Draft Specification
for
Punch Press Software

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QUICK WALKTHROUGH

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1.0 Background and Introduction

1.1 Background

Varimetrix Corporation (Varimetrix) develops and markets Mechanical CAD/CAM/CAE software. Recently Varimetrix released VxVision, the next generation CAM/CAM/CAE software. Varimetrix has quite a few Sheet Metal application modules such as Sheet Metal Unfolding and Parts Nesting. Currently it lacks PunchPress module. This document explain the proposed functionality, user interaction and development plan for PunchPress module.

1.2 Introduction

For manufacturing of the sheet metal components various pressworking operations are employed such as cutting (shearing, punching), drawing (forming), coining etc. The underlaying principle of all such operations can be described as the use of force and pressure to cut or form a piece of sheet metal into a desired shape.

Punching invloves nibbling i.e cutting of holes (either cutouts and/or contours) in a sheet (raw material) to produce desired shapes with the use of Punch or Nibbling tools and is generally performed on specifically designed punchpresses. Punchpress has Turret, multiple tool mounting capability to hold Punch tools. Generally standard tools are used, although for specific operations special tools may be used. To finish the cutouts/contours and certain operations (such as small notches, small internal details, etc.) Plasma, Laser cutting attachments are used on the PunchPress.

1.3 Application Areas

Some of the application areas for punch presses are in the production of :

- **Electronic metal work**
- **Electrical equipment boxes/enclosures**
- **Home/office furnitures and appliances**
- **Machinery of all kinds (contruction equipment, farm machinery, automobile, etc.)**

1.4 Need for PunchPress Software

With advancement in tools used for Design (CAD softwares) and Manufacturing technology (especially evolution of NC/CNC machine controllers), permit to write/develop manufacturing instructions (generally referred as Part programs) in a digital format. So the need for software tool to develop part program for Punchpress operations is quite obvious. User/Functional Requirements for punchpress software are a bit differnt from other CAM sofwtare (such as Lathe, Milling software).

1.5 User Requirements

Numerically controlled Punchpress provide additional functionality such as multiple tool holding capability, automatic tool changes, automatic force adjustment controls during operation, automatic part indexing, etc.

Hence while developing part programs with software, user need to be provided functionality to model (simulate) actual manufacturing process. This includes Turret and Tooling Staging (can be referred as Turret and Tooling file definition), Operation setup (i.e. work piece and clamps setup/positioning), Machine configuration definition. For most of the operation standard tool shapes (round, rectangular, square, oblong) are used. Certain operation may require special tool shape definition.

User may like to employ Automated Part Programming or Interactive Parts Programming or combination of both.

In Interactive parts programming mode, user makes the decisions (such as tool positioning i.e. location and orientation with reference to part geometry) and creates cutter/punch location (hit). During this process he may be guided by software. All these cutter locations are organised in Cutter Location Source File(CLSF).

In Automated Programming software makes intelligent decisions based on inputs parameters (available tools, part gemoetry, etc.), contraints and additional rules supplied by user, if any. CLSF is calculated automatically.

User may also like to edit/modify CLSF. Considering the parametric capability of base CAD system, on

top of which PunchPress software is build, user may be provided an option to update the setup configuration, and possibly re-calculate/re-create the CLSF. This may help to maintain associativity with changes workpiece , tooling and turret definition, manufacturing setup.

2.0 Functional Specification

2.1 PunchPress Definition

Punch Press configuration definition includes :

- **Turret Definition**

  Turret file Definition helps to model machine tool turret to PunchPress application software. To help user define and manage turret definition user will be provided with functionality to :

  - **Create various turret definition**

    (Turret definition includes station number, maximum and minimum tool size range, index angle increment, etc.).

  - **Verify/Display turret definition**

  - **Modify/Delete turret definition**

- **Tooling Definition**

  Tooling definition involves specifying various tool and thier parameters to PunchPress software before CLSF can be calculated. For punchpress tool management user will be provided:

  - **Tool Library Management Functionality, this may include:**

    - **Standard Tooling Library**

    - **Create Customized Tooling Library**

    - **Verify/Display Tooling Library**

    - **Modify/Delete Tooling Library**

  - **Tooling File Management Functionality, this may include:**

    - **Tool selection (loading tool to a turret file) from Tool library, specifying tool**

parameters and attributes.

- **Manufacturing Setup definition**

  Manufacturing Setup definition involves specifying workpiece, clamps location, definition/selection of machine configuration (home positions, machine co-ordinate system, zero position, etc.).

  For managing workpiece, clamps etc. for PunchPress operations, VxVision Manufacturing Components and Feature mangers will be employed. This functionality supports definition of manufacturing component/features based on existing CAD parts/sketches.

  For manufacturing setup management, functionality within VxVision Manufacturing module (Machine Manager, Setup Manager, Process Manager) will be used. Additional functionality, if neccessary, will be added.

2.2 PunchPress Parts Programming

PunchPress software will support Automatic and Interactive parts programming options. Details of functionality supported by each option will be :

2.2.1 Automatic (Ji Jia's section)

- **Automatic tool selections and automatic feature recognizations**
  - **The punch feature layout will be performed using sketch feature and CAM component functionality.**
  - **All features in the sheet are assumed to be punched.**
  - **No interactive feature selection will be required. The features in a punching sheet will be read automatically.**
  - **The searching for a tool to march a feature will go through all tools in all turrets.**
  - **Depending on features and tool selection, software will will generate Part Program.**
- **Basic operation types supported will be :**
  - **Punch Hits:**

    The following options will be provided for punch hits.

    - **Smaller feature first :**

The smaller feature will be punched first following this rule. If area clear operation is found, only the first hit is counted for this rule. The consequent hits will not follow this rule.

- **Selected tool feature first.**
- **Support these Sorting methods for those collected hits using same punch tool:**
  - **Shortest Distance.**
  - **Centroid.**
  - **X_Lace.**
  - **Y-Lace.**

- **Area Clear :**

The area clear operation is used with round, rectangle and square tools only. If a round tool is used, the scallop height will be used to control step forward size . A few options/rules for area clearing can be :

- **Equal Pressure Hit Points: This method will try to balance the press pressure**
- **Last then First.**
- **First then Last.**
- **Ascending Odd Order hits then Descending Even Order hits.**
- **Ascending Even Order Then Descending Odd Order hits.**
- **Sequential Lace Hit Points.**
- **Sequential Non-Lace Hit Points.**

- **Profile Clear:**

Apply either Punching or Nibbling to the open and closed profile.
Support Slugging and Shaking methods to break the parts and remnants.

- **Nibble :**

The nibble operations will allow users to define a tool path which follows or is contained within a boundary formed by existing entities. Linear and circular interpolation of nibbling will be supported in first phase of this project.
Support Canned cycles and Graphic cycles.
NURBS nibbling will be supported later.

- **Shear :**

  Support Standard Shear and Flip Shear Operations with Shear Line parallel to material edge in X or in Y direction.

All of the above operations will support collision free to the Clamp Dead Zone.

2.2.2 Interactive

- **Interactive PunchPress Part programming will provide user a functionality to make decisions (such as Tool selection, Punch area selection, Operation type selection, etc.). User will be able to specify necessary paramters for controlling the CLSF generation. Depending on user inputs, software will generate CLSF.**

- **User may be provided with an option to modify the CLSF generated by automatic CLSF generation method. CLSF editing functionality will have various options such as delete hits, add hits, replace hits.**

- **In subsequent versions of software, user may be provided with "Smart Interactive" functionality. This functionality will allow to selection individual geometric entities from workpiece, operation type, tool type, etc. and generate a segment(s) of CLSF. This functionality may what most of the industrial users will like to have.**

  Another set of functionlaity to add will be Interface with Parts Nesting. This interface will allow instancing of PunchPress Toolpaths(CLSF).

  Details of this functionality need to be worked out after dicussion with Varimetrix Development Planning group. Inputs from experienced industrial users may be very useful.

3.0 User Interaction

For performing the tasks outlined in Functional Specification section, a state of the art user friendly interface will be provided, employing the GUI tools developed for VxVision. This will make sure user interface is consistent with other CAM functionality/modules.

4.0 Limitations and Contraints

As of now, we do not see any technical limitations and handicap. Although the feedback from Vx Sales/ Marketing dept, Industry and also requests for specific functionality will have impact of depth of functionality that can be developed for first production release and subsequent product releases.

5.0 Development Plan

This section gives history, brief details of development plan, quality assurance and testing plan.

5.1 Project Plan and Schedule

The estimated effort requirements for the initial stage of this project (i.e. upto August) is 12 Man-months. (Project plan assumes 2 developers working for the above said project)

Activity	March	April	May	June	July	August	Rest of 1999
Project Definition	*						
Research and Prototype development		*					
CAM Database Planning and Development PunchPress Infrastucture Development (Tooling Library Manager, Turret Library Manager, Tooling file Manager)			*	*			
User Interface Planning and Development				*			
Automatic PunchPress Development		*	*	*			
Interactive PunchPress Development			*	*			
CLSF Output/PostProcessor Development				*			
Unit Testing	*	*	*	*			
QA Testing and Critical Bug Fixing					*		
Beta Version Release						*	
Enhacement & Bug Fixing						*	*

5.2 Quality Assurance and Testing

At the end of the current product development phase, PunchPress module will be tested using existing QA Tools. If necessary, additional tools will be developed to fit within current QA Archiecture.

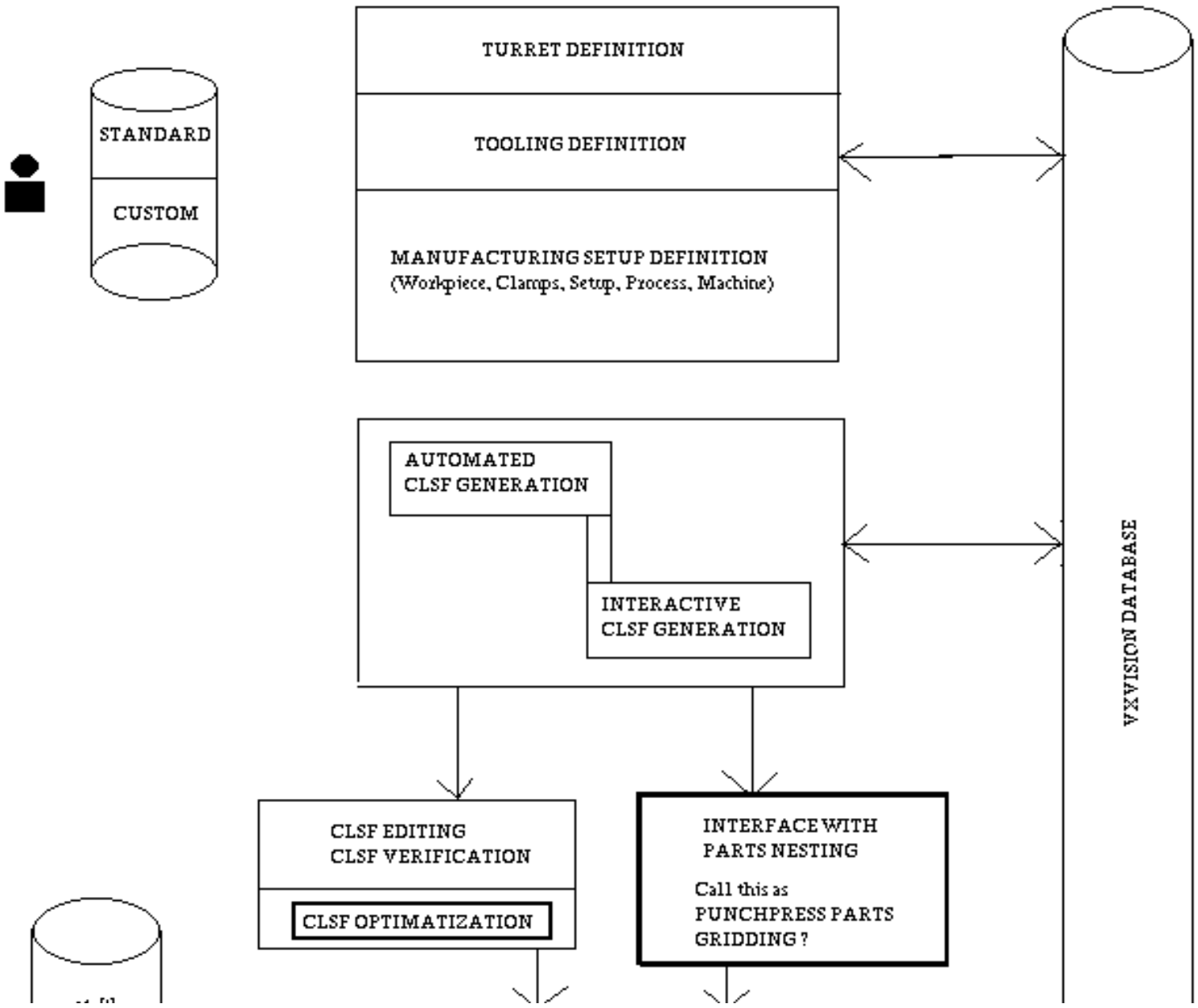
Also some practical problems can be attempted. For this inputs and co-ordination with Varimetrix Sales/

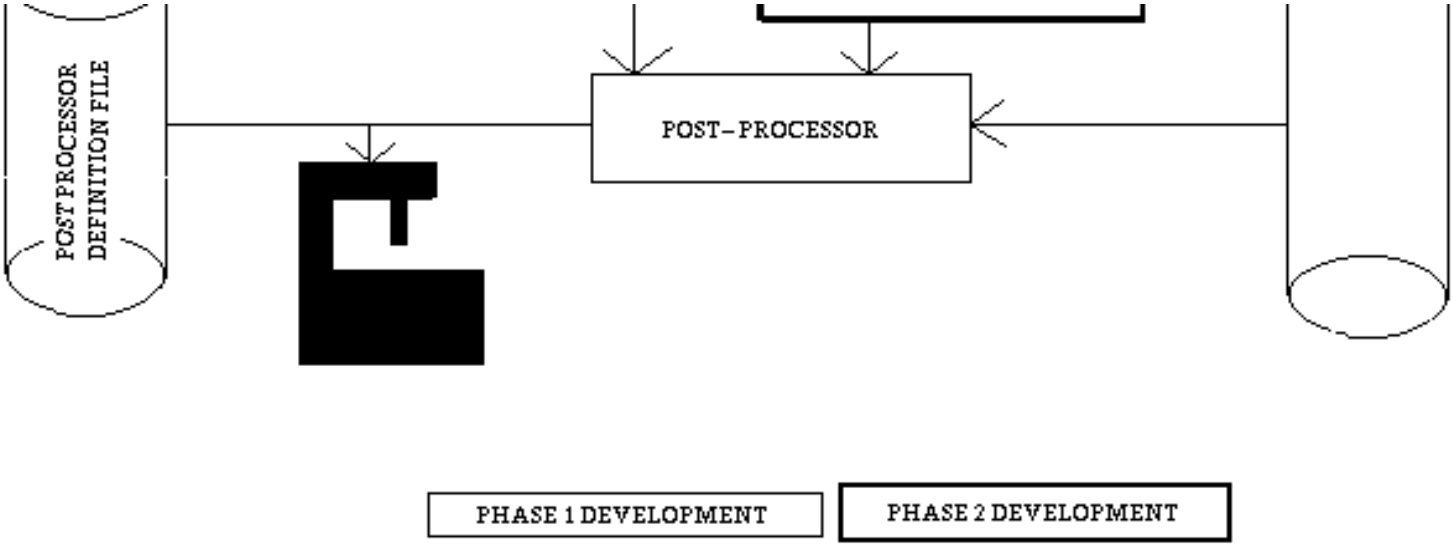
Marketing Dept. will be required. Sales/Marketing dept. can help to identify potential Beta test sites. Help and support from Vx Support dept. during this beta testing phase will be appreciated.

5.3 Product Maintenance

Varimetrix needs plan for product maintenance for PunchPress. During initial product deployment phase (may be upto 6 to 9 months period), maintenance requirements may be pretty heavy. During this period main focus will be bug fixing, develop missing/ additional functionality requested by user industry. After first year of development maintenance requirement may taper off (For planning purpose, estimated effort can be upto quarter man-year effort).

6.0 PunchPress Overview Data Flow Diagram





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