

### Why Up-gradation - Gear processing machines ?

#### **Gear processing machines**

Gear processing machines like Hobbing and Shaping, are the machines which are used to manufacture gears, internal and external splines and sprockets etc. Hobbing and Shaping machines are not general purpose machines but specialized for gear processing only. The “Synchronization of work piece and cutter rotation” is used to make gears on these machines. Shaving machines and Gear grinding machines are for finishing of the gear.

All gear hobbing machine, whether mechanical or CNC, consist of five common elements, which are listed below and shown in Figure 1-

1. A work spindle to rotate the work piece (shown in blue)
2. A cutter spindle to rotate the cutting tool, the hob (shown in yellow)
3. An arrangement to rotate the work spindle and cutter spindle with an exact ratio, depending on the number of teeth of the gear and the number of threads of the hob (shown in red). In conventional hobbing machines this ratio has been obtained by series of gears normally called as Index gear train.
4. An arrangement to traverse the hob across the face of the work piece (shown in green). To cut helical gears, same as index gears, another series of gears were used to rotate the work spindle with an exact ratio when hob travels across the face of the work piece. This relation is defined as per the helix angle to be generated on the gear tooth. This series of gear train is normally known as differential gear train.
5. An arrangement to adjust the center distance between the hob and work piece for different size work pieces and hobs

The following schematic diagram shows a conventional **hobbing machine**:

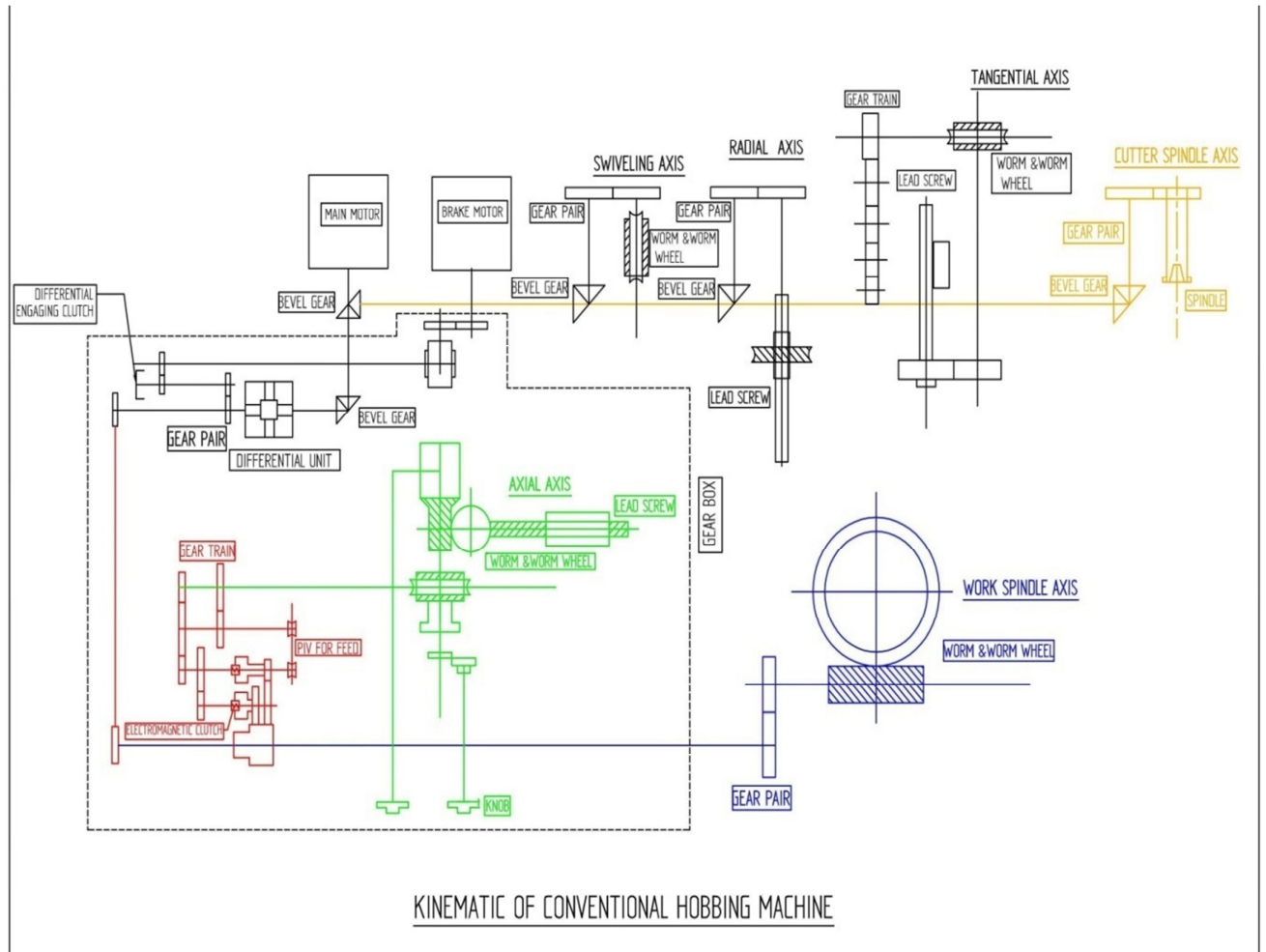


Figure 1

In conventional gear hobbing machine, all these interrelated movements are done through one single main motor and clutches used in the mechanical kinematics.

Depending on the hob (cutting tool) lead angle and helix angle to be generated on gear tooth, hob head (on which hob and hob spindle is mounted) angle need to set manually which is named as swivelling angle.

To calculate the exact ratio for index gear and differential gear for every different job to be made on machine is a specialised job and only few experienced setters are capable to find the ratios depending on the machine constants which varies for different manufacturers.

Complex kinematics and multiple parts involved in driving mechanism result in higher wear and tear of mechanical parts thus increases breakdown.

All such drawbacks of conventional machine have been addressed in CNC gear hobbing machine. CNC gear hobbing machine has direct drives for all axis as well as work-spindle and cutter-spindle.

Relation between cutter-spindle and work-spindle are controlled by CNC through function called EGB (Electronic gear box) which eliminates need of index and differential gear mechanism.

Separate and direct drives for every drive axis eliminate clutches. Following is the kinematic of a CNCHobbing machine (Figure 2)-

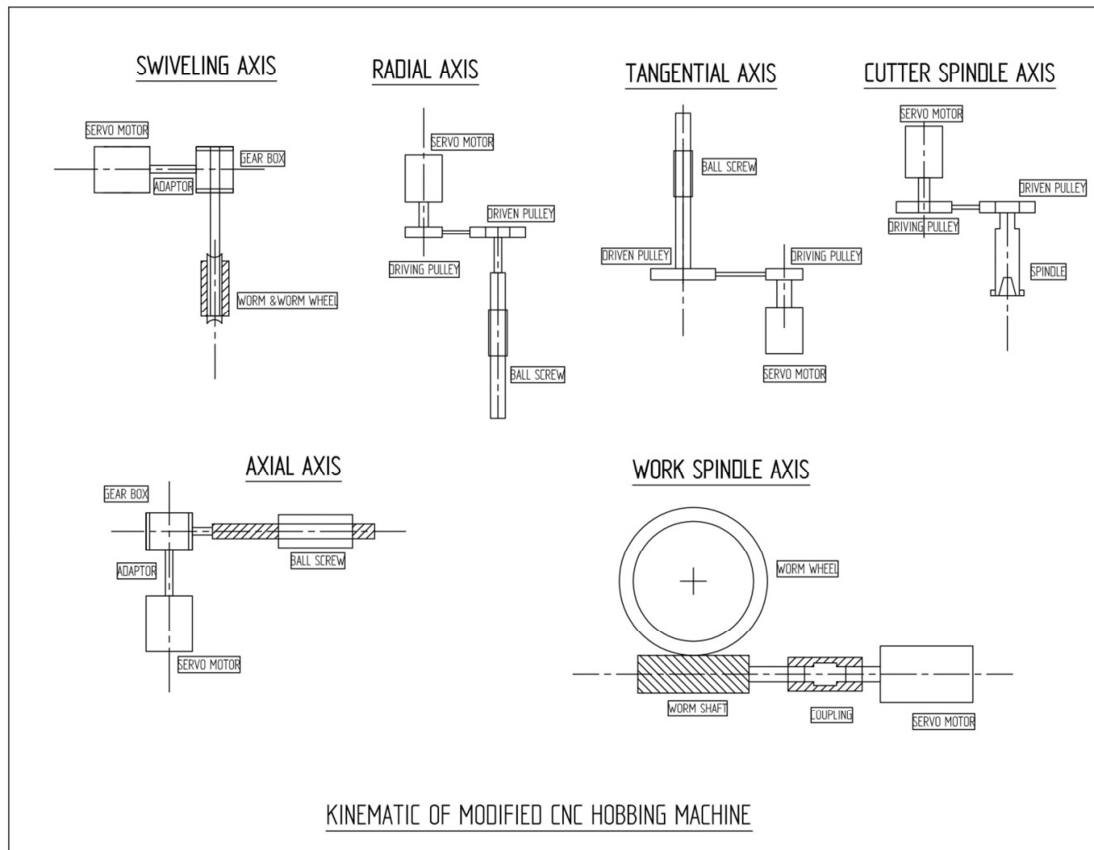


Figure 2

Following table can give a broad idea about advantages of CNC gear hobber over conventional machine.

### Comparison of features of Old conventional machine and modified CNC machine-

Serial Number	Conventional Gear HobbingMachine	CNCGear HobbingMachine

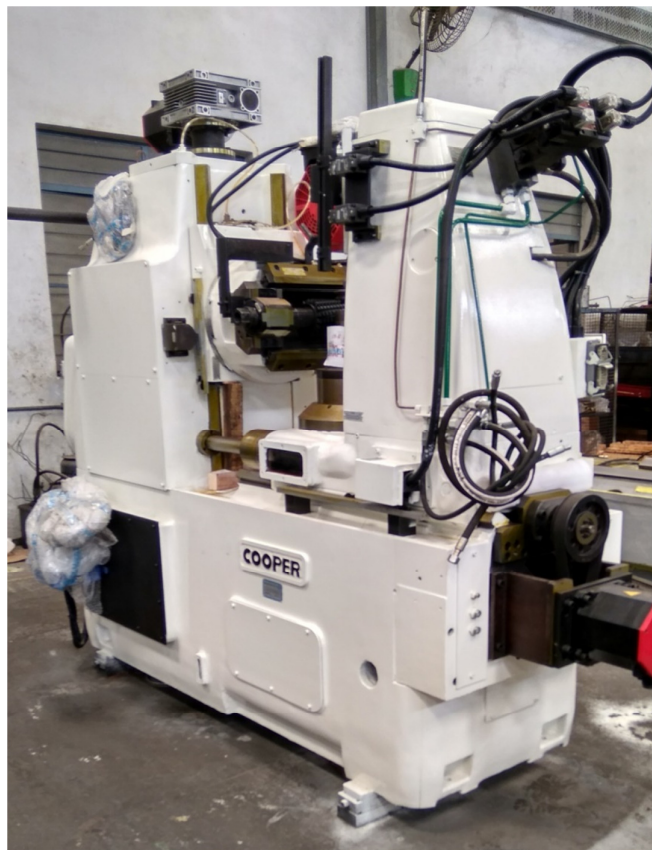
1	AC induction or DC motors are used for axis traverse, so axis traverse speeds are fixed.	AC servo motors are used for axis traverse so traverse speeds are controllable.
2	All feeds will be generated through main motor using clutches.	Different servo motors are used for radial and axial feed. Elimination of clutches.
3	Radial feedbox and change gears are used for radial feed.	Feedbox is removed and feed is programmable.
4	Axial feedbox and change gears or PIV is used for axial feed.	Feedbox is removed and feed is programmable.
5	Feed can be given in fix steps.	Infinitely variable feeds can be given so cycle time can be reduced with better quality.
6	Hob spindle speed can be vary using PIV or step pulleys.	PIV is removed and infinitely variable speeds can be given.
7	Radial movement is given through lead screw or hydraulic cylinder.	Radial movement is given through high precision ballscrew resulting in high position accuracy and repeatability for DOP.
8	Manual hob shifting or timer based hob shifting.	Manual hob shifting or timer based hob shifting.
9	Incorporate several interlinked drive trains for performing either single or simultaneous movements required of the individual machine groups. So complicated kinematics & use of clutches.	Simplified kinematics and clutched are eliminated.
10	Linkage between hob and table will be achieved by change gears.	Electronically generating drive for precisely synchronizing the rotary motions of hob and work piece and for effecting the supplementary differential rotation.

11	Special attachments are required to cut taper and crown gears.	Interpolation of radial and axial axis is possible so taper and crown gears can be cut.
12	Tailstock operation is manual.	Automatic tailstock operation.
13	Machine setting time is more as all settings are manual.	Cutting cycles are provided with menu driven programming and different set up data can be stored permanently.
14	Operating requires considerable gear knowledge.	CNC substantially reduces skill level as the gear know-how is now part of the software provided with the machine.
15	Feed rates and feed directions have to be set with mechanical means and need to be tested. Dead stops, trip dogs and limit switches must be adjusted. These setting and testing operations require experience and knowledge and consume a lot of time.	This is programmable.

Looking into all advantages of CNC gear hobbing machine with respect to quality, productivity, maintenance and ease of operation, along with elimination of skilled labour, every gear manufacturer wants to have a CNC gear hobbing machine. But a brand new CNC hobbing machine is a high capital investment.



**Old machine**



**Modified CNC Machine**

Considering the ROI and Break Even time, very few OEM's and MSME's consider this as a viable option. So alternatively they go for converting their old conventional machines into CNC machines by trusted names in the market. ARK MachTek has established itself as one of the most trusted brands in the ecosystem, when it comes to Reconditioning, Retrofitting and Rebuilding the conventional Hobbing, Shaping and Shaving machines into CNC machines in India.

### **Initial Years**

The journey of ARK MachTek started some 15 years ago. It was the year 2005 when the founders of ARK MachTek were looking for a business model which can challenge their technical creativity and can quench their thirst for entrepreneurial success. Having prior experience of working on Gear processing machines, their study revealed that most of the Gear manufacturers, were hampered with the low productivity, quality issues and maintenance issues of conventional machines. Conventional machines required the skilled operator, along with the complex calculations and knowledge of Change gear mechanism for speed variation. Conventional machines were having the mechanical clutches, brakes and flywheel with support arrangement for vertical axis. All these factors required too much of maintenance and using machines with optimal utilisation were way too difficult for the users. All these factors had been addressed in the new CNC machines but such high capital investment was not easy to afford by most of the end users even at that time.

ARK MachTek decided to customize the existing conventional machines of the customers by providing all the features of latest brand new CNC machines without compromising quality and productivity. With the strong technical team at the helm of affairs, ARK MachTek successfully modified the conventional machines into 3 axis CNC and 5 axis CNC machines. The 5 axis CNC Machines were able to provide the jobs with-in DIN 7 class that too at a higher productivity rate and with minimal maintenance. These machines were easy to use, maintenance free and parts program could be generated automatically by just filling the gear data, tool data and feed speed data into dash board.

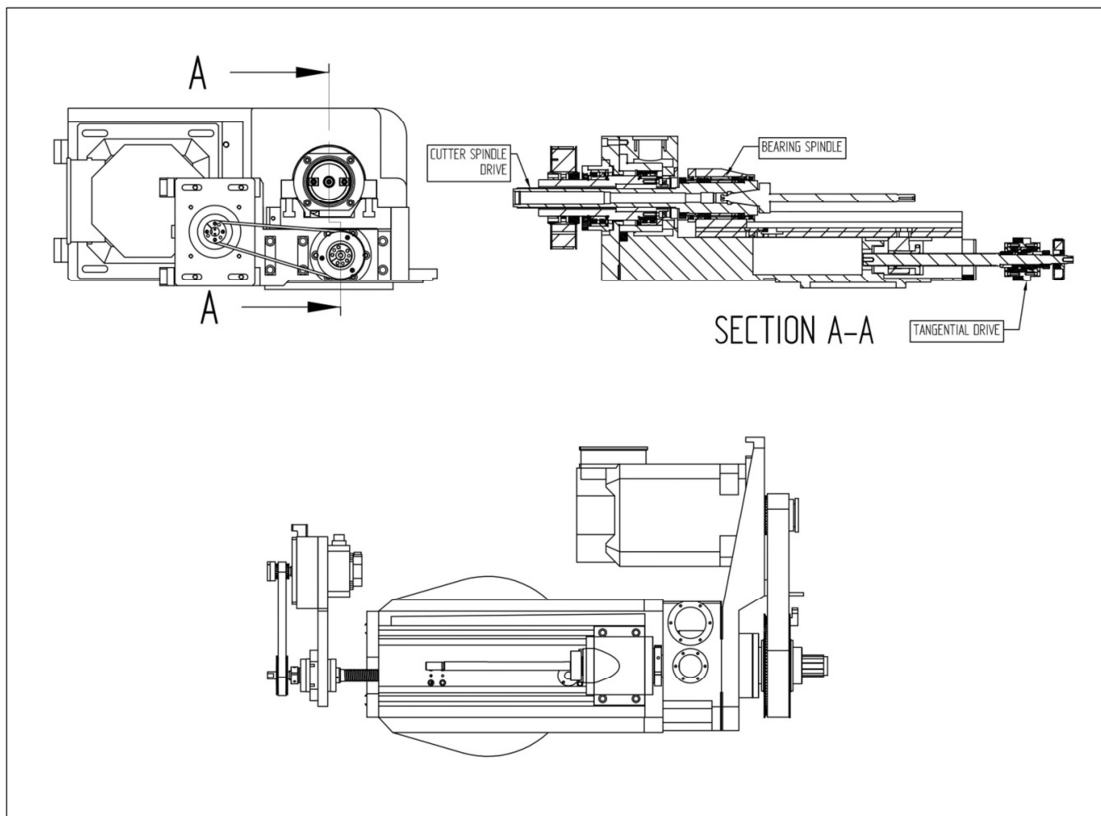
These modified machines by ARK MachTek were soon being compared with the new machines. Most important factor for these machines to become so popular was the reason that they could be customized irrespective of the model and size and that too at a price which was 1/3 of the new machines. The big OEM's in India also started opting for this option and the complete plants were started to get occupied by the modified CNC machines from ARK MachTek. Normally Shaving or Grinding operation is required after Hobbing, which is costlier



and time consuming compared to Hobbing. Quality gears produced on these machines reduced the tooling cost and cycle time which resulted in productivity and profitability. Taper and crowning without any additional attachment on these machines were key highlights of these modified machines.

### Features

- Customised features.
- 5 AXIS CNC/6 AXIS CNC conversions lead time is 4 months. Complete package of machine arrangement, up-gradation, trials and dispatch to customer as a customized solution
- Original machine may have Bush spindle arrangement . Bush spindles need continuous lubrication. Bush in the spindle gets worn out after ageing, resulting in run-outs on the cutting tool. Bush spindle gets heated up on high rpm so speed is the limitation. It gets changed to bearing spindle which can take care of all above problems and the speed of the spindle can be increased to 1000 rpm which otherwise was maximum upto 400 rpm.
- Own designed Hob head for Hobbing machines (Figure 3).

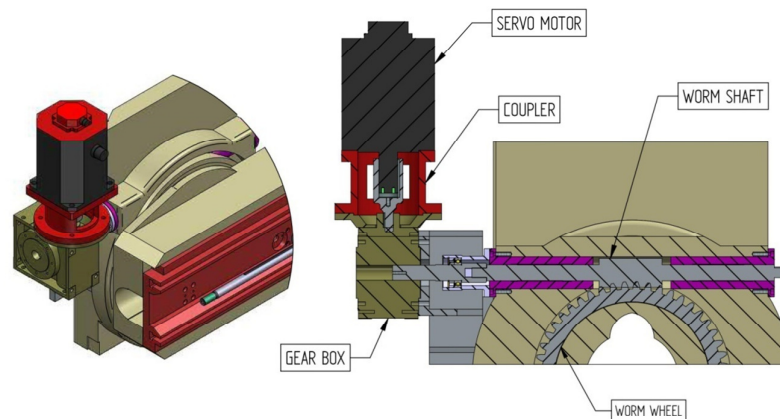




(Figure 3)

### Hob head schematic

- Spindles are with Morse taper bore arrangement for manual clamping as well as with ISO type bore taper for hydraulic clamping of cutter arbour as per the specific customer requirement.
- Cutter Arbour clamping arrangement can be modified from Morse taperto ISO-Hydraulic type.
- Manual swivelling axis gets modified into CNC axis. It eliminates the tedious process of setting the hob angle by providing automatic swivelling axis rotation through CNC.



### SWIVELING AXIS DRIVE

- Linear hydraulic axes like Radial and Axial gets modified into CNC axes with increased rapid in the new modified machines.
- If the rotary table worm wheel backlash is uneven and beyond control in the conventional machine, worm wheel is changed. We understood the process of generating various design parameters like Center distance of worm wheel- worm shaft, Worm wheel center height, metallurgy of worm wheel and worm shaft. ARK MachTek designed, got the worm wheel – worm shaft manufactured from international suppliers and assembled it successfully on machines. The whole process of confirming Blue matching on worm wheel as well as Backlash setting is of utmost important in table worm wheel assembly, about which ARK Machtek, with their continuous effort and hard work, has got a very sound knowledge now.

- Indigenously developed Menu driven programming. Least user interaction is needed to run the machine.
- Add on features like autoloader, complete machine guarding, Fixtures, Revolving center, Fixture clamping units, Deburring units and Hob arbours etc come as a complete package with machine as per customer requirement.
- IoT 4.0 is the latest development which is gaining popularity and more and more customers are taking interest in it.

### **Challenges faced during up-gradation**

#### **Customer's voice**

ARK MachTek does all kind of re-engineering related to Gear processing machine. For one of their esteemed client, who is a big OEM in India, ARK MachTek replaced the old worm wheel for more than 25 of their Hobbing machines including re-building these machines. This helped the OEM to increase the productivity, with achieving the jobs with-in DIN 7 at an affordable price, which allowed them to do the business efficiently. One of the conventional machines of 10 module, which OEM was using for Bull gears, was converted into 6-axis CNC along with the provision of Auto-loader. Hydraulic fixture and job clamping unit with automated swivelling axis helped the OEM to increase their production by 2.5 times with the ease of operation ensured.

Case study of a conventional machine, existing problems reported by customer and solutions planned and achieved by ARK MachTek-

#### **Machine – PA300 (Pfauter make)**

<b>Serial No</b>	<b>Old machine problems</b>	<b>Changes planned and achieved</b>
<b>1</b>	Bush spindle – speed-feed limitations	Bearing Spindle with increase speed and feed
<b>2</b>	Manual arbour clamping	ISO Type Hydraulic arbour clamping
<b>3</b>	Dead center	Revolving center
<b>4</b>	Table drive through change gears	Table drive through direct CNC MOTOR- Index shaft

		drive
5	Existing table worm wheel- worm shaft and brake worm wheel-worm shaft pair was having uneven backlash.	Table worm wheel – worm shaft and brake worm shaft-worm wheel was replaced with new one
6	Lead and profile variation	Lead and profile achieved with-in desired limits
7	Swivelling axis was manual	Swivelling axis was automatic
8	Skilled operator needed	Eliminated the need of skilled operator

#### Benefits realised by cutomers–

The modified machine was maintenance free and easy to use. The increased spindle speed allowed the machine to operate with such a speed and feed that cycle time reduced to 3 to 4 times for various jobs as compared to earlier. Productivity increased significantly.

Following comparision will describe this point in more detail-

Serial no	Old machine cutting parameters	Modified CNC machine cutting parameters
	47 teeth Bull gear- 6.5 module	47 teeth Bull gear- 6.5 module
1	1 <sup>st</sup> cut speed and feed -120/1.20	1 <sup>st</sup> cut speed and feed -200/2.00
2	2 <sup>nd</sup> cut speed and feed -350/2.00	2 <sup>nd</sup> cut speed and feed -400/2.50
3	Original cycle time – 26 minutes (for 2 jobs)	New cycle time – 10 min 40 seconds (for 2 jobs)

Due to automatic clamping of arbour and automatic movement of tailstock, the setting time reduced significantly, this in turn increased the productivity. The automatic movement of Tangential axis allowed the uniform wear and tear of cutter hob, this in turn increased the life of tools. The smooth running, with easy to use menu driven programming and good build

quality of machine ensured that customer can have the maximum benefit of a CNC machine that too at 1/3 rd price of a new CNC machine. This way customers get the value for their money by converting their assets into a world class product that too at a reasonable price with the best of quality assured.

As it is evident that from it's inception ARK MachTek is helping the Indian MSME's in achieving their business goals along with competing with International suppliers by converting their assets into a quality product equipped with modern technology at an affordable and competitive price. ARK MachTek strongly supports “**Make in India**” concept and is echoing the vision of our honourable Prime Minister - “**Be vocal, forlocal.**”