International Journal of Mechanical Engineering and Robotics Research

ISSN 2278 – 0149 www.ijmerr.com
Vol. 2, No. 4, October 2013

Research Paper

ECONOMICAL ANALYSIS AND UP GRADATION OF EXISTING MACHINE TOOLS THROUGH RETROFITTING

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Due to emerging concepts like globalization and liberalization today customer have choice to change their demands frequently? Hence market life of product reduces. Conventional senescent manufacturing machine tools cannot meet these requirements. In order to sustain competition and exist in global market, Indian manufacturing industries need to upgrade its technology for its very survival and also to sharpen its long term competitive edge. This is possible by upgrading the senescent machine tools to restore accuracy level, improving availability, enhancing productivity and capability. CNC Retrofitting is a cost effective method of upgrading capabilities of existing machine tools. Suggestions regarding future work are incorporated herewith. Feasibility of retrofitting is analyzed by means of case study.

Keywords: Ball Screw, Programmable Logical Control (PLC), Automatic Tool Changer (ATC), Digital Read Out (DRO) system

INTRODUCTION

Since customer today have access to world market due to globalization liberalization etc. they have option open to change more frequently their choice, as they have more variety of products with improved quality and lower price. Hence market life of product reduces such demands cannot be met by conventional ageing manufacturing machine tools because they limited capability, flexibility and become obsolete with time In countries with developing economics like India since capital constraints always prevail, up gradation of exiting machine tools through reconditioning and retro fitting is best possible answer to them. Retrofitting lead to cost effective modernization of existing workshop.

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LITERATURE SURVEY

Khasgiwala and Basak (1998), "CNC retrofitting of machines for competitive advantage" proceedings of LE. (I) Seminar held in Jabalpur 1998. Outlined that reconditioning of old equipment has a significant role to play in developing countries like India due to prohibitive costs of new equipment, lack of adequate foreign exchange resource for machinery imports and scarcity of capital. Once the life span of a machine is over, its reliability decreases rapidly and planning of spare parts becomes a difficult task. The components have a low residual life and could fail without a warning. Reconditioning or partial repair tends to strengthen certain located areas, but the risk of breakdown in areas not reconditioned continuous to remain Daga "CNC Retrofitting of conventional machines, a cost effective approach for small scale manufacturers", Vision 1994-95, Indian Institute of Industrial Engineers. Outlined that to bring CNC operation into working, it is not necessary to go for a new CNC machine. It can be achieved by incorporating CNC features for example DRO CNC system. PLC's, thirstier drives etc. into exiting senescent conventional machine tool oiling of old equipment has a significant role to play in developing countries like India due to prohibitive costs of new equipment, lack of adequate foreign exchange resource for machinery imports and scarcity.

Idea of Renovation

Since Sunbeam Auto Pvt. Ltd. has been incepted they have complied so many machine tools and plants Out of these fair no. of machine tools and plants have gone old. Though there are lots many advantages of using new CNC machines all these machines cannot be discarded and replaced. For any industry 1:1 replacement of machine tools by new CNC machines is not possible one the issue of replacement versus renovation of senescent machine tools, the 4R's approach (Retire, Relegate, Renovation and Replacement) has been thought of.

Renovation of senescent machine tools has a significant role to play in developing economics like India due to following reasons:

- Prohibitive cost of new equipment.
- Lack of adequate foreign exchange resources for machinery import.
- Scarcity of capital.
- Inadequate knowledge and no local support.

CNC Retrofitting

Today's urgent need to modernize conventional machine tools and acute difficulties being faced by industries regarding availability of large capital are contradicting each other. High prices for new large and medium size CNC machines make it difficult for and user to reap the benefits of CNC technology. In this context one via media to introduce CNC technology is though retrofitting.

The process involves addition of new system or module to enhance the capability of existing machine. The purpose is therefore to upgrade the conventional senescent machine tool. CNC retrofitting will find a place today industry due to following reasons:

- Cost effective monetization of existing workshop.

- Large size senescent machine tools, large in number which cannot be discarded.

Retrofitting is a stepping stone to a full fledge CNC technology.

Figure 1: Conventional Lathe

Reconditioning

Reconditioning of equipment may be defined as a planned systematic engineering actively designed to restore the equipment to its original sound performance condition. It is a practical exercise intended to bring back the equipment work out after long use to its original reliability and performance state. This process involves repairs to certain problematic areas in the machine, like grinding and scrapping of guide ways to remove slackness due to wear and replacement of certain parts depending upon the intended performance of the machine.

Need of Reconditioning

Reconditioning of old equipment has a significant role to play in developing countries like India due to prohibitive costs of new equipment, lack of adequate foreign exchange resource for machinery imports and scarcity of capital. Once the life span of a machine is over, its reliability decreases rapidly and planning of spare parts becomes a difficult task. The components have a low residual life and could fail without a warning.

Reconditioning or partial repair tends to strengthen certain located areas, but the risk of breakdown in areas not reconditioned continuous to remain. The power in the machine is limited to the weakest component and the reliability of the machine is defined by the most unreliable mechanism in the equipment and reconditioning or partial parts tend to postpone the problems for future period.

MATERIALS AND RESULTS

Economic comparison for machine performance calculation.

Number of working hours/year

= (2 x 8) x 6 x 50

= 4800 hrs

I = interest rate = 20% per annum,

S = Salvage value = 0.1 x capital cost

Interest taken as 20% per annum.

Table 1: Case Study

	Initial Cost	Annual Maintenance and Other Cost	Hourly Labour Cost
16 C Conv.	18 lakhs	Rs. 2.1 lakhs	Rs. 80
Upgraded CNC	45 lakhs	Rs. 2.4 lakhs	Rs. 80
New CNC	90 lakhs	Rs. 5.0 lakhs	Rs. 80

Conventional Turret Lathe

1. Depreciation $\frac{C-S}{Y} = \frac{18-1.8}{10} =$ 1.62 lakhs

2. Interest/annum $= \left[\left\{\left(\frac{C-S}{2}\right)+S\right\}Xi\right]$

$= \left[\left\{\left(\frac{18-1.8}{2}\right)+1.8\right\}x0.20\right]$ = 1.98 lakhs

3. Total annual cost = 1 + 2 + Maintenance cost

   = 1.98 + 2.1 + 1.62

   = Rs. 5.7 lakhs

4. Machine hour rate = $\frac{III}{\text{working hrs.x availability}} + \text{hrly. labour cost}$ =

   [taking 78% availability] = 232.24 Rs

Upgraded Machine

The work piece material used

1. Depreciation = $\frac{C-S}{Y} = \frac{45-4.5}{10} =$ 4.05 lakhs

2. Interest/annum = $\left\{\left(\frac{C-S}{2}\right)+S\right\}Xi$

   = $\left[\left\{\left(\frac{45-4.5}{2}\right)+4.5\right\}x0.20\right]$ = Rs. 4.95 lakhs

3. Total annual cost = 1 + 2 + Maintenance cost

   = 4.05 + 4.95 + 2.4

   = Rs. 11.40 lakhs

4. Machine hour rate = $\frac{11.40x10^5}{4800x0.96}+80$

   = Rs. 327.39

New CNC Machine

1. Depreciation = $\frac{90-9}{10} =$ Rs. 8.1 lakhs

2. Interest/annum = $\left[\left\{\left(\frac{90-9}{2}\right)+9\right\}x0.20\right]$

   = Rs. 9.9 lakhs

3. Total annual cost = 8.1 + 9.9 + 5

   = Rs. 23 lakhs

4. Machine hour rate = $\frac{23x10^5}{4800x0.96}+80$

   = Rs. 579.13

   = Rs. 579 [Taking 96% availability]

Case Study

In the present

Name of component: Commutator Segment

Operation involved: Facing, Boring, V Grooving

Table 2: Result Analysis

	16C Conv.	Upgraded Machine	New CNC
Machine hour rate (Rs.)	232.24	327.39	579
Machining time (in hours)	3.00	1.00	0.916
Cost of machining (Rs.)	696.72	327.39	530.36
Capital cost (lakhs)	18	45	90
Number of component produced/year*	1500	4500	5241

Note: *Estimating that same component produced throughout year.

Data Before Upgradation

Total working hours = 4800 hours

Down Time = 1050 hours

- Availability = (4800–1050)/4800 = 78.0%
- Up time ratio = (4800–1050)/4800 = 0.78
- Down time ratio = $\frac{1050}{4800}$ = 0.22

Data Obtained After Upgradation

Total working hours = 4800 hours

Down Time = 185 hours

- Availability = (4800–185)/4800 = 96.0%
- Up time ratio = (4800–185)/4800 = 0.96
- Down time ratio = $\frac{96}{4800}$ = 0.04

Figure 2: Cycle Time Reduction

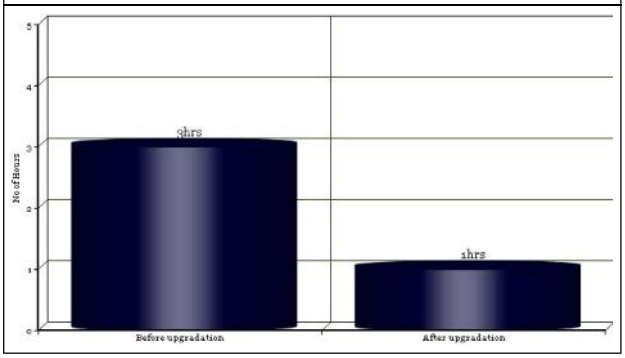


Figure 3: % Availability

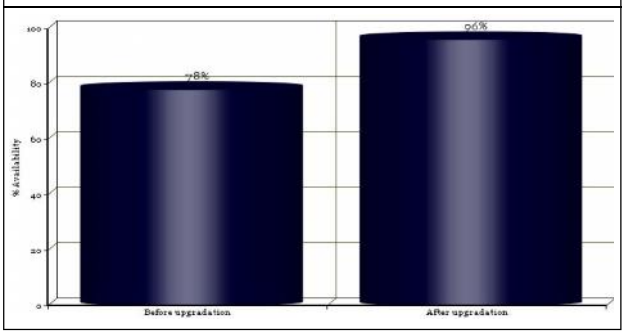


Figure 4: No. of Components / Year

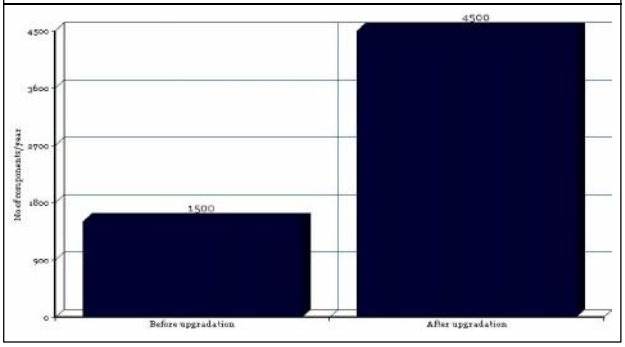
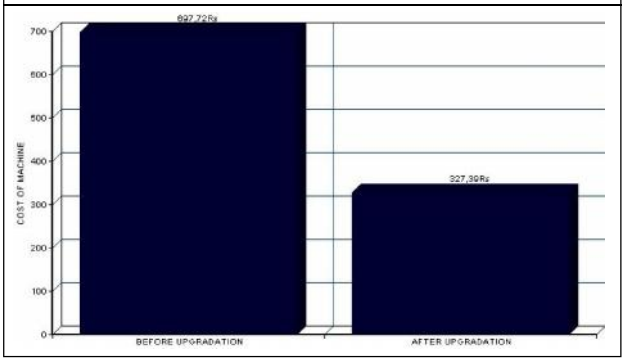


Figure 5: Cost of Machine



Cost Justification for High Cost Automation

Since we know every conventional senescent machine tool is not recommended for renovation. Features of automation that add value to retrofit machine like robot, AGVs, etc., are not justifiable until they are cost effective. Hence they are recommended only for certain machine with high initial cost which can ably support such automated features. One example is quoted below.

Kolb's Multi Spindle Drilling Machine

Machine has 8 spindles for simultaneous drilling of holes on baffle plates of HCM division. Due to continue use of ageing the productivity was considerably reduce.

M/c has been upgraded with state of art CNC controller having latest features and integrating ASI bus concept high rating AC spindle and servo motors and drives for high reliability and fast diagnostics. It has been completely reconditioned and upgraded for use of high speed delta drills resulting in increased productivity, flexible automation, cycle time reduction, etc., Cost – Saving – 6 cores.

Figure 6: CNC Machine

RESULTS AND DISCUSSION

- During Upgradation defective parts are either repaired or replaced to bring back original accuracy. This leads to lesser down time, higher machine accuracy, which in turn increase availability from 78% to 96%. Accuracy's are almost similar to those of Original CNC machine.
- By introducing automatic tool turret, hydraulically operated tall stock, modified numeric CNC controller and servo drives, selection of tool, speed and feed are performed automatically according to instruction given in program. These things lead to dramatic decrease in cycle time 3 hours to 1.00 hour. Fatigue to worker is reduced and his duty is limited to loading and unloading, entering program.
- By retrofitting high performance ball crews in place of conventional lead screw transmission efficiency drastically improved with sliding contact replaced by rolling contact.

Table 3: With the Use of Sliding Contact in Place of Rolling Contact Improvement of Efficiency

Ball Screw	**Lead Screw**		
96%	60%	Linear	Efficiency
96%	40%	Rotating	Efficiency

- AC servo motors, drives induced higher speed upto 1000 rpm without drop torque.
- Accurate positioning, precession feed attained through PLC controlled turret give higher accuracy's, better repeatability, hence lesser rejection and her quality.
- Cycle time reduction, high quality with lower rejection makes cost of the production very much lower.
- Chip conveyors, machine enclosure, attached for safety of worker enhance time saving. Centralized automatic lubrication system improves tool life and facilitates extended Operation.
- By incorporating power tool in the turret for drilling, and grinding we can further improve productivity.
- Hydraulic chuck, automatic job handling added to further improve, productivity.
- C-axis arrangement will improve capability of upgraded machine to machine intricate complex parts.

With the help of computer program it is very easy to decide the feasibility of a machine for Upgradation. We have also analyzed the cost effectiveness of upgraded machine at par with CNC as well as conventional machines.

CONCLUSION

The results obtained have proved that retrofitting is very cost effective method for enhancing productivity, availability and improving performance level. With suitable and economical application of automation, value addition takes place and takes performance of retrofitted machine becomes further better. Customized retrofit makes maximum re-use of existing equipment and is therefore more economical than a complete new installation. With the possibility to sequence the retrofit installation, service interruptions can be minimized. At the same time, our clients' power systems get upgraded to the latest available breaker, protection and control technology, increasing functionality and improving reliability and safety.

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