SERVO DRIVE AND MOTOR DRIVEN POWER PRESSES FOR ELIMINATION OF UNLOAD POWER CONSUMPTION

(***For Punjab Forging and Foundry Cluster***)

Cluster Brief:

The Indian Forging Industry has emerged as a major contributor to the manufacturing sector of the Indian Economy. The composition of the Indian forging and foundry industry can be categorised into four sectors – large, medium, small and micro. The industry is predominantly labour intensive but now with increasing globalization it is becoming more capital intensive. The current investment in the plant and machinery by Indian forging companies is worth of INR 27,833 crore.

The Indian forging industry is well recognized globally for its technical capabilities. With an installed capacity of around 38.5 lacs MT with capability to forge variety of raw materials like Carbon steel, super alloy, titanium, aluminium and so forth as per the requirements of user industry. [1] The increasing trend in exports and domestic sales are the triggers for capacity utilization of 60-80% observed in past few years. The small scale units are increasing their capital investment to keep pace with the increasing demand especially in the global markets as also to broaden the areas of demand for forgings. Many of them are now suppliers to Original Equipment Manufacturers (OEMs) in the sectors like automobile, construction and mining equipment, railways, etc. which speaks volumes about efforts at technology and quality upgradation. Just like any other industry in India, the forging industry is also facing stiff competition from international market due to efficient technologies and their cost competitiveness.

In North India, the region of Batala, Jalandhar and Ludhiana represented in adjoining map is known for its forging and foundry industry. The major products that the forging industry in the region manufactures are bearings, hand tools, gears, valves, automotive products and agricultural machinery. The foundry industry is concentrated in the Batala region which is mostly involved in job work based casting production. The foundry industry mostly produces castings for agricultural equipment, engines, gears etc.

Table 1: MSME forging and foundry industry details in Punjab region

S. No.	Region	Type	Number of units	Article manufactured
1.	Batala	Foundry	100	Agricultural equipment, motor casing, gearboxes
2.	Jalandhar	Forging	200	Hand tools
3.	Ludhiana	Forging	1500	Hand tools, Automotive parts, Railway parts

Existing practice:

Broaching machines in broaching operations:

Broaching is a precision machining process required especially for odd shapes that uses a toothed tool, called a broach, to remove material. In linear broaching, the broach is run linearly against a surface of the work piece to effect the cut within one pass. High quantity production work pieces of small to medium-sized castings, forgings, screw machine parts, and stampings. Broaching machines can be further classified as per their

[1] The data adopted from Association of Indian Forging Industry (AIFI) website

application, i.e. internal or surface broaches depending on shape, size and complexity of machining required. Punjab forging industries majorly use hydraulic horizontal and vertical motion broaching machines. Hand Tools industry primarily use broaching machines for precise movements and complex shapes. As per our survey analysis Jalandhar and Ludhiana hand tools industries, more than 50 vertical and horizontal broaching type broaching machines are being used in 7-8 units out of 15 surveyed. These machines are equipped with motors of different sizes and capacities of motors. The capacity of motor installed varies from 5 hp to 50 hp. The production process is given below:

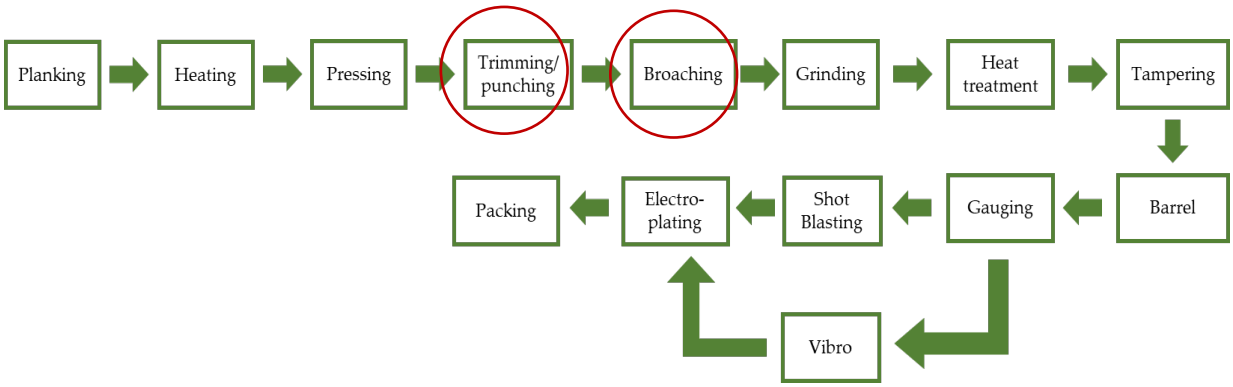

Figure 1: Process in hand tool manufacturing

Table: 2: Brief survey summary on broaching machines in cluster

Total number of surveyed units with broaching machines	15
Total number of broaching machines	50
Motor capacity range based on capacity (hp)	5 to 50

Power presses in open die forging:

In a forging operation after hammering of hot forged components, removal of flash by means of pressing against cutting die that runs the periphery of the work. The cluster presses are purchased with considerations purpose, the size of the production products, the material to be used and the required output. These presses are mostly employed for blanking, cutting, piercing, trimming, drawing, reducing, stamping, punching & bending in forging or casting processes. The primary survey identify more than 320 presses of different types are being used by approximately 70% (i.e 42 out of 62) of total forging units in the cluster inclusive of mechnical (friction, screw), power presses (C frame, H frame, cross shaft), pneumatic and some hydraulic type. Below figure shows the availability of presses by their type in the forging industries.

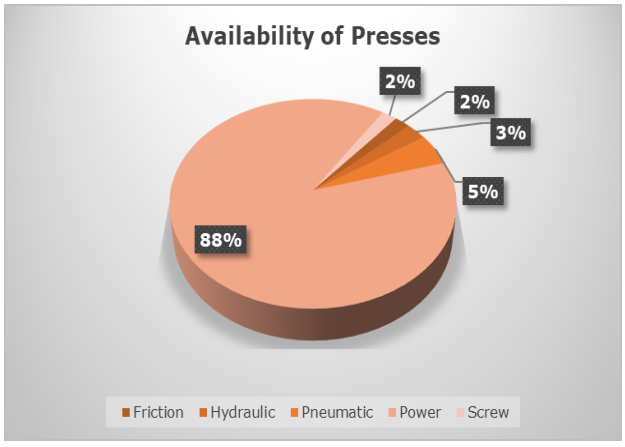

Figure 2: Availability of presses in the Forging Industries

Figure 3: Working power press at forging unit

Power presses are necessary for trimming the end product also preferred due to their fast and precise operation. There are more than 272 power presses operating amongst the survyed units. Following table 3 will give highlight about power press capacity.

Table 3: Brief survey summary on power presses in cluster

Capacity range (hp)	<7.5	7.5 to 20	21 to 50
Numbers	97	165	12
Total number of power presses (mechanical, C type and H type)	272		
Power presses capacity range (tons	10 to 400		
Motor capacity raneg based on capacity (hp)	2 to 50		

Analysis of technology:

Based on energy audit conducted in forging units, analysis of broaching operation is considered for calculation of saving potentials. These motors operate on loading and unloading pattern. The loading time is usually 20% to 40% of the cycle time. However, the motor keeps running at the minimum load even on unload condition. This leads to high electricity consumption even in non-productive duration. An illustrative table of current electricity consumption on one machine at a unit in Jalandhar is given below:

Table 4: Case study: Electricity consumption of broaching machine throughout the day

Parameter	Unit	Value
Capacity of motor installed on broaching machine	kW	22.37
Power consumption during load period	kW	19.60
Power consumption during unload period	kW	10.43
Load time of motor in one cycle	seconds	3
Unload time of motor in one cycle	seconds	11
Total operating hours of motor in a day	Hour	10
Total electricity consumed in a day by existing motors (kWh)	kW	123.95
Total electricity consumed in a day by servo motor (kWh)	kW	73.32

Thus, it can be seen from above example that the 22 kW servo motor system is actually saving approximately 50 kW of electricity for 10 hours of operation in a day. The extent of this technology is applicable for power presses installed in the units for their trimming/ punching processes.

Figure 2: Process in automotive parts manufacturing

Justification of technology selection:

Based on the initial surveys, energy audits of forging units and discussions with few unit owners (listed in table 6), we understand that there exists a good opportunity of installing servo technology on the broaching machines and power presses. In normal forging operations, the power presses are placed after hammer for precise trimming. The hammering time is major bottleneck in forging production processes, the product needs to be hammered multiple times before passed to trimming. Since, the power presses used are usually with higher production rate, resulting in significant idle time at unloading. The motors on presses continues to consume energy during unloading operation, which considerably higher time than loading time. Servo

technology reduce the electricity consumption during unload period to almost zero. This reduces the wasteful usage of electricity and reduces significant power consumption.

The technology has been analyzed and tested on following parameters/ criteria:

Table 5: Technology selection criteria

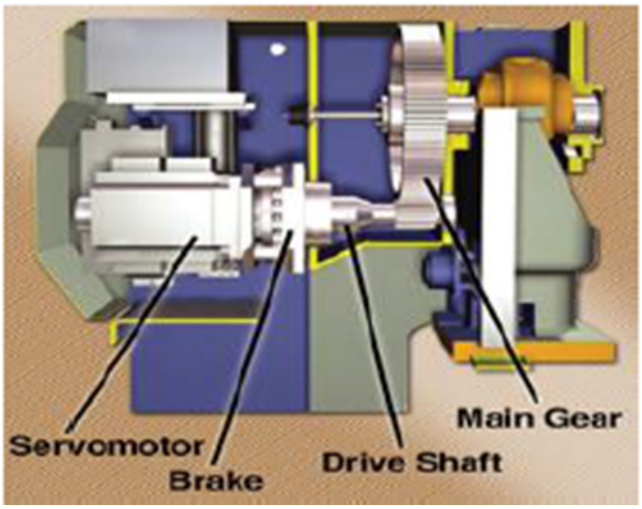

Figure 4: Servo motor and drive arrangement diagram

Parameter	Criteria	For the proposed technology
Energy Conservation potential	15% of equipment/ technology	>25%
Payback period	Less than 2 years	16 months – 24 months
Replication Potential	<Min 20 MSME or 30% of MSME	Replication potential of minimum 35 units. About 55% of the total number of identified MSME suitable for project in the cluster
Vendor availability	Yes	Yes
Ease of implementation	2 - 3 months	0 Easy; commissioning period around 1-2 week

Table 6: Stakeholder consulted for Servo motor technology upgradation for forging broaching machines and power presses:

S. No.	Name	Contact details	Feedback/Comments
1.	Vishvkarma Bikes, Ludhiana (Industry: Cycle parts)	Name: Mr. Prabhat Mishra, General Manager (Operations) Phone: 9384248184	• Power presses are used for shearing, stamping and trimming purposes. • Usually all cycle industries with above mentioned operations and machining capabilities have power presses (maybe of different types) • Unit has voluntarily taken up two conventional power press technology upgradation by servo motor. They order two Schneider make Servo motors along with controller and drive of rating 3.1 kW, 200 Nm torque with brakes from quantum automation Bangalore at price of 2.01 lacs

			• Servo motor controlled power presses provides the 1 rpm safety interlock, ensuring safety of labour in high speed operation. • The estimated energy consumption shall be minimum, based on the internal calculations
2.	Lucky Engineers, Ludhiana (Industry: Cycle parts)	Name: Mr. Sohrab Singh, Owner Email: md@luckyengineers.com Phone: 8284880000	• Power presses are fast and precise, requires for high quality production • Old power presses are available in market at cheaper cost • It would be good if we can reduce the unloading power consumption
3.	Big ben industries, Ludhiana (Industry: Cycle parts)	Name: Mr. Deepak Sharma, Finance Head Phone: 0947951000	• The broaching machines are used for multi odd shapes • For high torque operations, hydraulic broaching machines are used • Recently have ordered Chinese servo broaching machine • The estimated energy consumption shall be minimum, based on the internal calculations
4.	Ajay Industries, Jalandhar	Name: Mr. Shyam Goswami (Owner)	• Energy audit identified the potential for broaching machine retrofit and there is a scope for implementation considering cheap cost of innovation
5.	Baum Forge, Ludhiana (Industry: Hand Tools)	Name: Mr. Jatin Chadha, Managing Director Email: jatin@baum.co.in Phone: 9815901218	• Power presses with Type H and C frame are commonly used in hot and cold forging operations • Power presses are controlled by usually induction motors • Unit operate mechanical and pneumatic presses, however inclined towards hydraulic presses for productivity

Energy & monetary saving:

A single unit has multiple broaching machines and power presses. These machines can be retrofitted with the servo motors and associated system with to reduce the power consumption. An actual case has been considered for calculating the energy and monetary benefits where energy consumption for 10 broach machines and 3 trimming machines is estimated. The saving calculations are as below:

Table 7: Energy saving calculations

Parameter	1	2	3	4	5	6	7
Capacity of existing motor (hp)	50	30	30	20	15	7.50	20
Type of machine	Broach	Broach	Broach	Broach	Broach	Broach	Trimming
Number of motors (no.)	1	1	1	2	2	3	3
Capacity of existing motor (kW)	37.30	22.38	22.38	14.92	11.19	5.60	14.92
Actual load on motor in loading condition (kW)	25.30	19.60	14.30	11.80	8.90	7.30	12.30
Actual load on motor in unloading condition (kW)	14.70	10.43	8.89	4.42	3.93	2.20	4.40
Total operating hours in a day (hr.)	10	10	10	10	10	10	10
Load time of motor in one cycle (seconds)	4	3	2	2.80	2.50	2.40	1

Parameter	1	2	3	4	5	6	7
Unload time of motor in one cycle (seconds)	12.50	11	5	8.50	7.50	6.30	4
Average duration when motor is loaded (%)	24%	21%	29%	25%	25%	28%	20%
Total electricity consumed in a day by existing motors (kWh)	172.70	123.95	104.36	124.97	103.45	108.21	179.40
Capacity of new servo motor (hp)	50	40	40	30	20	10	30
Capacity of new servo motor (kW)	37.30	29.84	29.84	22.38	14.92	7.46	22.38
Actual load on motor in loading condition after installing Servo (kW)	37.30	29.84	29.84	22.38	14.92	7.46	22.38
Actual load on motor in unloading condition after installing Servo (kW)	1.49	1.19	1.19	0.90	0.60	0.30	0.90
Total electricity consumed in a day by servo motor (kWh)	101.73	73.32	93.78	124.38	83.55	68.22	155.76
Electrical savings achieved in a day (kWh)	70.97	50.63	10.57	0.60	19.90	39.99	23.64
Number of operating days in a year (no.)	320	320	320	320	320	320	320
Total savings in a year (kWh)	22,710	16,201	3,383	190	6,367	12,795.7	7,563
GHG savings achieved	22,256.1	15,877.2	3,316.10	186.94	6,240.01	12,539	7,412
Tentative cost of 1 motor (₹)	1,75,000	1,50,000	1,50,000	1,25,000	1,00,000	80,000	1,25,000

The benefits can be summarized as:

- ✓ Reduction in electricity consumption during unloading
- ✓ Reduction in power surges
- ✓ Faster and precision in operations
- ✓ Safety interlocks and automation enhancement capability
- ✓ Cheap cost of installation
- ✓ Easily implementable by MSME units with the help of in house electrical and fabrication capabilities

Replication Potential:

Based on the 62 survey conducted among the forging and hand tool units in Punjab cluster, 8 energy audits and discussion with multiple unit owners, it is identified that the retrofitting of power presses and broaching machines has replication potential in minimum 35 units with similar setup. Brief summary from the survey conducted is shared below:

Table 8: Summary of survey

S. No.	Parameter	Batala	Ludhiana	Jalandhar
1.	Total surveys conducted	19	56	25
2.	Forging and hand tools units surveyed	0	41	8
3.	Number of units with power presses or broaching machines installed	0	34	8
4.	Total number power presses in the cluster	272		
5.	Total number of broaching machines in the cluster	50		

For deriving the replication potential, we consider the scenarios presented in table 9 with the help of case study energy savings achieved by 7.5 hp and 30 hp broaching machines from table 7. The range consider broadly covers motor capacities among the surveyed units.

Table 9: Scenario analysis for replication potential of surveyed units

Parameter	Values
Total number of power presses and broaching machines*	225
Total possible electricity savings (kWh)**	29,88,214
Per unit electricity cost (₹/kWh)⁺	7.5
Total electricity cost savings (₹)	2,24,11,608
Total investment (₹)⁺⁺	3,37,50,000
Payback (months)	18.10
Total tons of oil equivalent saved (TOE)	256.9

Assumptions:

1. **Power presses and broaching machines of motor capacity lower than 7.5 hp are not considered as the saving potential and relative investment do not have financial feasibility.*
2. ***Current cost of electricity in Punjab region considered;*
3. *⁺Assumptions: energy savings by 7.5 hp and 30 hp servo system presented in table 5 are considered for possible energy savings in scenario 1 and 2 respectively. The savings may vary depending on size of the motor.*
4. *⁺⁺For investment calculations, cost of each motor is considered as 1.50 Lacs.*

It can be inferred from above that there is significant savings in electricity by installing servo system. A simple payback period estimation of installation of servo motor is approximately 14 to 19 months.

The replication potential calculated in table 8 only represent surveyed units in Punjab cluster. However, actual potential of this technology can be considered for complete number of forging and hand tools industries that is roughly estimated in table 1. This technology also can be scaled up for other forging clusters across country i.e. in Maharashtra, Gujarat, Tamil Nadu, Haryana, Delhi, Karnataka, Jharkhand, West Bengal and Andhra Pradesh, etc.

Availability of the technology

Wide variety of servo motors and its accessories are readily available in local as well as multinational markets. Few of the technology providers are listed for reference in India.

1. **Quantum Automation**

   Mr. Adarsh CP, Sales Manager, Quantum Automation Bangalore.
   Contact details:
   Email: quantumautomation@outlook.com
   Phone: 08072966719

2. **Rapid Tech Automation industries**

   Address: #1 & 2, Ward No.23, Savakanahalli Gate, D.B.Pura Road, Devanahalli, Bangalore-562110
   Email: info@rapidtechautomation.in; manjumech401@gmail.com;
   Call: 08971405137 | 08431009242

3. **Delta Electronics**

   Address: 407-408, Himalaya Marg, 35C, Sector 35, C, Chandigarh 160035

4. **Schneider Electric**

   DLF Building, Tower C, N-10, DLF Cyber City, DLF Phase 2, Sector 24, Gurugram, Haryana 122002

5. **Mitsubishi Electric**

   DLF Cyber Greens, 2nd Floor, Tower A & B, DLF Cyber City, DLF Phase 3, Gurugram, Haryana 122002

6. **Navyug Industries**

Contact details: 09216726949, 9855726949
Address: 1221/1, Dhandari Khurd, Industrial Area C, Ludhiana - 141003

7. **Monika Engineers**

Contact details: 01612546445, 2547511
Address: Rukmani Towers, 77-A, Industrial Estate, Ludhiana, Punjab-141003

Effect on the process

There are no negative impact on existing setup, on the other hand the production process will improved with technology upgradation. Most of the servo systems are capable to communicate by means of handshaking signals to operate in synchronous manner in automated systems. The servo motor size may increase depending on torque requirements, however the overall electricity consumption will be low. Also, this technology can be implemented within 1-2 week without production shutdown.

Challenges for technology implementation:

- Careful handling required
- Continuous periodic maintenance required
- Lack of skilled manpower for maintenance
- Only suitable for low torque operations. Higher torque requirements may be costly

Mitigation plan:

- Protective casing for servo motor, sensors and its components
- Standard operating procedure guidelines posters to be displayed near machines
- Information on how to plan the periodic maintenance and maintenance methodology

Annexure:

Below shared links should illustrate the working of servo power presses (in 3D animation):

1. https://www.youtube.com/watch?v=4BWr9cuR4PI

2. https://www.youtube.com/watch?v=6z9S8K8of1Q#action=share