COMPUTER AIDED DESIGN AND MANUFACTURING OF PIPELINE ENERGETICS SYSTEMS COMPONENTS

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ABSTRACT: *In contribution are described applications of computer aided systems in area of pipeline energetic systems manufacturing. There are used commercially offered CAM systems. Disadvantage of these systems is high price and hardware exacting. Besides commercial there is possible use specialised systems which are designed for concrete user conditions. To these specialised systems we can line up the system EDBTS 11 created by workers of Faculty of Production Technologies TU Presov. This system is designed for control program creating of BTS11 control system, which serves for controlling of slotting and baking positioning devices.*

Introduction

Future in area of manufacturing of pipeline distribution system components with complicated shape is aimed at using of computers with proper software equipment. Manufacturers of pipe components, because of the accelerating and make projecting of components more first-rated, use in the design stage CAD systems (Computer Aided Design). But manufacturers must often take care of problems with manufacturing quality of component, mainly in the cases when it is needed to make pipeline with the shape defined by several curves. There are recommended to use a proper CAM systems (Computer Aided Manufacturing) in the cases of manufacturing stage. These systems use geometrical data obtained from part in design stage and saved in CAD data bank of computer [1, 3].

Computer Aided Design of Pipeline Systems Component

CAD system is in sphere of design of pipeline energetic systems able to use mainly for designing of pipes with more complicated shape, which are unavoidable for creating of complete pipeline. This is the question of parts like for example knee-joint, which can be of several diameter, radius of curve and swerve angle, can be manufactured as solid or many parts connected by welding joint. Then there are breeches pipe components in T-shape, which are made by many segments (minimally 2). In the case of first-rated realisation of welding joint, it is unavoidable all the segments of a weldment and mainly parts where a weld will be realised, manufacture with best precision. By this we can prevent the necessity of finishing and fitting of weldment segments in welding stage. This can reduce the time of welding and reduce the probability of bad weld realisation [2].

Considering the fact that the segments of pipeline is connected to one solid there are several types of penetration with various sections (mainly circular section, tetragonal and rectangular section). In the case that these segments are manufactured by bending from thin-walled sheets and then jointed by welding is important to define and make spread out shape for semi-finished article, which in the place where the weld will be, often has the shape of a curve with compound geometry. Because of the design automation and reducing of time, which is needed, for realisation of design and also for exact transmission curve defining is in the cases better to use proper CAD systems, which are differed by function, performance and by price.
From the point of application in the area of projecting of pipeline systems is possible to classify CAD systems to [5]:

1. *Small CAD systems*
   Enables only drawing on the plane and serve as drawing board. There are no special tools for automation of design of pipeline elements. We can place to these group systems as AutoCAD LT, AutoSketch, VectorWorks, DesignCAD, Atrix Technical, SmartSketch, TurboCAD, OrCAD and others.
2. *Middle CAD systems*
   These systems are noted by the part which is designed as 3D model and then from this model are

created 2D drawings. The most famous systems are: AutoCAD, MicroStation, CADKEY, Cimatron. The newest systems created especially for operation system WINDOWS are: SolidEdge and SolidWorks. Example of pipeline component design by system Cadkey is shown on Fig. 1.

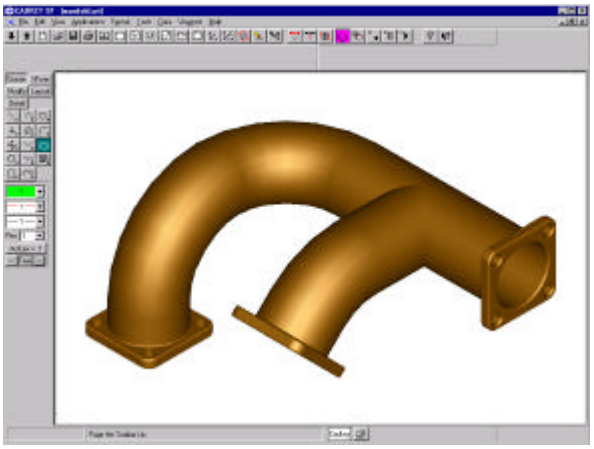

Fig. 1 Design of pipeline component in system Cadkey

3. *Big CAD/CAM systems*
   We can place here complex CAD/CAM systems, which were created mainly for workstations. In present time it is possible to use them on PC´s. These systems provide not only design stage including the possibility of various types of analysis, but production stage too (CAM). There are following systems in this group: CATIA, EUCLID, Pro/ENGINEER, I-DEAS and Unigraphics.
4. *Plant Design Systems*
   These are the biggest of design systems. PDS are used mainly in area of projecting and building of technological units, in area of maintenance of production lines, for data and technical information maintenance, for serving of engineering nets in chemical and consumption industry and in energetic. PDS systems have the specialised application which helps create pipeline systems. Pipeline systems are created by components which are stored in catalogue base. PDS systems takes control in designing of pipelines, if the connection is proper (non-return flap valve, check valve etc.). System automatically complete pertinent pipeline with insulation and with heating between components takes care of possible collisions in space etc.
   Well known PDS systems are: Plant Design System by Intergraph, Plant Design Management System by CADCENTRE, PASCE by EA Systems, Plant/CMS by CSA, AutoPLANT (Rebis) and Plant Space (Jacobus Technology).

Architecture of modern CAD systems consist of a system of modules, from which is possible to create a whole configuration of system. Modules for sheet metal parts design make projecting easier in area of bended parts and arisen by penetration of several profiles. After the bended part is created the margin bends folds and flanges are added and then we can set thickness of material. Created part is possible to modify even the requested values of material thickness, bending radius, shape and discharging value are reached. Important function of these modules is automatically displaying of bended part in unrolled shape, what can be directly moved to system for NC production technologies (punching, flame cutting, laser cutting, jet cutting, plasma cutting). Self-evident is collision control in unrolling (overlap material), control for material cranking as the result of little bending radius, or control to possibility of tool damage and part deformations [10, 13].

Computer Aided Manufacturing of Pipeline System Components

History of CAM systems is dated from 50th years, when the draft of numerical controlled machines was designed. But establishing the draft of Computer Numerical Control (CNC) machines, which is dated

to 1970, enables wide progress in area of CAM systems. Because of the fact of using part geometrical data, which is possible to create in CAD system aimed for NC programs creating, the systems which arose in 80th years takes the area of computer aided design as well as computer aided manufacturing. These systems are marked as CAD/CAM systems [14].

CAM systems enables customers use them in area for preparing of data and programs for numerically controlled machines and also for automatically manufacturing off parts, assembly systems, circuits etc. Above all these systems use geometrical and other data, which were reached out in stage of computer aided design from CAD systems. The most worked out sphere of CAM systems is Numerical Control (NC) manufacturing sphere. This is the question of techniques where the NC programs are used, e.g.: lathes, milling machines, drilling machines, bending machines, gear grinding machines, conventional and nonconventional machines (water jet, laser, plasma), but also forming machines and pressing machines. There are two basic types of direction in numerical control. The difference is in the way of program storing. In the case of CNC (Computer Numerical Control) is control system of production device directly connected with local microcomputer, where the proper program is stored. The second, more modern case is characterised by flexible distributed control of such production machines from one centre - DNC (Distributed Numerical Control). Postprocessors are in many ways the part of CAM system. Postprocessor provides the translation of geometrical data which defines tool path. This path is accepted by control system of proper production machine. CAM system very often has postprocessor library for the most using control systems and also modules for simulation - animation of manufacturing. User can take control of running operations (its chronology), which are serviced on a part and check possible collisions (tool-part, tool-fixture).

CAM systems are maximally orientated on computer aided manufacturing and their part serving for design is on low level (enables user create only wire or surface models, but not volume models). In many cases they absolutely doesn't support the stage of CAD and models are taken over specialised CAD systems (e.g. SolidEdge, SolidWorks, Cadkey etc.). The most extended and the most quality special CAM system are of modular conception and enables creating of NC programs for 2 - 5 axis milling, lathe, wire cutting, devices for water jet cutting, plasma cutting etc. They have library of completed postprocessors and serves for translating of generated tool path to shape, which is understandable to control system of production machine. These systems also have modules simulation of production process on computer display, which helps to check faults in NC program (interference with model and tool, high speed feed of tool when model is machined, possibility to check model from various sides or in section) [4].

EDBTS 11 - Computer Aided Design and Manufacturing System for Pipeline Components

As was mentioned in the last chapter, there are quiet a lot commercially offered CAD/CAM systems, which are characterised by high functional properties, but for many companies are out of reach because of the high price and high service costs.

In many cases are these CAM systems not used because they have functions which in area of pipeline components manufacturing (mainly parts cut from sheet metal with following shaping) are impossible to use. Many of pipeline component manufacturers use simple programs, which are not exacting on computer capacity and very often are realised on demand of user.

To these systems is also placed program EDBTS 11 created by workers of Faculty of Manufacturing Technologies of University of Technology in Kosice with a seat in Presov. This program is aimed for creating of control programs for BTS11 control system. Positioning devices are used as supporting device for cutting torch, laser heads plasma torches or torches for water jet cutting. Mentioned technologies of cutting are the most often used technologies in production of unrolled shapes of pipeline components from thin-walled sheets. Positioning device can be delivered by manufacturer on requirements of user with fix pick up or portables pick up. Accuracy of position of end part devices in range -0,2 to +0,2 mm and when

the program is read second time, it is read without deviation. Device consists of main axis (co-ordinate x), on which are with several rolling guides positioned trucks. The direction of the motions is perpendicular on themselves. On transversal path is placed tool plate which has clamp for torch or pneumatic vertical support with clamp of torch. Propulsion of both axes provides one-way servomotor with integrated digital sensor for scanning of position and for speed control. Device is operated by control system BTS 11, which enables manual operation and program mode [11, 12].

For effective program creating for unrolled shapes component cutting from sheet metal was created special program EDBTS 11. Used coding language was Turbo Pascal 7.0 and it is able to provide it on personal computers PC 486 or Pentium with installed operation system WINDOWS 95 and higher. It serves mainly for automated generating of programs for production of pipeline systems components (mainly normal, respectively under certain angle of lead direction pipeline securing).

When the program runs, at first we can see opening dialogue window (Fig. 2) where the user must choose the type of productioned component (T-main segment, T - connectivity segment, knee-joint-segment in knee, knee-joint-pipe segment). After choosing of certain option then is displayed other dialogue window, which is presented by form for entering of input technological and dimension data. Dialogue window of program EDBTS 11 for entering of input data is shown on Fig. 3.

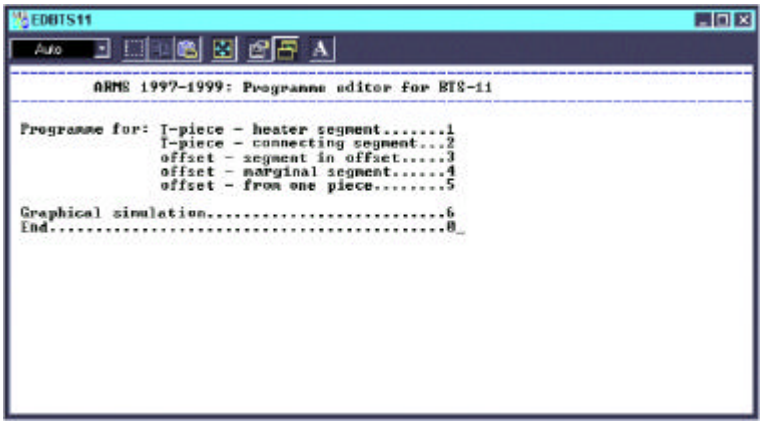

Fig. 2 Opening dialogue window of system EDBTS 11

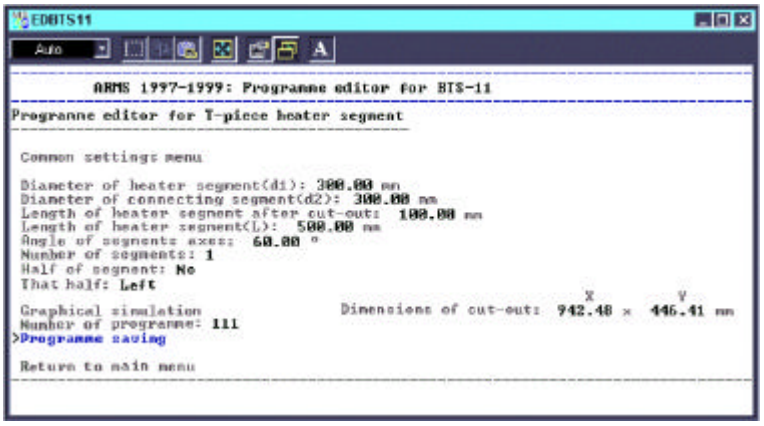

Fig. 3 Dialogue window of program EDBTS11 for entering of input data

The programme is automatically generated when the input data are entered and when the option "Program creating" is chosen. After this it is possible to check if the program is correctly generated. It is possible after graphical simulation of motioned cutting head on plotting device in reduced scale. Simulation of cutting head

in motion when the segment of pipeline component is cut is displayed on Fig. 4.

Fig. 4 Simulation of pipeline component cutting in program EDBTS 11

Designed environment for generating of chosen group of task enables creates also programs for pipe - knee parts from requested number of segments, respectively can be completed by other tasks, which will be requested by practice.

Conclusion

The most used CAD/CAD systems in present time are characterised by following marks: uses new forms of program implementation - property orientated approach (coding language C++ etc.); have modular structure; use mainly 3D modelling and techniques, modelling tasks, construction tasks, simulation and analysis tasks runs parallel (Concurrent Engineering) what helps reduce time of part planning and manufacturing; used data are not only geometrical but also technological and are unambiguous during all process of design complete and accessible for all applications; for data transmission is used new STEP - ISO standard; aided dynamical data exchange (between subjects in system); are opened from side of extending by new modules; it is possible to use them in Internet and intranet, too.

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