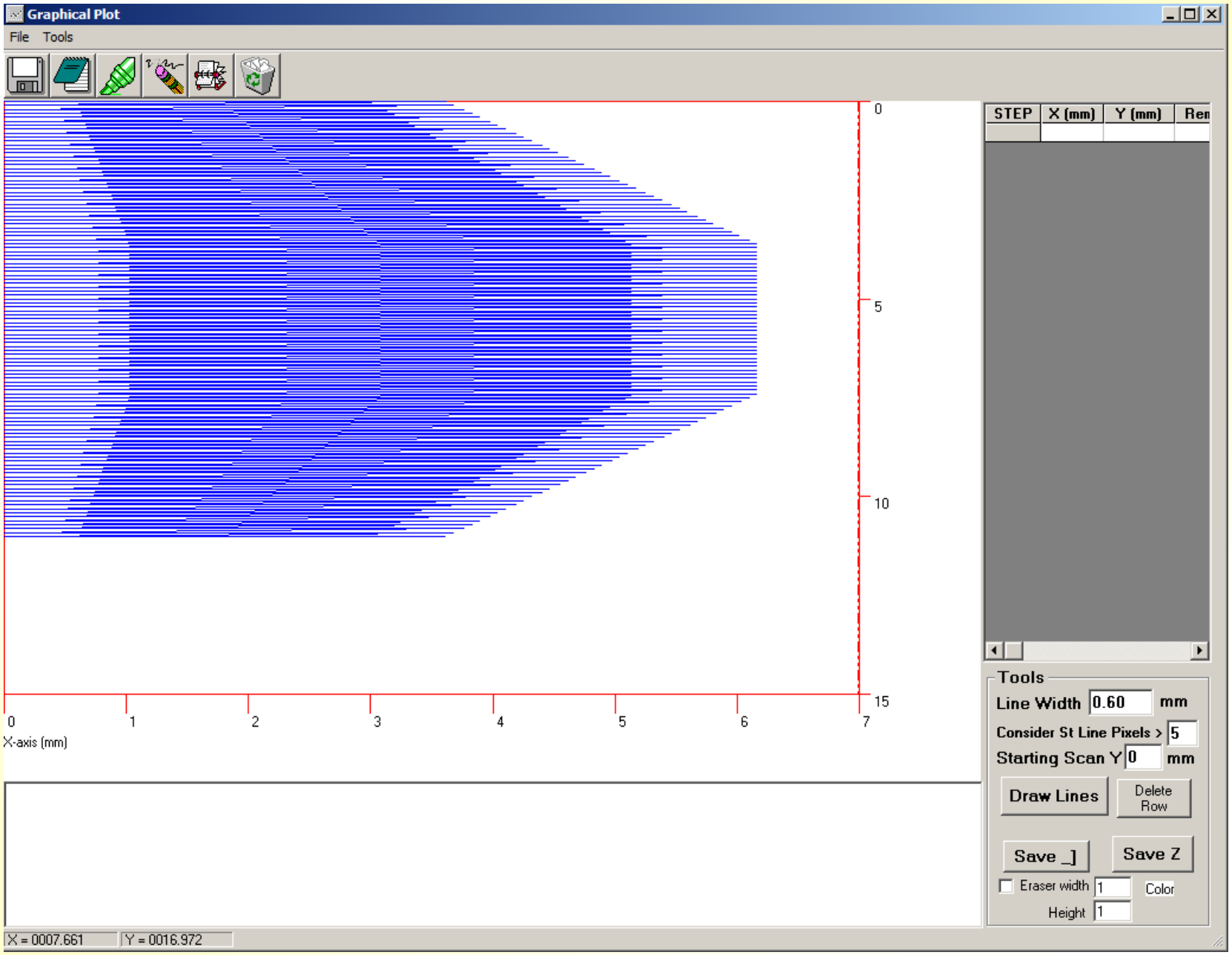
Pattern Filling with Z shape



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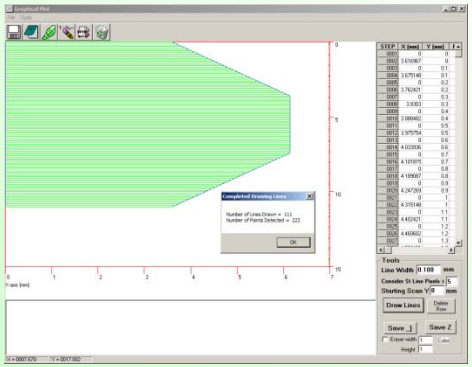
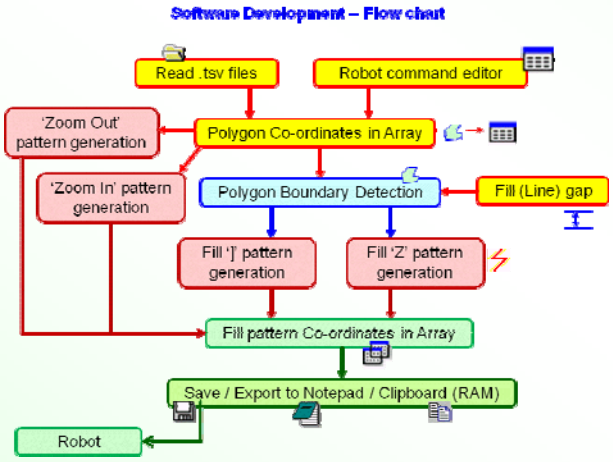
Conclusion

- Direct Write Technology has many advantages for explosive print applications
- A new software program has been developed by the authors based on Direct Write Technology
- The software is capable of generating robot commands for printing complex filled pattern using 3-Axis Desktop Robot coupled to a pneumatic dispensing system
- The software has been practically tested and yielded successful results in printing user-defined patterns





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THANK YOU

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