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COMPUTERIZED DATABASE DECISION MANAGEMENT SYSTEM IN PRODUCTION TRAVELER SHEET

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ABSTRACT

A production traveler sheet is a document which is filled by people, records how a product is manufactured and how many steps need to be followed during the process period. Problems arise when manual work is negatively impacted because production traveler sheet are either deficient, incomplete and time consuming. In this paper a production traveler sheet shows how aircraft skin is assembled and traveled. A lean tool, value stream mapping and computerized database management system were used to analyze the production traveler sheet for automatic assembling of aircraft skin. Through the application of lean concept and computer database system, lead time saving and manufacturing efficiency are obtained by reducing or eliminating non-value activities and process time.

INTRODUCTION

Automatic drilling and riveting technology is one of the newly developing technologies under the requirements of the automatic assembling of the aviation manufacturing industry.

It has been widely applied in the automatic assembling of aircraft skin. However, during the manufacturing process, lots of data, such as the rivet brand, the federate, the milling parameters, etc. Traditional paperwork has to deal with large amount of data which can be very complicated and easily misused.

Computer database systems can overcome the problems that the traditional paperwork database system might encounter. Computers are the new age primary information management tool. A computerized database system can easily provide not only the information for customers, but also help the manager to understand the process status and to control product quality. Production Traveler Sheet (PTS) is the documentation that records all the processing data need to be collected by each station in making a product.

Problem Statement

- Businesses may encounter difficulties in dealing with the huge amount of daily information in business.
- Without computer application systems lots of time, effort, and paper are spent on data-collection.
- Difficult to track information with traditional paperwork:
  1. When will the process be done?
  2. How is the process going?
  3. Which station is the product in process now?

Objectives

- To produce a Production Traveler Sheet (PTS). This is done by using computer application software to develop a Database Decision Management System (DDBMS) that can produce PTS.
- Main Benefits:
  1. To easily track information for customer order as the result of improved adherence to schedules
  2. Faster response to market changes
  3. Improved utilization of facilities and labor

LITERATURE REVIEW

Automatic Riveting Database

Aircraft includes plenty of panels. These parts are assembled by automatic drilling and riveting system to improve their assembly efficiency and accuracy. Their assembly is so complex and difficult. In order to improve the assembly efficiency and accuracy, assembly sequence for automatic drilling and riveting process must be optimized.

At present, automatic drilling and riveting sequences are decided by engineers experience. The experience cannot effectively improve riveting assembly efficiency and make it be optimal. Several researchers have done lots of work in this field.

Xiao Hong etc have developed a new multi-objective optimization method based on ant colony optimization (ACO) to optimize the automatic drilling and riveting sequence. The multi-objective optimization model of automatic drilling and riveting sequence planning is built considering two objectives, efficiency and precision. The cost of time and the precision of automatic drilling and riveting are described by means of the points coordinates [1].

Moreover, in order to fully understand the distribution of residual stress and the relationship between residual stress and process parameters during riveting process, lots of researchers have done FEM calculations based on some software, such as ABAQUS, ANSYS, Deform, etc. Some advanced optimization methods for improving the accuracy and efficiency were also proposed [2–5].

However, due to the database development which can be used to organizing and managing the parameters, little research has been devoted to it.

Riveting Technology

The riveting technology is widely used in the aircraft industry. In recent years, new techniques were developed in joining by metal forming. Jacek Mucha analyzed the shearing strength analysis of single-lap joints made by self-pierce riveting with a solid rivet for various joining parameters [6].

Chen etc. [7] recalled some results on the riveting process and the strength of one kind of riveted joints obtained by simulation and experimental investigations in a previous paper. The numerical results were in very good agreement with the experimental results. Curran etc. [8] used Knowledge Optimized Manufacture And Design (KNOMAD) to design the manufacturing process which include the riveting process.

The riveting technology is a common used technique, in 2013, there were over 1000 papers published all over the world to discuss this technology. Most of them were about the process optimization and process simulation. Few references were about the parameters optimization and management based on lean-six sigma and database.

Database Technique

A database is an organized collection of data, Database management systems (DBMSs) are specially designed applications that interact with the user, other applications, and the database itself to capture and analyze data. A general-purpose database management system (DBMS) is a software system designed to allow the definition, creation, querying, update, and administration of databases. Well-known DBMSs include MySQL, PostgreSQL, SQLite, Microsoft SQL Server, Oracle, SAP, dBASE, FoxPro, IBM DB2, LibreOffice Base and FileMaker Pro. A database is not generally portable across different DBMS, but different DBMSs can interoperate by using standards such as SQL and ODBC or JDBC to allow a single application to work with more than one database.

The database used in manufacturing process is a hot topic not only in industry, but also in IT industry. Since the development of IT techniques, some database techniques are widely used in manufacturing process to manage and organize the data.

Product variation, market competition, globalization, product customization, product diversification, etc., are the major challenges facing manufacturing enterprises in the 21st century. They are in a quandary because those issues work at the core of product design along with environmental characteristics. A product after manufacturing in terms of poor performance, emergent behavior, and high cost tend to company liquidation [9].

A.S.M. Hoque [10] has develop an intelligent system for manufacturing features in the area of CAD/CAM. It brings the design and manufacturing phase together in design stage and provides an intelligent interface between design and manufacturing data by developing a library of features.

There is an interesting topic about the database development is the negative database generation. Negative Representation is inspired by Artificial Immune System. Different from the general information representation, Negative Representation stores the contents not in the positive database to represent the original information. Negative Databases (NDB), which is a form in Negative Representation, is very promising in information security and privacy protection. Different from the positive databases, the negative databases store the compression form of the complementary set of the positive databases. Presently work indicates that NDf3s are equivalent to SAT formulas. Liu Ran [11] from The University of Science and Technology of China has developed the negative database used in information hiding, privacy data collection and negative authentication in his Ph.D. dissertation. It can be a useful tool for developing our riveting database.

Another developing direction of the manufacturing database is the Expert System. An expert system is a computer system that emulates the decision-making ability of a human expert. Expert systems are designed to solve complex problems by reasoning about knowledge, like an expert, and not by following the procedure of a developer as is the case in conventional programming.

Mmtaz Ipek [12] tried to solve the materials selection prob-

lem by means of an expert system approach to manufacturing. There are lots of reports about expert system and its applications can be found in Springer and Science direct, even in ProQuest. However, in my opinion, as an artificial technology, expert system cannot replace the expert in real production process, for some experts dont want to share their experiences and knowledge due some reasons.

METHODOLOGY

In order to offer their internal and external customer a better service and utilize of facilities and labor, a lean manufacturing method is proposed in this paper in which waste could be eliminated. In this case, the application of VSM could be a better way to show processes.

The VSM is a lean tool that using a current sate map indicates areas of waste and improvement to suggest a future or idea state map incorporating those improvements

Current State Map

Approach The steps involved in the development of PTS are as follows:

Step 1. Study case-studies in the literature and developing a procedure to solve the problems those are most relevant to this case-study.

Step 2. Understand the manufacturing process: Study current system and talk to other departments for their needs to be incorporated into this system.

Step 3. Development of the computerized data module: Define the structures of the tables and make the relationships related to each other.

Step 4. Collection and verification of data information: Collect and input all the data collected and test the verification of this computerized database module.

Step 5. Development of user interface: Design forms and reports in a manner that will help the user in his decision making process by providing the information in any desired format.

Database System A database system is a computerized record-keeping system kind of like an electric filing cabinet. There is a variety of potential operations can be performed on the files of which some are listed below:

- adding new, empty files to the database;
- inserting data into existing files;
- retrieving data from existing files;
- changing data in existing files;
- deleting data from existing files;
- Removing existing files from the database.

To better establish the process and to obtain potential problem areas, the flowchart shown in Fig. 1 was formulated that outlined the basic steps in drilling and riveting process.

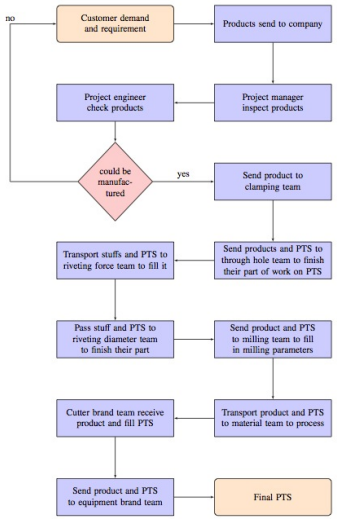


FIGURE 1: Process flowchart for existing drilling and riveting

Eight types of waste and description are listed in Table 1 which presents actual example and recommended causes of each type of waste.

The activities from the process flowchart, the process time, lead time and the summary of the possible areas of improvement is shown in Table 2 Lead time is the total time is takes to filling PTS from the time it is received to the time the results of the PTS are given to next department. It is estimated using calendar days (CD). CD include both working and non-working days. Processing time (PT) is the actual time that the PTS is either dealt with, or handled. It is measured by hours (HR) and days (D).As indicated, there is the possibility for improvement in each of activities.

Future State Map

As illustrated in Table 1, there are eight major types of waste. To be specific in aircraft assembling process, Table 3 shows the primary activity, the lean tool recommended for improvement, and how the tool can be used for improvement.

Any of processes in the current state map could reduce waste in the aircraft assembling process. A Database system management in production traveler sheet was applied aimed to easily track information for customer order as the result of improved adherence to schedules. It could faster response to market changes and improved utilization of facilities and labor. The revised process flowchart incorporating the lean concepts is shown

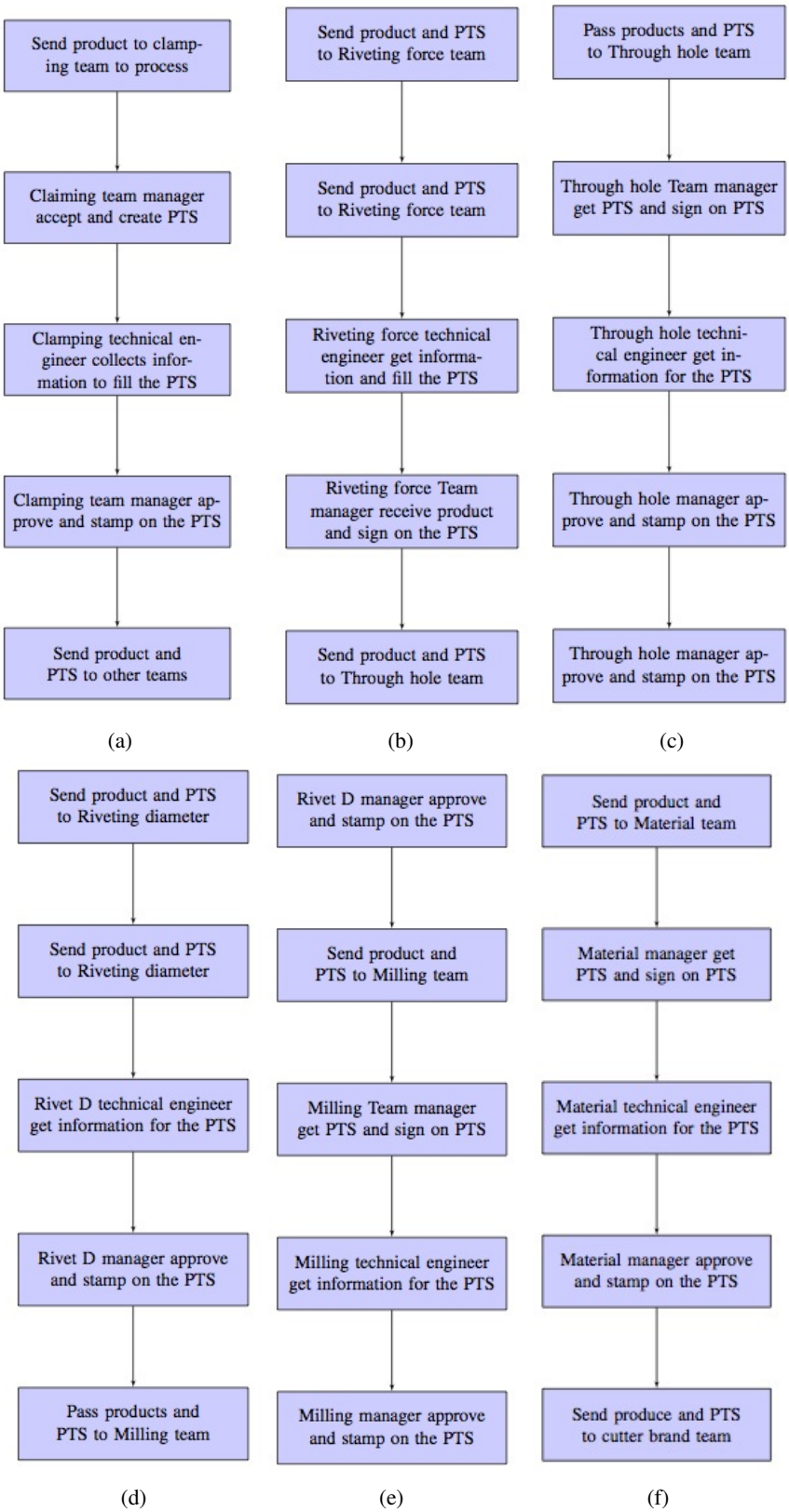


FIGURE 2: (a)Claiming force, (b)Riveting force, (c)Through hole diameter, (d)Rivet diameter after riveting, (e)Milling speed, (f)Materials

TABLE 1: Types of wastes and possible causes

Type of waste	**D**escription	**E**xample	**Possible causes**
Overproduction	Producing work prior to its being needed or producing more work than is needed	Redundant reviews Excess paperwork	Routing approval form and letter within office
Waiting	Any time period where any resource is not being used	Waiting for comments from manager and technical engineering	Sending PTS to someone who is unavailable in office
Transportation	Moving a resource from one place to another or requiring a lot of motion to perform an activity	Aircraft skin is moved from one department to another department with PTS	RDifferent teams are located in the different places and need a lot of motion to move products
Unnecessary processes	Activities that are non-value -add	Activities that are non-value -add	Preparing routing approval form and letter within office
Inventory	Assets or resources that are unused or waiting	Assets or resources that are unused or waiting	People in different department has large workload and prioritized other work instead of filing PTS
Unnecessary movement	Multiply methods, approaches, paths, or tools for performing the same work	Multiply methods, approaches, paths, or tools for performing the same work	Filling PTS are done by more than one engineer. Different people use individual mark and abbreviation
Defects	Any error that occurs	Some mistakes during the filling PTS	A lot of drawing and table need to be review in order to filling the PTS, heavy workload will lead to some slight mistakes
Underutilized people	Not using peoples mental, creative, and physical abilities	Unbalanced workloads and low-level personnel performing the PTS	Lack of training

as Figure. 3.

Database System Design

These processes that are given in database selection include:

1. User Management in the Riveting Department: Administrator and Users
2. Drilling Parameters Management:
   (a) Bit speed (rpm): Max Speed and Min Speed
   (b) Bit feed speed: Max Speed and Min Speed
   (c) Bit approach speed: Max Speed and Min Speed
   (d) Hole diameter: 3/16 Type; 1/4 Type; 5/16 Type; 3/8 Type
   (e) Surface smoothness
   (f) Burr height
3. Riveting Parameters Management:
   (a) Claiming force
   (b) Riveting force
   (c) Through hole diameter: 3/16 Type; 1/4 Type; 5/16 Type; 3/8 Type
   (d) Rivet diameter after riveting: 3/16 Type; 1/4 Type; 5/16 Type; 3/8 Type
   (e) Milling speed
4. Ideal values SQL query
   (a) Standard query
   (b) Hole diameter query: 3/16 Type; 1/4 Type; 5/16 Type; 3/8 Type
   (c) Unit exchange
5. Manufacturing Parameters establishment
   (a) Equipment brand set up: Upper board of outer wing; Lower board of outer wing; Upper board of mid-wing; Lower board of mid-wing
   (b) Materials set up: Upper board material; Lower board material; Upper skin material; Lower skin material
   (c) Cutter brand set up: -24 cutter; -18 cutter
   (d) Rivet brand set up: 3/16 Type; 1/4 Type; 5/16 Type; 3/8 Type
6. Post Riveting Operations
   (a) Inspections:
      i. Check internal riveting reinforcement removal
      ii. Check surface roughness measurement
      iii. Check board reinforcement removal
      iv. Check skin reinforcement removal

TABLE 2: Current state map - possible opportunity of improvement

Process	**P**rocessing time	**L**ead time	**O**pportunity for improvement
Company receives costumer request	2HR	2CD	Yes
Project manager and project engineer check products	4HR	3CD	Yes
Transportation of stuffs from manager to clamping team	3HR	1CD	Yes
Clamping team creates a PTS and fill it by hand	8HR	3CD	Yes
Pass stuffs from Clamping team to Riveting force team	3HR	1CD	Yes
Riveting force team receives stuffs and fill PTS by hand	7HR	3CD	Yes
Delivery the PTS to Through hole team	3HR	1CD	Yes
Through hole team gets stuffs and fill their work in the PTS by hand	7HR	3 CD	Yes
Pass stuffs to Rivet diameter team	3HR	1CD	Yes
Rivet diameter team receives them and finish a part of PTS by hand	6HR	3CD	Yes
Transportation from Rivet diameter team to milling team	3HR	1CD	Yes
Milling team gets PTS and fill it by hand	8HR	3CD	Yes
Milling team sends stuffs to material team	3HR	1CD	Yes
Get enough information to fill the PTS in the material team	6HR	3CD	Yes
Delivery the PTS to Cutter brand team	3HR	1CD	Yes
Cutter brand team receives stuffs and work on their part in the PTS	5HR	3CD	Yes
Pass stuffs to Equipment brand team	4HR	1CD	Yes
Equipment brand team gets stuffs and finish PTS	5HR	4CD	Yes
Final PTS	3HR	1CD	Yes

TABLE 3: Lean office tools used to develop solution

Primary element	**T**ool	**U**sage
All office activities	5S	Keeping desk clear and organized in order to know what work has to be done in a short time
Transportation between different department	SOP	Move the product(aircraft skin) in a integration workshop
Each department Manger approval	Just in time	Make sure to send PTS to their office when they are there
Technical engineers in each department work on the PTS separately and Pass it between them	Database system management	Using one database to let them work together and improve the efficiency
Defect of handwriting	Database system management	Avoiding typo by using computer database in which some parameters are already put inside

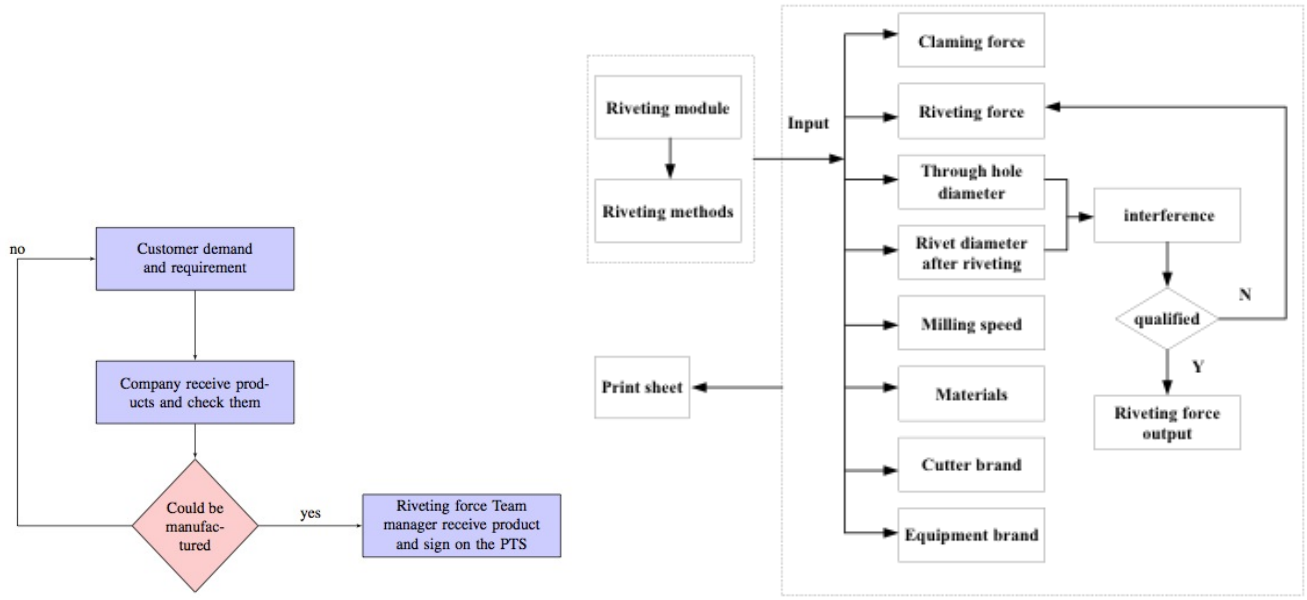
v. Check board displacement

7. Excavation Data

(a) Examine: rivet; board; skin
(b) Optimal: Bit feed speed; Bit speed; Bit approach speed

In designing the PTS a conceptual, logical and physical model is constructed in descending steps the basic order is shown in Figure 2.

Microsoft Access, also known as Microsoft Office Access, is a database management system from Microsoft that combines the relational Microsoft Jet Database Engine with a graphical



(a) (b)

FIGURE 3: Revised process flowchart by using database system management

user interface and software-development tools. It is a member of the Microsoft Office suite of applications, included in the Professional and higher editions or sold separately.

Microsoft Access stores data in its own format based on the Access Jet Database Engine. It can also import or link directly to data stored in other applications and databases.

Microsoft Access is used as the DBMS for the development of the computerized PTS. Visual C++ code is added to the database so that menus, toolbars, and other features can be customizable.

Microsoft Access features:

- It contains the queries, forms, reports, and macros necessary to display the data in a meaningful way and to update the data as necessary.
- It does not require the databases users to know how to design any of its elements. All elements of the database are fully predefined during the applications design stage.
- It is automated by VBA code, so that users can make choices from command buttons or custom-designed menus rather that from the lists in the database window.

Internal Design:

1. Descriptive tables store identifiers such as ID numbers and full names: rivet tables; material tables; project tables
2. Transaction tables record data about events or activities: Rivet Selection and Manufacturing Transaction Tables, Rivet to Board and Skin Transaction Table
3. Other tables include the rest of operations such as inspections and excavations: Post riveting operation table, Inspection result table, Excavation data table
4. Relationships are connected by the primary keys in each table
5. Queries: Query for summarizing transaction tables, Query for tracking riveting status

RESULTS AND DISCUSSIONS

User Interface: Designed to provide a convenient and easy way for the user to enter information and data into the database system

1. Design consideration guidelines (Design the system in a menu-driven fashion where the user can select the function he/she wants to perform at any given time just selecting that button. Design the system in a manner that the input to be entered needs only to be in the form of simple numbers. Provide the user with various options that he/she can choose from to perform different tasks. Set default values for the inputs the first time a file is selected in the system.Design the output reports in a manner that would help in the decision making process.)
2. Main Menu:
   (a) Open the PTS(Worker key information and data)
   (b) Display the database window(Password for authorization, Manager can modify)

TABLE 4: Comparison of Current State and Future State Data

Process	**C**urrent state map	**F**uture state map	**Difference**	**N**otes
Company receives products and check them	5 Days	3 Days	2 Days	Combined the two activities in to one
Transportation of stuffs from manager to integrated workshop	1 Days	0 Days	1 Days	Products are put in integrated workshop
Clamping team enter database and select their parameters then save it by computer	3 Days	2 Days	1 Days	Through Database it is convenient to select clamping parameter from limited data
Pass stuffs from Clamping team to Riveting force team	1 Days	0 Days	1 Days	There is no need to transportation
Riveting force team receives stuffs and fill PTS	3 Days	1 Days	2 Days	Get Rivet force information from the limited data costs less time by Database
Delivery the PTS to Through hole team	1 Days	0 Days	1 Days	There is no need to transportation
Through hole team gets stuffs and fill their work in the PTS	3 Days	1 Days	2 Days	Get through hole information from the limited data costs less time by Database
Pass stuffs to Rivet diameter team	1 Days	0 Days	1 Days	There is no need to transportation
Rivet diameter team receives them and finish a part of PTS	3 Days	2 Days	1 Days	Through Database it is easy to choose riveting diameter parameter from limited data
Transportation from Rivet diameter team to milling team	1 Days	0 Days	1 Days	There is no need to transportation
Milling team gets PTS and fill it	3 Days	1 Days	2 Days	Milling team gets PTS and fill it
Milling team sends stuffs to material team	1 Days	0 Days	1 Days	There is no need to transportation
Get enough information to fill the PTS in the material team	3 Days	1 Days	2 Days	Get material information from the limited data costs less time by Database
Get material information from the limited data costs less time by Database	1 Days	0 Days	1 Days	Get material information from the limited data costs less time by Database
Cutter brand team receives stuffs and work on their part in the PTS	3 Days	1 Days	2 Days	Choosing cutter brand parameter from the Database is not time consuming
Pass stuffs to Equipment brand team	1 Days	0 Days	1 Days	There is no need to transportation
Equipment brand team gets stuffs and finish PTS	3 Days	1 Days	2 Days	Through Database it is easy to select equipment brand information
Final PTS	1 Days	0.5 Days	0.5 Days	Database will create a final PTS when all the parameter information is given

(c) Generate reports(Password)
(d) Computerized PTS database system

The user interface of the Automatic Drilling and Riveting System is shown in Figure. 4a, which represents the mainframe of the system. Fig. 4b and Figure 6 show the different function of the database. Fig. 4b shows the logging UI, only the users enter the name and password correctly can have the access to the database.

Fig. 4c shows the interface of the setup of equipment brand. Users can add, delete, and update the rivet brands.

Figure. 4d shows the detail information about drilling parameters.

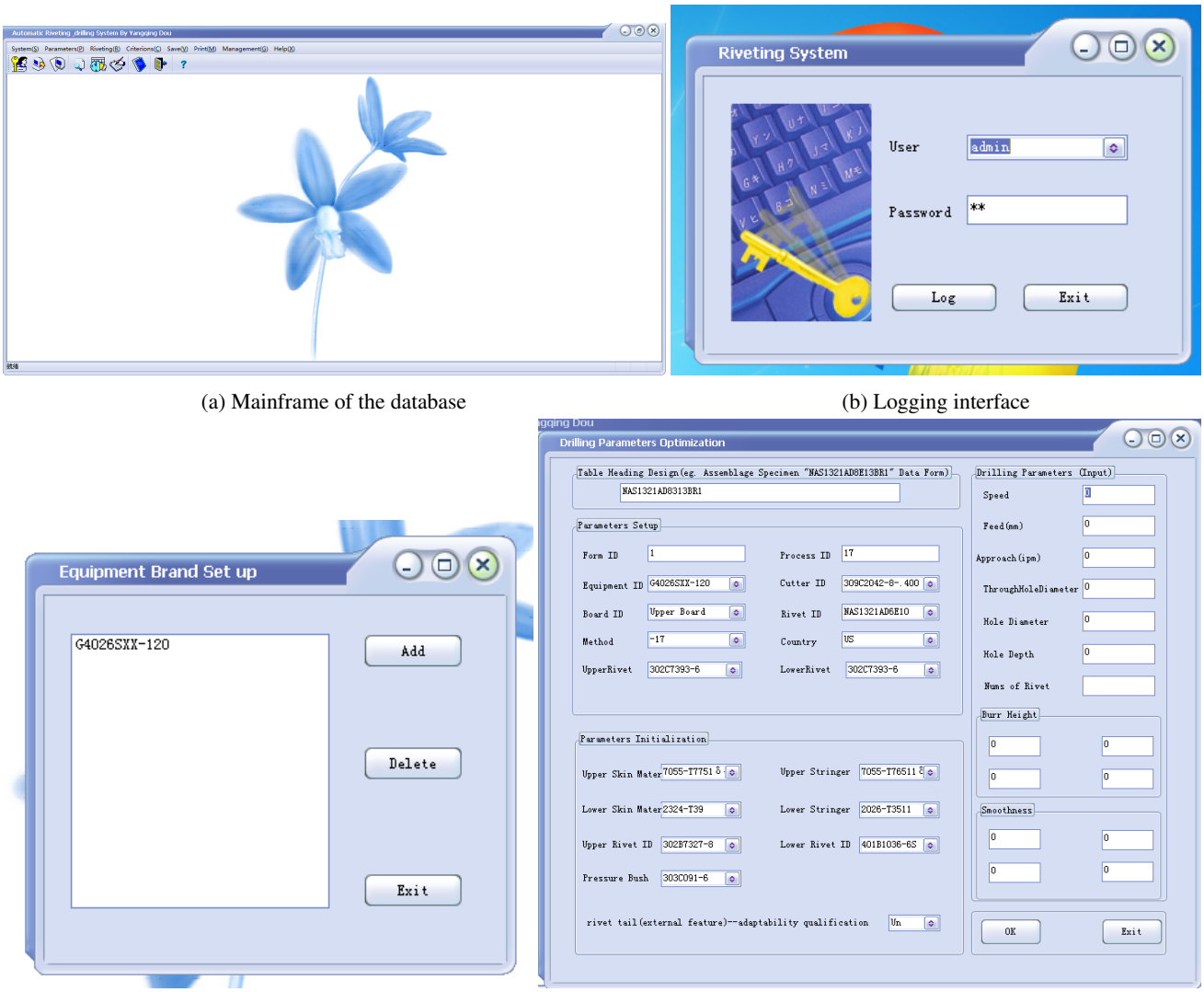
TABLE 5: Summery of improvement

Metric	**C**urrent State	**F**uture State	**I**mprovement (%)
Lead time	38 Days	13.5 Days	64.5
Number of activities	18	10	44.4

The effects of using database system management in production traveler sheet impacted lead time, process time, and number of activities. Table 4 is the comparison of the current and future state activities and associate time. The difference of time and activities are displayed. Table 5 demonstrated the improvement of future state. The lead time decreased from 38 calendar days to 13.5 calendar days, an improvement of 64.5%. The number of activities decreased from 18 to 10. In order to identify what kind of activities has been eliminated or reduce, Table 6 is shown the detail information

CONCLUSION

The result of this case study indicates the application of lean concepts to the aircraft assembling can reduce or eliminate non-value activities. Measureable improvements were achieved in the amount of lead time, process time, and the number of activities. By using the Database system management, a lot of non-value activities have been eliminated. The lead time decreased about 64.5%. The number of activities in the process was reduced from



(a) Mainframe of the database

(b) Logging interface

(c) Setup of rivet brand

(d) Drilling parameter

FIGURE 4: A Production Traveler Sheet (PTS) is designed using several manufacturing processes

18 to 10.

This paper proposed a database system management which could Track information by entering the project number is a far better system of control than following a paper trail.The user can write some queries and generate a report that can be used in making decisions. These reports can be cross referenced with actual paper trails to assure consistency. Once proven accurate report generation can be looked at as a self-controlling apparatus. The user can print all the process data with only one click. That bears more weight than the normal tradition way. Through the application of lean concept and computer database system, lead time saving and manufacturing efficiency are obtained by reducing or eliminating non-value activities and process time.

For further research, it could be further in four directions:

- Barcode reader could be implemented that allows data to be collected rapidly and with extreme accuracy.
- Security features could be enhanced allowing clean separation between general user and administrative or managerial access.
- A more flexible and adaptable design allowing a wider range of applications within the same system.
- Enhancing the user interface by interconnecting the data in ways that allow more ways for the user to acquire all relevant data about a particular part.

TABLE 6: Reduced activities

Reduced activities	**R**educed time	**S**pecifics
Company receives products and checks them	2 Days	Combined the two activities in to one
Clamping team enter database and select their parameters then save it by computer	1 Day	Through Database it is convenient to select clamping parameter from limited data
Riveting force team receives stuffs and fill PTS	2 Days	Get Rivet force information from the limited data costs less time by Database
Through hole team gets stuffs and fill their work in the PTS	2 Days	Get through hole information from the limited data costs less time by Database
Rivet diameter team receives them and finish a part of PTS	2 Days	Through Database it is easy to choose riveting diameter parameter from limited data
Milling team gets PTS and fill it	1 Day	From limited data which existed in Database pick up the milling parameter
Get enough information to fill the PTS in the material team	2 Days	Get material information from the limited data costs less time by Database
Cutter brand team receives stuffs and work on their part in the PTS	2 Days	Choosing cutter brand parameter from the Database is not time consuming
Equipment brand team gets stuffs and finish PTS	2 Days	Through Database it is easy to select equipment brand information
Final PTSl	0.5 Day	Database will create a final PTS when all the parameter information is given
Transportation between different department	1 Day	There is no need to transport

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