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CAD/CAM in Nigerian Manufacturing Industries: The Case of Nigerian Casting Industries

Adejuyigbe, S.B.
Department of Mechanical Engineering, Federal University of Technology,
P.M.B. 704, Akure, Nigeria

Abstract: This study discussed the application of Computer Aided Design/Computer Aided Manufacturing (CAD/CAM) in Nigerian Casting Industries. Questionnaires were administered in twelve (12) casting industries visited, in Lagos, Osun and Kogi States.The results of the research shows that 42% of the under study had incorporated CAD/CAM into their casting industries, while about 58% has not incorporated CAD/CAM into their operation. The percentages of the expatriate involved in the casting operation in these industries were examined to have about 13% and also the plant ages were examined. The result of the study shows that the use of Computer as an aid in casting industries has greatly improved the casting operation at all sections/stages of production. It was however discovered that about 71% of Nigeria casting industries are still depending on foreign raw material (software packages) because of insufficient software developers that are very few in our developing society.

Key words: CAD/CAM, manufacturing, casting, industry, Nigeria

INTRODUCTION

Manufacturing is the process of converting raw materials such iron glass or polymer into useful products, such as kettle and telephone to machinery such as railway locomotives and aircraft. Manufacturing industries have been called as one of the competitive technologies in today economy. Manufacturing industries include casting, material removal via conventional machinery, deformation, composition and spray deposition.

Foundry or casting engineering deals with the process, which includes:

- Preparation of pattern;
- Making the mould;
- Melting of metal;
- Pouring of molten metal into the mould;
- Solidification; and
- Shake out and fettling.

The basic mould available in developing countries like Nigeria is sand mould[1,2]. But due to the unsatisfactory dimensional accuracy and finishing surfaces of sand casting, the application of special casting methods was introduced which can actually produced intricate jobs such as centrifugal casting, die casting, investment casting, shell casting and other precision casting processes. The objectives for carrying out this research work are to;

- Find out to what extend has the computer been used and incorporated into the manufacturing industries in Nigeria most especially in the casting industries;
- Proffer ways by which the casting industries can be encouraged to embrace the use of computer as an aid in their production system.
- Evaluate if there are manpower needed to man the various areas of production process where computer will be needed in casting industries.
- There is no up to date research work of such in a developing country like Nigeria to know the level of our computer awareness and utilization in the manufacturing industries, most especially casting industries, hence the need to carry out this research.

Computer Aided Design (CAD): According to[1,3,4] they defined Computer Aided Design as design activities that involve the effective use of computer to create, modify or document engineering design. Computer Aided Design and Drafting (CADD) is a form of automation that helps designers prepare drawings, specification, part lists and other design related elements using special graphics and calculations- intensive computer programs[5,6].

Although CAD systems originally merely automated drafting, they now usually include three-dimensional modeling and computers simulated operation of the model rather than having to build prototypes and change components to determine the effects of tolerance ranges.

Computer Aided Manufacturing (CAM): Computer Aided Manufacturing (CAM), is the use of digital computer to enhance the shop floor manufacturing process which include monitoring and controlling of manufacturing equipment shop floor information system with automatic data gathering[2]. CAM is a form of automation and control system that employ feedback that is, they use part

output to control their input[7,8]. Once the automated process is set up, human participation in the manufacturing process involves little more than maintenance and repair of the equipment.

MATERIALS AND METHODS

Twelve (12) casting industries were visited for the administration of questionnaire. Majority of the company visited are located at Lagos State, Osun State, Ondo State, Oyo State, Delta State and Kogi State. The reason for choosing these locations can be explained by the fact that more casting industries are strategically located around these six states than any other states in Nigeria.
Tools used to carry out the project are;

- Questionnaire;
- Visitation to the casting industries used for the study; and
- Personal interview of some Professionals in the field.

About 24 questionnaires were distributed in which 17 were administered by the Production Engineers, Operation Manager, Foundry Manager and Technicians of those companies.

RESULTS AND DISCUSSIONS

Personal interview in the casting industries visited: From the personal interview conducted in the casting industry the following results were obtained;

Effect of Computer-Aided Design and Computer-Aided Manufacturing (CAD/CAM) in casting industries: Some of the personnel working in the casting industries made the following assertions that the introduction of CAD/CAM into their casting industry has greatly improved their products in the following ways;

- Improving casting technologies;
- Improving process control;
- Improving dimensional control;
- Reduction casting defects;
- Reducing operation time and cost;
- Reduction of drafting labour;
- Reduction of wastages in product manufacture; and
- Eradication of prototype.

Problem facing the introduction of Computer-Aided Design and Computer-Aided Manufacturing (CAD/CAM) in casting industries: The major problem facing the introduction of CAD/CAM into the casting industry is in the area of;

Table 1: The reason for the introduction of CAD/CAM

Reason for CAD/CAM	(%) Grading
Customer's enquiry	13
Technology advancement	6
Sales and profitability	73

Source: From the questionnaire distributed and collected

Table 2: The frequency of training of Technical Staff

Frequency of training	Percentage (%)
Annual	20
Bi-annual	13
Quarterly	7
Irregular	60

Source: From the questionnaires distributed and collected

- Software developer who can write the programme needed for casting operations.
- Inadequate information in which most of the ordered software packages will not be able to work or run on the available machine in Nigeria.
- Most of the machines available in the some of the casting industries visited are obsolete technologically.
- Government instability and some foreign exchange problems

Result obtained from the questionnaire distributed and collected: The results of the questionnaire were compiled together under the following headings;

- CAD/CAM in various section of casting;
- Research and development;
- Manpower and manpower development; and
- Machinery and equipment.

CAD/CAM in various sections of the casting industries: Some questions were asked under this section and the result is as shown below;

Have you Introduce CAD/CAM in your company?: The data obtained from the 12 industries visited shows that only 9 industries have introduced CAD/CAM while other has not. This result shows that there is improvement but more effort still needed to be done to upgrade the present state.

Reason for the introduction of CAD/CAM into casting industry: The result shows that the reason for the introduction of CAD/CAM into their casting industries is mainly on sales and profitability.

There is little concern about the technological development and advancement of their product. From the foregoing therefore it can be concluded that Nigeria Casting Industries are mainly focusing on profit they can make out of their sales.

Table 3: The range of plant's age

Age in years	Percentage (%)
1-10	20
11-20	14
21-30	19
31-40	22
41-50	25

Source: From the questionnaire distributed and collected

Table 4: The percentages types of automation in casting industries

Type of automation	Percentage (%)
Computer numerical control	15
Numerical control	25
Robotics	2
No automation (manual)	58

Source: Questionnaires distributed and collected

The result obtained from the questionnaire was quite different from that of the professionals interviewed in the casting industries under study. They have the following reasons:

- To increase the productivity of designers and the manufacturer;
- To improve the quality of casting products; and
- To reduce wastages.

Therefore it is necessary that these industries should also focus on some of the points enumerated above as to increase the use of CAD/CAM in casting industries.

What section /Department in casting industry do you use or introduce CAD/CAM?: The data obtained from the industries shows that the use of computer as an aid in all the foundry sections is of paramount importance. And the result in this section shows that nearly all the sections have a touch of using computer in their section. Some who are yet to introduce it are struggling to do so. Since it was evident that the introduction of the Computer to any facet of the section has positive effect on those sections and their eventual product.

Why is development of CAD/CAM in casting industries crawling in Nigeria?: The data obtained from the case study industries shows that;
Nigeria technology has not grown to the level of investing their time, risking their scarce money to develop the technology.

It was also revealed that Nigeria does not have enough experts in the field of CAD/CAM relating to casting. Also there is nothing motivating the little software developer we have on ground. Incentive from the Government is not there. All research findings are laying waste in the Universities and the industries that develop them. The industries are not interestedin what is going on in the University. And the University researchers are not showing enough interest in the industry either. The little trails made so far meet some frustration along the line.

Effect of introduction of CAD/CAM in to casting industry in Nigerian economy: The result from the questionnaires, interview and industrial visitation shows that the introduction of CAD/CAM has lead to the eradication of prototype, improvement on quality, improvement on productivity and reduction in wastages. It has also remove the level of labour required and it has improved the products to meet international standards

Government attitude towards the development of CAD/CAM in casting industry: The result from the questionnaires, industrial visitation and personal interview shows that government did not encourage the application of CAD/CAM in casting industries because;

- There are no provisions for the training of workers in the area of CAD/CAM so that there can be enough professionals that can handle this sensitive discipline.
- There is no technological Institute where CAD/CAM professionals are trained.
- Government owned casting industries visited under this study are not functioning well and have not effectively utilized this type of professionals in their industries.

Manpower and manpower development: Part of this research is tailored towards investigating the current state of manpower and its development in Nigeria Casting Industries. Questions were asked under the followings;

- **Use of expatriate:** The questionnaire inquires whether expatriates are employed or not. The result shows that only 13% employ in all the industries visited are expatriate. This is very encouraging and it shows that the level of our manpower development is very high in Nigeria. We just need some training to rise up to the required level of expertise in Nigeria.
- **Training of technical staff:** The result shows 100% of the company's training their technical staff either by sending them on short courses, or training them internally and even some sending their staff for overseas training

From the Table 2 above it is clear that majority of the company do not have pattern for staff training. Some or most of the companies train their staff when there is a need or emergency.

Table 5: The means of maintenance

Means of maintenance/ repairs	Percentage (%)
In house technical staff	40
Contract service	-
Upgrading	20
Both	40

Source: From the distributed and collected

Table 6: Utilization of software programme

	Percentages %	
Casting industry	Foreign	Local
Casting Industry A	65	35
Casting Industry B	70	30
Casting Industry C	85	15
Casting Industry D	60	40
Casting Industry E	70	30
Casting Industry F	70	30

Source: From questionnaire distributed and collected

In Nigeria, as well as other developing countries manpower problem in the process of industrialization have been largely caused by the fact that the training of skilled personnel was prevented by the economy of the countries, the industrial underdevelopment, backwardness and the limited spreads of appropriate organized vocational training directed at the provision of skilled manpower.

Equipment and machinery: The results of the survey indicated that about 35% o f the visited casting industries were equipped with latest machine for manufacturing while the remaining 65% did not have. It can therefore be clearly stated that not up to the average of the casting industries visited are equipped with latest machines, which make them unable to meet up with the present technological advancement, as witnessed in advanced countries.

- **Plant's age:** From the information gather from the casting industries visited, it show that most of the machines and the equipment has already pass their economy life, because there is no enough money to upgrade, replacing those machines and equipments, which as been the source of set back to the Nation Nigeria. The Table 3 below shows the range of plant's ages.

Automation: Automation which consists of Numerical Control (NC), Computer Numerical Control (CNC) and Robotics have been existing since 60's, although, most of the casting industries in Nigeria were established after then, but the result of the survey shows that there are still shortcomings on their parts. The results are show in Table 4.

As shown in Table 4 above, about 58% of these companies do not have automated machines. This shows that most Nigeria's casting industries are limited in operation since automation is suppose to be faster, cheaper at long run and easier in operation.

Maintenance and repairs: The existing plant also need repair replacement and upgrading. The result is shown in the figure below;

The result in Table 5 shows the majority of the companies employ both contract service and in house services.

The side of maintenance and repairs, the nation's casting industries are fairly all right, but they need more input so that the effect of good maintenance and repair can be clearly seen in the product output.

Software utilisation in different casting industries: The dependence on foreign raw materials, is too high, more than half of the software are imported into Nigeria due to shortage of software programmers who can write good and workable programs (Table 6).

The result show in Table 6 indicates that the mean utilization of foreign software packages is 71% and the mean utilization of local software is 29%. It can therefore be clearly deduced that there is high dependency on foreign software for use in casting industries.

CONCLUSION

The introduction of CAD/CAM in Nigeria Casting Industries has greatly improve the level of productivity, process control, quality of cast products to meet up with approved International Standard, reduction of casting defects, developing environmental improved materials to meet today's regulation. From the findings of this research it shows that;

- There is a little concern about technological advancement of the nation Nigeria in the area of introducing CAD/CAM into all the facet of casting operations in Nigeria industries.
- Government attitude towards the introduction of CAD/CAM into casting industries is not encouraging by not having functioning research institutes which could have been a source of developing manpower needed in this area of specialization.
- The level of dependence of Nigeria Casting Industries on foreign raw materials like software program is too high. There is an urgent need for the development of appropriate software packages for casting industries.

- Nigeria Casting Industries are mainly focusing on profit they can make out of their sales, instead of quality and satisfaction of customers.
- Some of the machines in the industry are obsolete; the provision of new and modern machines, so as to be able to produce intricate parts needed in the industries should be encouraged.

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