RESEARCH PAPERS
FACULTY OF MATERIALS SCIENCE AND TECHNOLOGY IN TRNAVA
SLOVAK UNIVERSITY OF TECHNOLOGY IN BRATISLAVA

2020 Volume 28, Number 47

PROCESS SCHEDULE OF MATERIAL FLOW ACTIVITIES IN iCIM 3000

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Received: 25 August 2020, accepted: 4 November 2020, published: 27 November 2020

Abstract

When the modeling production or assembly processes, it is decisive to choose the type of model that allows the process to be simulated as efficiently as possible. The technical preparation of production must respect the impact of randomly changing the order conditions and, at the same time, specific working conditions. The complexity of such a system can be modelled using simulation models. These simulation models can be designed based on the work algorithm of the production line in question. An algorithm is a finite sequence of well-defined instructions to accomplish a task. The final solution to the concept of a flexible production and assembly system will be to design a simulation model; algorithm is part of this simulation study.

Key words

Flow chart, simulation model, production system, assembly system, material flow

INTRODUCTION

The simulation is not a tool that allows you to directly obtain the optimal material flow. Simulation modeling is rather a support tool that the researcher needs, especially when the process is complex and a larger number of options is available to perform it. The simulation helps to select the optimal technology based on the output values of the individual variants. The designer uses a tool that allows the optimization of the course of individual processes on the basis of reliable and reality-friendly data, which leads to an increase in efficiency level of the overall process. In this paper are analysed basic properties of flexible manufacturing systems to the assembly system iCIM 3000. Generally the simulation increase the effectiveness of the system.

The simulation makes it possible to analyse critical points also in the process of assembly or technical preparation of production. One of the simulation tools is a flow chart. The elaboration of the iCIM 3000 material flow algorithm is to precisely define the material movement according to the specified input conditions, and to use the given algorithm in the analysis of a flexible production assembly system.

FLEXIBLE MANUFACTURING SYSTEMS

Utilisation of information technology in all activities of the production or assembly process is important for the automatic monitoring of the technological process.

Logistic modifications in manufacturing process can be accomplished according to the particular criteria and assessments of several variants of possible modifications. To be effective, the choice of modification is conducted by team of experts interested in the material flow study using various logistics methods and simulation programs. Selection of a suitable method or simulation program depends on specific conditions of manufacturing processes.

Selection of manufacturing systems

At present, there are several types of flexible manufacturing systems that can be divided into several divisions. Figure 1 shows division of flexible manufacturing systems.

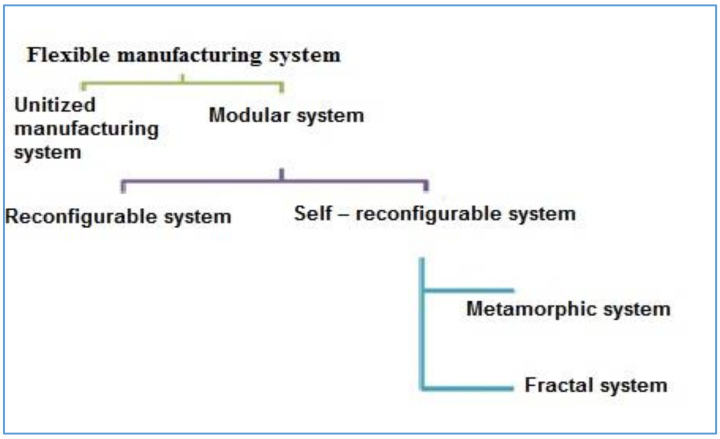


Figure 1 *Classification of flexible manufacturing systems*

Following are the definitions of the most important and the most widely-used types of manufacturing systems:

- Flexible manufacturing system – a functional configuration of manufacturing devices that are related to the material and information flow, to enable the effective production of a small number of particular products.
- Unitized manufacturing system – a flexible configuration of compatible elements and their mutual relations, enhanced by new elements with intention of the system parameters modifications.
- Modular system – a flexible configuration of unification modules of functional logical configuration into a higher level functional entity.
- Reconfigurable system – a modular system with configuration ability of its own modules to create an innovated system.
- Self – reconfigurable system – a reconfigurable system that is able to independently its own module configuration to create an innovated system.
- Metamorphic system – a closed self-reconfigurable system.

DOI 10.2478/rput-2020-0013

- Fractal system – an open self-reconfigurable system that consists of ProActive elements (fractals). Their structure repeats and monitors mutual aims [1].

iCIM 3000 FLEXIBLE MANUFACTURING ASSEMBLY SYSTEM

Production system is a process with all the activities, processes and equipment necessary for the preparation of production and the production of the specified production object. All production objects, such as tools, support, loading facilities, equipment, devices and machines, have to communicate with each other and be operated in coordination with all movements and steps. Their communication depends on their interconnected relationships [7]. The iCIM 3000 is a flexible production system, which consists of the devices combined into one unit, such as a control station, assembly station, automatic storage system and the CNC machines, which include a CNC milling machine and a CNC lathe. These devices are connected by a pallet conveyor system carrying the base plates of the so-called carrier with the workpieces located on it, as shown in Figure 2 [2].

Internal subsystem of manufacturing process is divided into:

- Technological subsystem – consists of all production machines and devices that perform technological operations producing the technology of production object.
- Transport and manipulation subsystem –consists of all devices performing manipulation with all material objects related to the production implementation of the object in a specific manufacturing system.
- Storage subsystem – consists of all devices performing the operational storing of all material objects related to the production implementation of the object in a particular manufacturing system.
- Control subsystem – consists of all devices and elements that participate in control of quality production capacity and in accuracy control of activity of every manufacturing system.
- Directing and information subsystems – consist of all facilities (HW, SW) participating in directing and controlling- informational provision of manufacturing system [3].

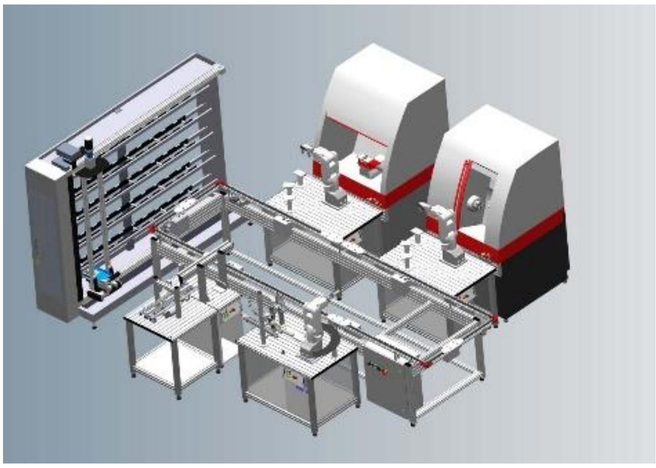


Figure 2 *Flexible manufacturing system* ***of*** *iCIM 3000*

We need to know the exact workpiece support of the manufacturing–assembly system for a convenient design of material flow. We should also answer the following questions [4]:

1. What do we have to produce? (To assemble?)
2. How much and what do we have to produce? (To assemble?)
3. What is the cost structure of production? (Of assembly?)

Optimization of manufacturing process can be performed by using a flow chart. Manufacturing process workflows, or flow charts, detail the granular activity-level steps that must be completed to create finished goods from the time raw materials are received at the manufacturing facility until those materials are turned into finished goods. Companies in all manufacturing industries constantly look for the ways to achieve continuous process improvement (e.g., Lean Six Sigma, Total Quality Management, Just-in-Time Production, etc.)

Flow charts should be utilized to dictate efficient communication protocols among functional teams. The manufacturing and assembly stage includes setting up the facility for production runs and putting the materials through to completion. Flow charts of the production run allow you to measure KPIs (e.g., Defects Prior to Assembly, Product Mixing Time, etc.) for specific yet critical steps in the assembly process.

Workflow illustrates the generation of bills of materials based on production demand, and the subsequent staging and pre-treatment of those materials for eventual use in the manufacturing process [5].

The assembly configuration consists of five elements (Figure 3).

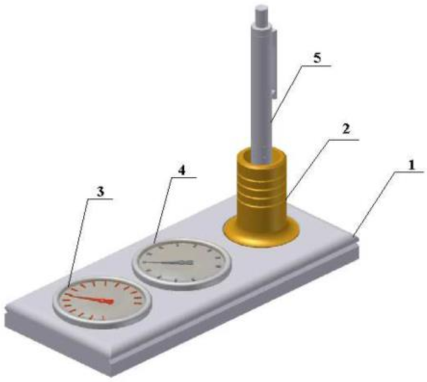


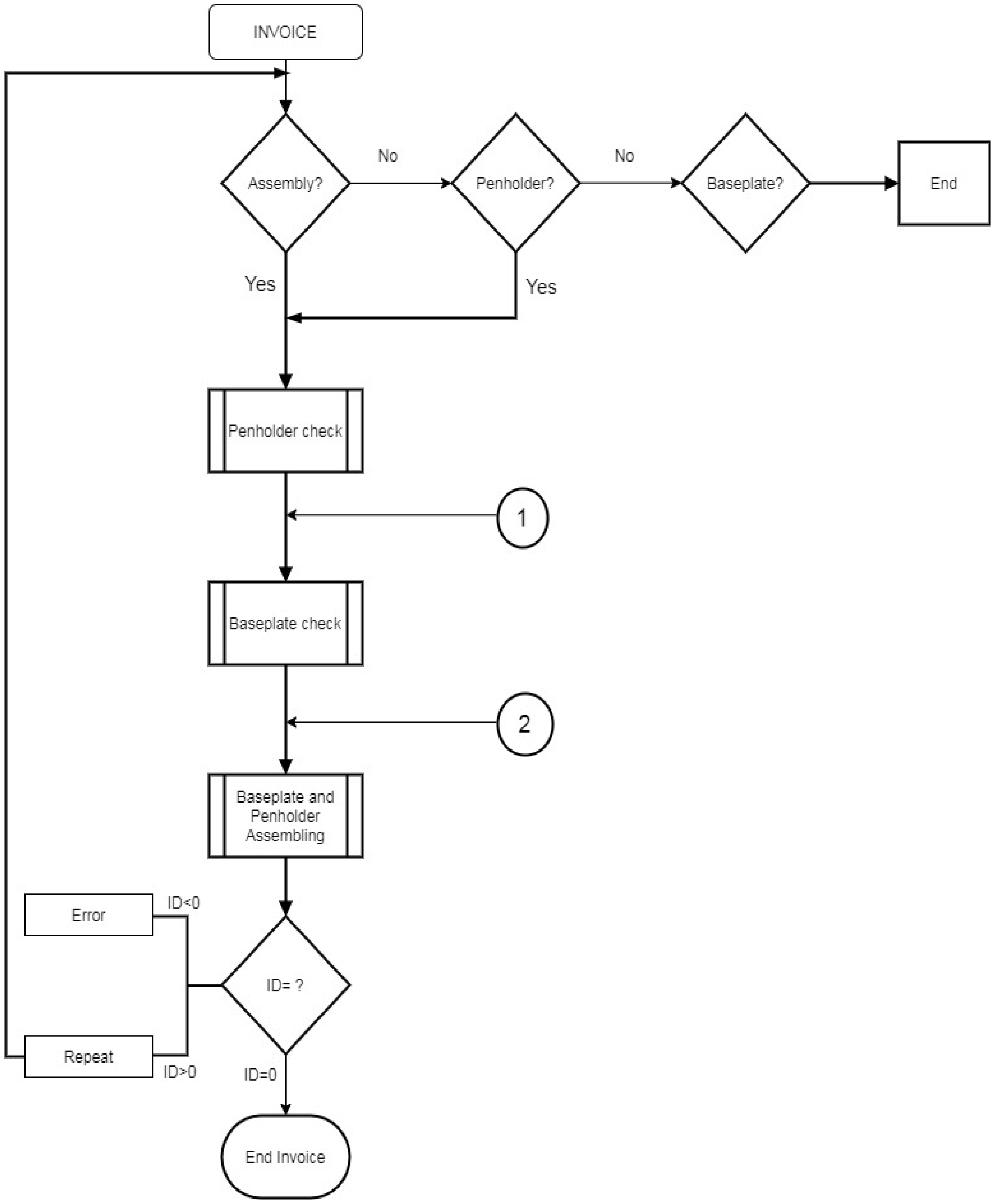
Figure 3 *Example of manufactured product in iCIM 3000*
1 – base plate, 2 – penholder, 3 – thermometer, 4 – hygrometer, 5 – pen

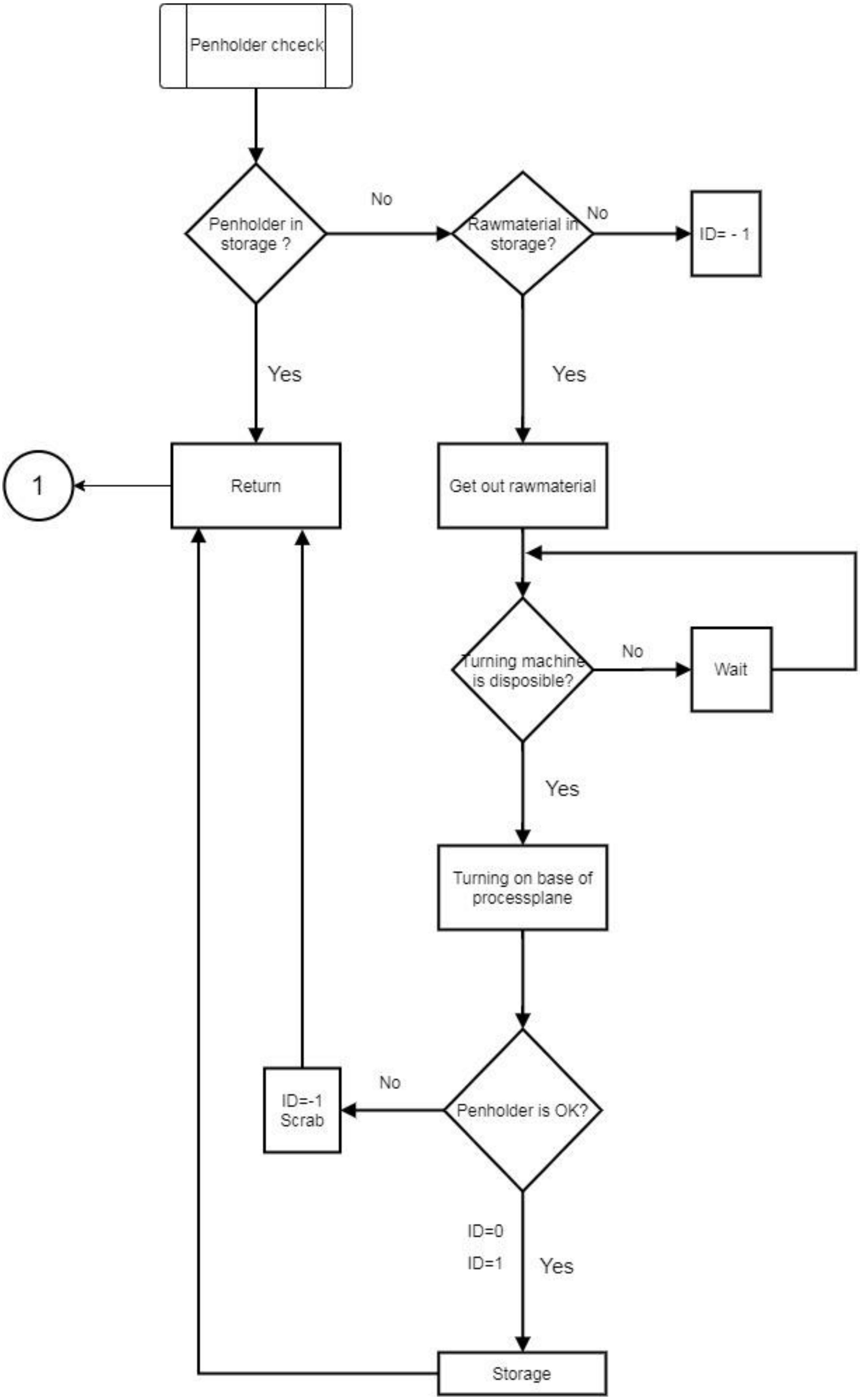
For a detailed analysis of the production assembly system, it is necessary to define a possible variant of the assembly. There can be several assembly variants, depending on the choice of the component from the rack stacker, conditioned by the initial order. The input material for use in the ICIM 3000 manufacturing process shown in Figure 4, which can vary during assembly.

Figure 4 *Workpiece for designing the assembly system variants*

FLOW CHART OF MANUFACTURING–ASSEMBLY FLOW IN iCIM 3000

The analysis of the production process by means of a flow chart serves to graphically represent the logical structure of the production process. The graphic expression should ensure easier orientation and understanding of the process operation.




Penholder chceck
Penholder in storage ?
No
Rawmaterial in storage?
No
ID= - 1
Yes
Yes
1
Return
Get out rawmaterial
Turning machine is disposible?
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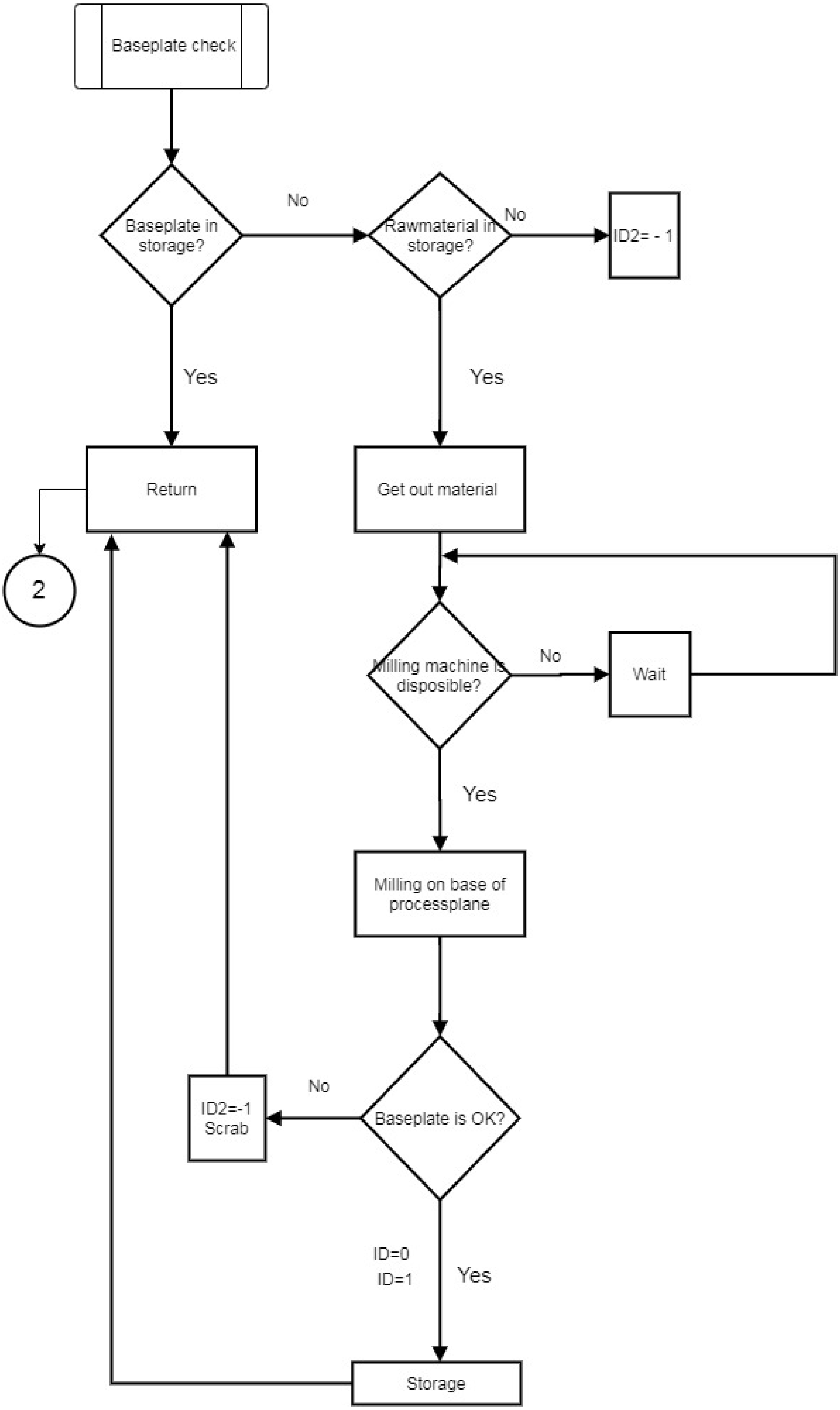
Wait
Yes
Turning on base of processplane
No
ID=-1 Scrab
Penholder is OK?
ID=0
ID=1
Yes
Storage



Baseplate check
Baseplate in storage?
No
Rawmaterial in storage?
No
ID2= - 1
Yes
Yes
Return
Get out material
2
Milling machine is disposible?
No
Wait
Yes
Milling on base of processplane
No
ID2=-1 Scrab
Baseplate is OK?
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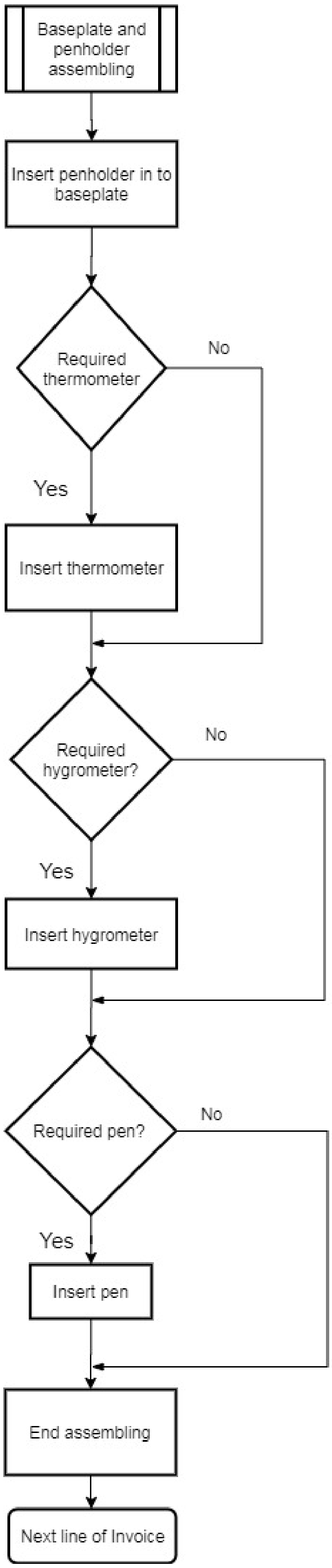

***Figure 5** Flow chart of production process in iCIM 3000*

DISCUSSION

When implementing the iCIM 3000 manufacturing-assembly system, the ideal condition of the activity description was used. However, after a real start-up and analysis of the activities of individual iCIM 3000 stations, several errors and problems appeared immediately. The entire manufactured assembly product was wrongly assembled, the pen fell out of the robot's gripper when being inserted into the pen holder, the control camera system did not detect the incorrect rotation of the thermometer or hygrometer, the robot incorrectly grabbed the pallet and the control system reported an error in the following step. Some problems were due to external effects, e.g. the problem of camera system related to specification of the correct orientation of thermometer and hygrometer. The problem depends on inconstant local conditions in time. Some of problems can be eliminated by interfering with the mechanical parts of the iCIM 3000, e.g. when the pen falls out of the robot's gripper, there is the possibility to change either the shape of the gripping part of the gripper or the pen. The problems are gradually dealt with in individual steps within the iCIM3000 system. In terms of those shortcomings and defects, it is necessary to unambiguously define and classify the sequence of individual steps of station operations in the manufacturing-assembly system.

CONCLUSION

During the real assembly of the iCIM 3000 manufacturing-assembly system, several errors and problematic steps arouse, bringing the whole system to the state of error or crisis, which was followed by other erroneous operations. After a thorough analysis of individual steps, operations and procedures, a step-by-step flow chart was prepared. According to algorithm determinism, in each situation, it must be clear what and how it is to be performed and how to continue the execution of the algorithm. The graphic expression should ensure easier orientation and understanding of the process operation. Based on the analysis performed using a flow chart, we will create a simulation model of the intelligent production system. The simulation model will be used to implement simulations of various material flow strategies within an intelligent production system, in order to optimize the work of the system. The aim of the final scientific study is to develop a simulation model. The proposed flowchart is only a part of the simulation study. It is also a part of the conceptual model design clarifying the logic of the sequence of process steps.

Acknowledgement

This paper was written with the support of the KEGA 021STU-4/2018 Project by the title *Development of a laboratory for the design and maintenance of production systems supported by the use of Virtual Reality*.

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