COMPUTER AIDED SCHEDULING MODEL OF MATERIALS HANDLING IN CHEMICAL ANALYSIS FLOOR

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Abstracts The automated chemical analysis shop floor are developed for the environmental pollution problems in our chemical analysis center.

This shop floor have the several equipments include weight, pour, dry, heater, boiler, mixture, spectroscopy etc. And the material handling components are made up by the stored stack, conveyore, turntables, robot etc. Computer simulation has been an important tool for these complete design problem. We have designed the arangement of chemical equipments and material flow systems by using the simulator "AutoModII". "AutoModII" is one of the advanced simulator, CAD-like drawing tools with a poweful, engineering oriented language to model control logic and material flow.

The result is the modeling of the chemical analysis system in accurate, three dimensional detail. We could designed the set able layout and scheduling system by using the AutoModII simulator.

Keywords Simulation, Scheduling, Automation, Chemical analysis

1 INTRODUCTION

Environmental pollution is an internationally discussed problem. This is caused by the gap between earth's limited resource and the expansion of human activities. Its countermeasure is currently being studied, but to understand processes of pollutions, massive amount of chemical analysis must be done.

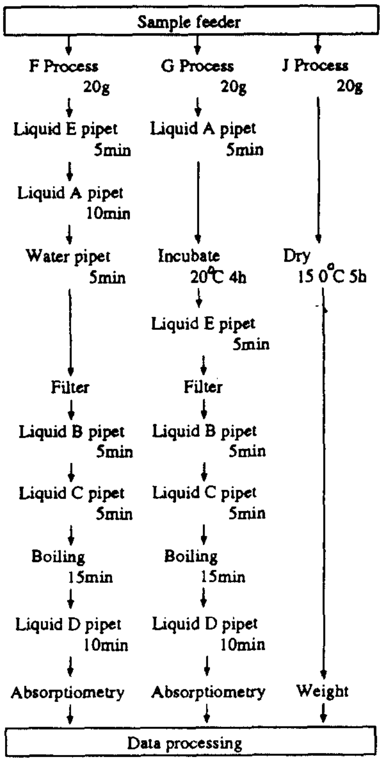

Fig.1 Flow-chart of analizing process

But in reality, various chemical analysis are not being carried out, due to lack of human resource, and the research is not going smoothly.

Purpose of this research is to fully automate chemical analysis line using current robot technologies that achieves shorter research period and higher qualitative accuracy.

This research is subsidized by the Private University Association as joint project theme.

2 CONTENTS OF CHEMICAL ANALYSIS

For chemical analysis line, we have chosen oceanic pollution as a major theme, and as a first step, process of analyzing the relationship between purification activity of bacterias on seabed is investigated.

This process requires to collect about 100 to 150 containers of test materials per day, and to perform injection of chemicals, string, filtering, cooling and heating, weight measurement, and absorptiometry, all done through three lines in flexible manner and then process data.

The exact content of this process is shown on Table 1. The flow chart of analizing process is on Fig.1.[1]

Table 1 Exact content of process

	Reagent	Exact content
1	Liquid A	Glucose liquid
2	Liquid B	Feri-cynide potassium liquid
3	Liquid C	Sodume carbonate anhydride liquid
4	Liquid D	Ferric sulfate liquid
5	Liquid E	Merucuric chloride liquid

As material handlers needed for this process, 3 robots, linear actuator, linear conveyor, and turn table 1 each, and for individual processes, feed hopper, stirrer, pipetter, electric weight sensor, and filter are located around conveyor.

And heat treatment such as thermoly grostat, heat setting mantle, muffle furnace, are located for robot to take in and out data materials.

Location diagram of the chemical analysis processing cell is shown on Fig.2.

Types and makes of individual materials are shown on Table 2.

Table 2 Types and makes of individual materials

NO	Equipment	Type
1	Robot Movemaster	RV-M1
2	Linear conveyor	SBM 150 × 200
3	Turn table	
4	Linear actuator	
5	Personal computer	PC-9801 FA,PC-9801 UF
6	Electric weight sensor	MP-300
7	Feed hopper	MF-60-30
8	Pipetter	ADT-1
9	Thermoly grostat	IN-61
10	Heat setting mantle	DN-44
11	Muffle furnace	FP-41

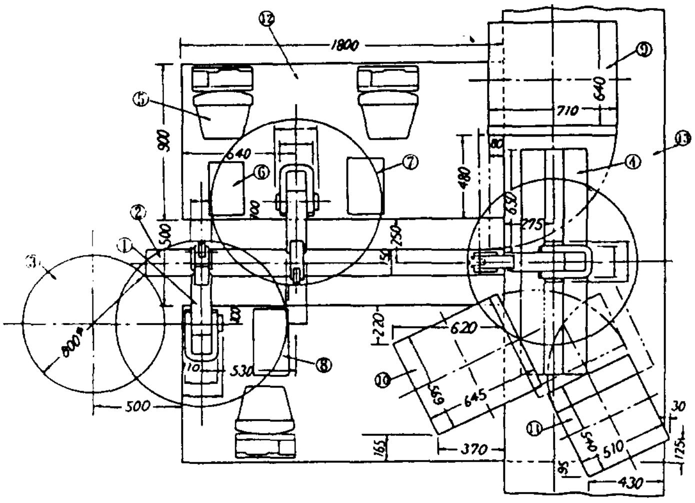

Fig.2 Location diagran of the chemical analysis processing cell

3 MANUAL SIMULATION

The chemical analysis line's process procedure must take number of analysis, human resouce available, and time management into consideration, and the line must be able to be built fleibly.

Also, it is important to make the system easy enough to be planned in laboratories where very few planning experts are available.

Therefore, as a first step, we simplified the process as much as possible, and extracted problems and their solutions through manual simulations.

3.1 Basic planning of analysis line

First of all, flow of the basic line is placed, as shown on Fig.3, stocker on one side of main transfer-line, and line of analysis instruments on other side. Test data materials on tray will automatically be disposed after the process on load/unload transfer-line that consists of conveyor and small robots. The process consists of material handings such as opening/closing test material's tab and analyzers door, and then the calculation of analyzed data.

3.2 Reutirement for process line

As a prerequirement of the process, we assume that 36 kinds of test materials for 3 process lines(108 containers total) are collected per day for analyzing data.

For systematization, we try to achieve a smooth analyzing process that will not generate block and idle situation, through expert's knowledge base, technique, and resistance fluctuation assumption.

Time it takes to load/unload and also time it takes to transfer are set to 5 minutes per each movement regardless of distance for its simplicity, and process periods except heat treatment process are set to 10 minutes.

Heat treatment process is to be buch processed in 2 layered tray with 18 pieces in each layers, because it takes 4 hours to incubate and 5 hours to dry in 150 degrees.

Initial condition of the system should be empty, machines are enabled, and breakdown is not considered.

Queue priorities of transfers and load/unload are determined by real system's control logic. And stockers are assumed to be usable at all time.

3.3 Simulation result[2]

As a first step, simulation except on heat treatment that would take a long time was performed for preprocess' analyzers. This was to find out the slowest process and determine conditions of machines' freeplay and the relationship between number of machines and makespan.

The simulation program was written on personal computer for this.

From the result, it was found that the slowest process was the process of feed hopper and weight sensor. Fig.4 shows the result of simulation of makespan difference when number of feed hopper and weight sensor, which has a slow process speed, is varied.

As a result, the best number of feed hopper and weight sensor is determined to be 3 to 4.

4 SIMULATION USING "AutoModII"

4.1 Simulation's description

As a second step, definite location of analyzers, conveyor, auto stocker, and robots are planned and analyzing process was simulated using "AutoModII"(*).
"AutoModII" is a network style simulator for material handlings, developed by ASI. User can plan the equipment layout, specify rules to manage material handlings, and the simulation result can be checked through computer graphics which makes it easy to catch any flaw that might occur in real system.

(*)This simulation is performed under the machine owned by Seibu Electric Co.

4.2 Organization of process line

The line's organization is shown under Fig.5. This layout of analzers, conveyor, auto stocker, and robots is made using 3 dimentional planning by "Auto ModII".

Fig.5 is drawn in 2 dimensions, but as on Fig.7, it is able to display using 3D in any degrees using computer graphics.

The simulation data is shown in Fig.6. The time scale is set so that the real system's 1 minute is simulator's 1 second, becouse the simulation program in "Auto ModII" is included the heat treatment procces that will take a long time.

4.3 Simulation result

The simulation program was written on engineering oriented language to model control logic and material flow, that combines CAD-like drawing tools.[3] [4]

The simulation data is shown in Fig.6. From the result, it achieved a smooth analyzing process in each steps. The 1-st step's makespan was a few longer than the after steps by the reason in intial condition of each process.[5]

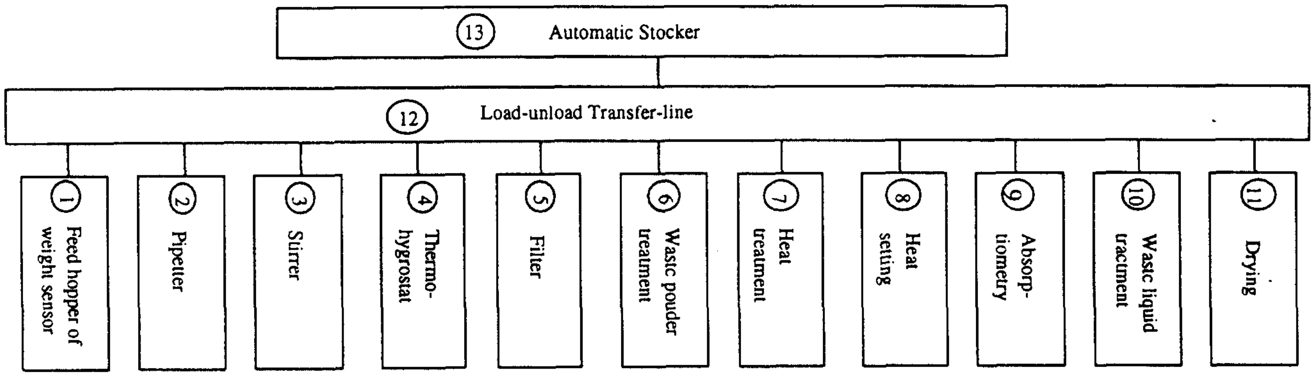

Fig.3 Basic plan of analysis line

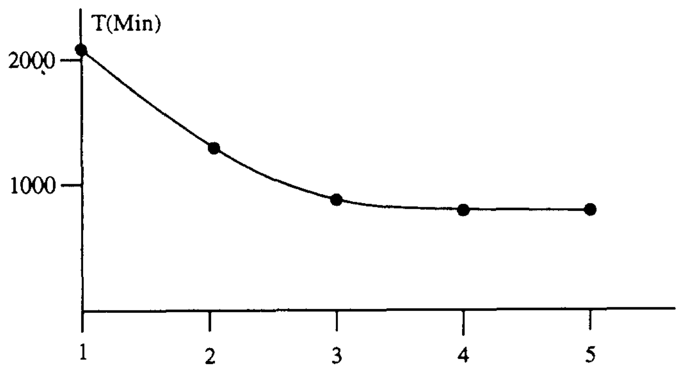

Fig.4 Make-Span VS Number of feed hopper weight sensor

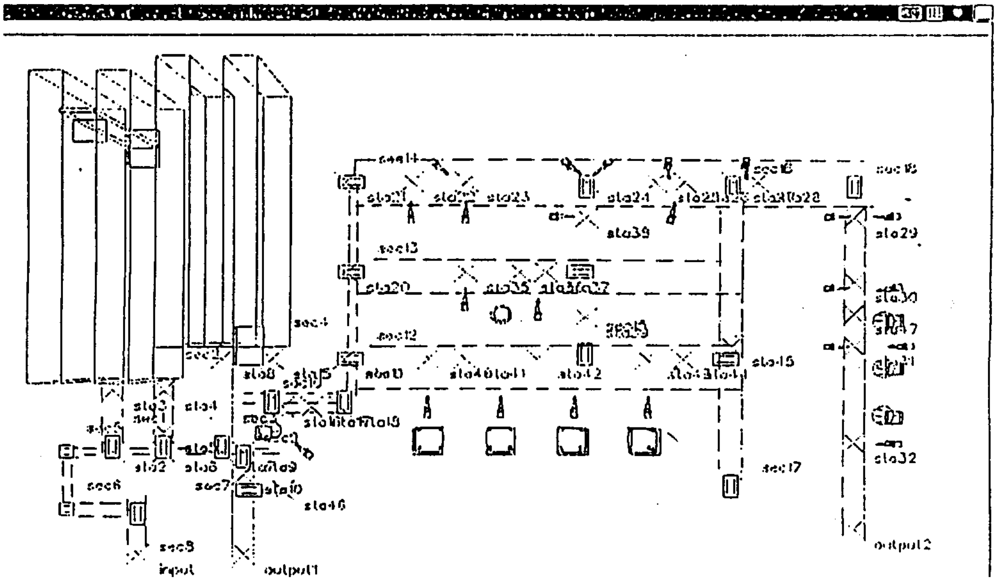

Fig.5 The layout of analysis line

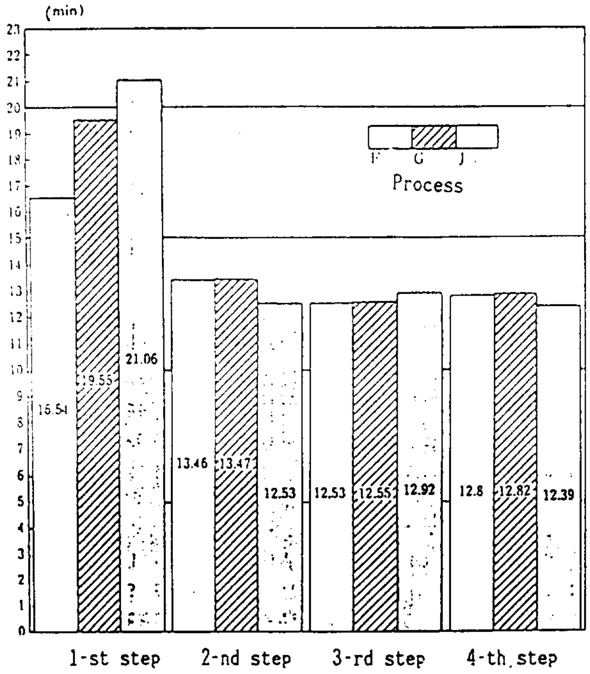

Fig.6 Make-Span in each cycle time

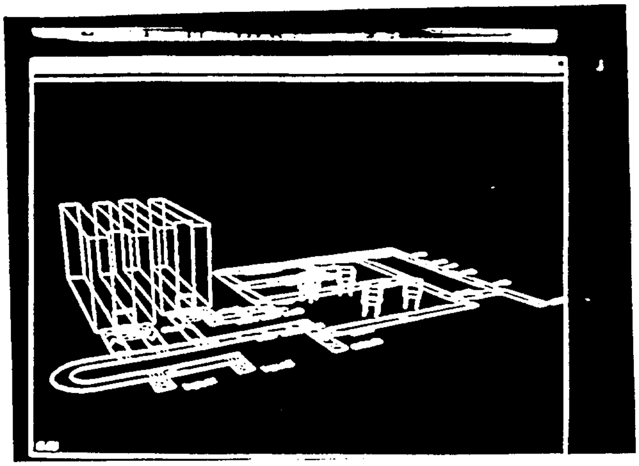

Fig.7 Photograph of 3-D display

5 CONCLUSION

Scheduling model of materials handling in chemical laboratory process was made by manual simulation and an industrial simulation system "Auto ModII".

Our actual chemical analysis processing cell was operated smoothly according to this simulation results.

Coupled with automation robots are also changing to the nature of the laboratory, accelerating the evolution of researchers from mere gatherers of data, to specialists who have the tools and the time necessary to understand the meaning of that data.

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