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# Spur Gear Cutting Attachment for Lathe Machine: A Key to Increased Productivity, Decreased Cost and Floor Area Requirement

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## ABSTRACT

*Lathe is a very important manufacturing subsystem in many sectors.Even though it is a versatile machine, it has some limitations while performing certain operations like a spline, gear cutting. The use of milling machines in the production of spline and gear cutting is well recognized. If an attachment on general purpose lathe is made available, the cost of production of a product could be reduced. A CNC machine can perform the many operations more effectively and the human involvement is limited. However, due to increase in the cost of a CNC machine and the indirect costs associated with these machines, they are considered as white elephants in a certain class of manufacturing units. The main objective of this paper is to Design and Analysis of Spur gear cutting attachment for Lathe machine to increased Productivity, Increased flexibility of Lathe, Decreased Cost, and Floor area Requirement. The developed design is modelled by using CATIA V5 and the model is simulated in Solid works motion simulator software. By using ANSYS Software we tested the strength of the spur gear cutting attachment in Lathe machine.*

**Keywords:** *Spur Gear, Lathe machine, Milling machine, Optimization, Ansys*

## INTRODUCTION

Workshops and small-scale industries are heavily constrained to use general purpose machines due to financial limitations. Machines such as Lathes and Milling machines are versatile with these groups as they required minimum funding and are easy to maintain. Researchers always attempt to help these industries through innovative methods to enlarge the ambit their production using these general purpose machines. A variety of attachments are already in use by these industries.

Even though various attachments like keyways, slotting, internal keyway, grinding wheel and eccentric turning for lathe machine. Still, it is facing some difficulties like machining of gear cutting and sp lines on the shaft. To overcome this difficulty it is necessary to design an attachment for the lathe. Which is able to overcome these difficulties and flexible to use it in standard lathes.

## LITERATURE REVIEW

S. Amar conducted to a reviewed on the attachment is a good tool for contemporary industrialization which is able to undoubtedly facilitate to enhance the productivity and can facilitate the industries to enhance the standard of keyway operation. The compact style of attachment can facilitate simple operation of the keyway.

Dr. G. Naga MalleshwarRao conducted a study on overview of eccentric turning attachment. with the help of V-block, studs, center plate, center rod, base plate, nuts, scale etc., they have implemented this design successfully and executed this attachment might helpful to reduce time while performing desire operation.

M.Narasimha1 review done adjustable multi-spindle attachment. The main motto of this project is machining 3 t-slots at a time, which is in the range of 40 mm to 320 mm. In initial stage this attachment was designed in CAD model letter this attachment was fabricated based on there recent to accomplish. The accomplished of the requirements in the range of 40 mm to 160 mm in a single pass to cut T-slots by implementing three different cutters on an arbor in a milling machine Tool.

J.C.Harbison focused on a milling attachment for lathes. He modified the attachment that cutting tool fitted to the arbor and that is supported by chuck and tailstock. He modified direct indexing to compound indexing.

J.W.Bracus states that a gear cutting attachment. He was studied and modified smith's attachment and he tried to initiate indexing in the attachment.

T.E.Smith said that a keyway and gear cutting attachment for lathes. He is the initiator for this concept he builds a gear and keyway cutting attachment for lathe by adding another motor to the cutting tools and chuck modified as holding and indexing device but this attachment is heavy and complex.

## MILLING

Milling is a machining operation that will do machining by fixing workpiece at a certain position and then doing operation by guiding cutting tool towards the workpiece. That is a vertical milling operation there are different milling operation is available in now a days and most of them are operated by CNC machines to get much precision and reduce time in production.

## MACHINING

Machining covers a good style of actions that take a material and switch it into one thing else. It is outlined as a controlled method that takes the material and transforms it into a desired final form and size. This may embrace material-removal as seen with such actions as cutting, drilling, boring, or material addition. Although machining is most ordinarily used with the metal product, machining can even be through with materials like wood, ceramic, plastic, and composite materials.

## SPUR GEAR

Spur gears consist of parallel teeth to the axis and are utilized for transferring power between two parallel shafts. They are simple to manufacture and low cost. They need the most effective potency and smart accuracy rating. They are used in high speed and high load application altogether varieties of trains and an honest sort of velocity ratios. Hence, they perceive wide applications right from clocks, organization gadgets, motorcycles, vehicles, and railways to aircrafts.

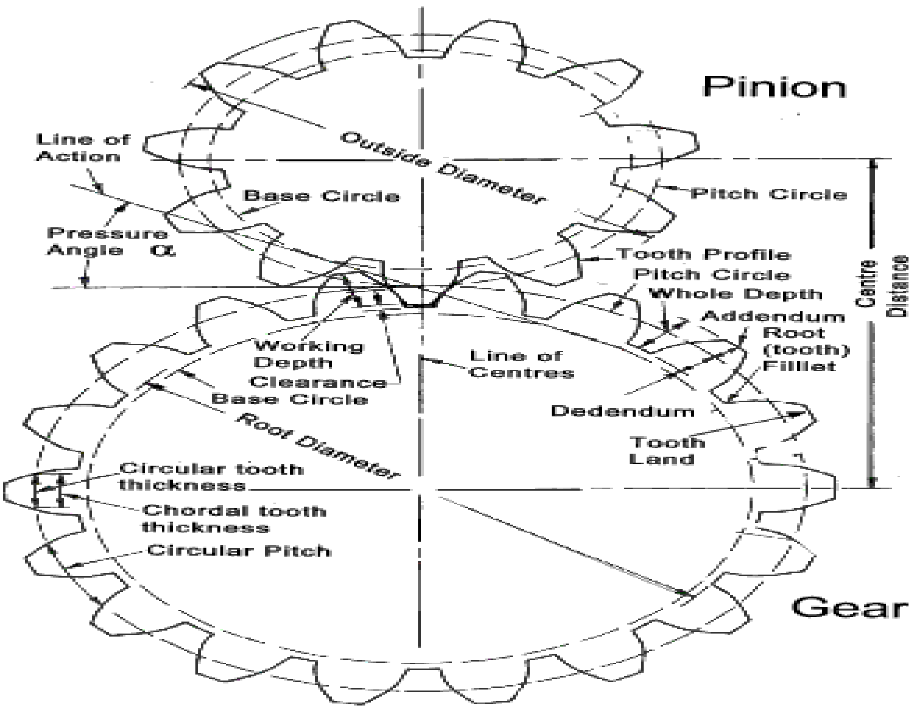


**Figure1.** *Spur gear*

## METHODOLOGY

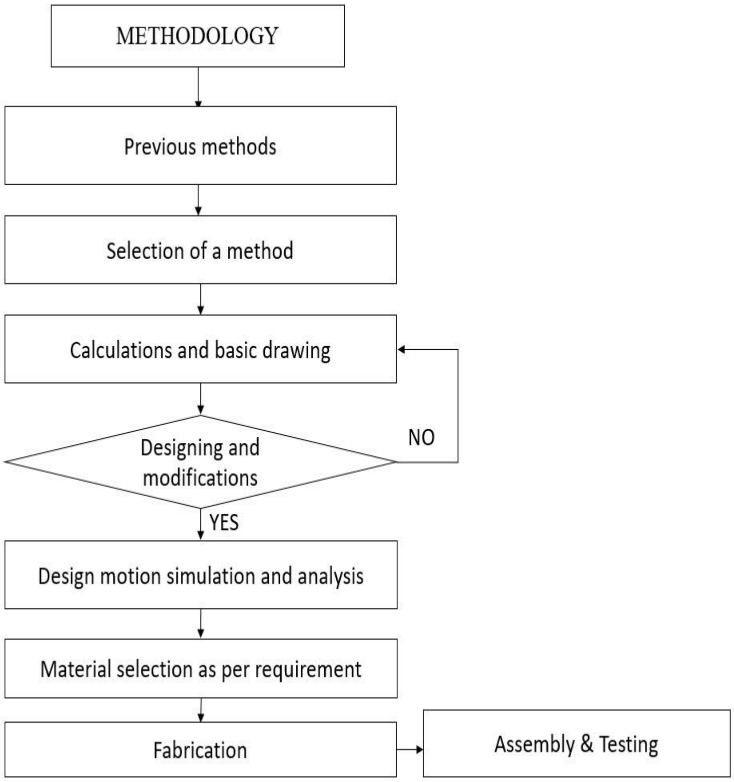


**Figure2.** *Methodology flow chart*

## CALCULATIONS

### Spur Gear Creation

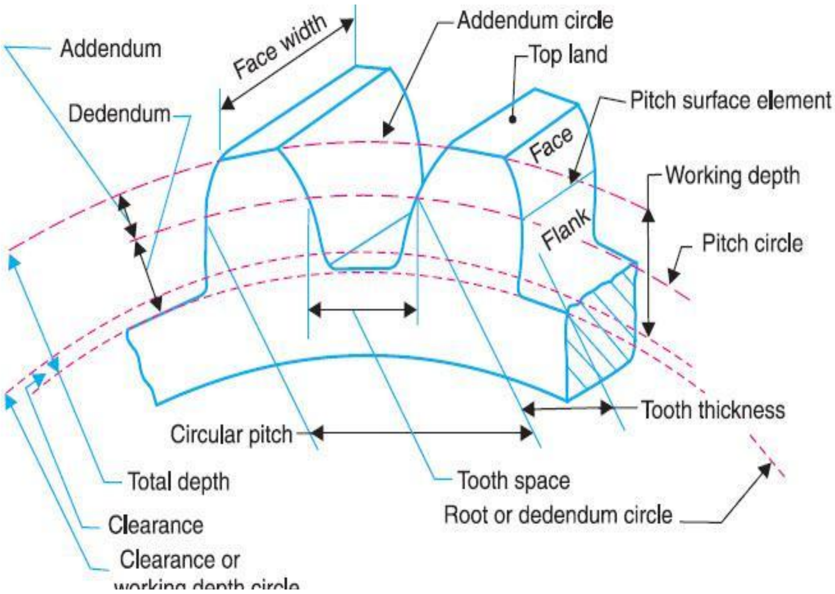


**Figure3.** *Spur gear nomenclature*

| | | | |
|---|---|---|---|
| Whole Depth (W) | = 2.157/P | Circular Pitch (CP) | = 3.1416/P |
| Addendum (a) | = 1/P | Diametric Pitch (P) | = N/D1 |
| Tooth Radius(R) | = ¾(CP) | Teeth number (N) | = D1xD |
| Pitch Diameter (D1) | = N/P | Dedendum (d) | = W-a |

Outside Diameter (D) = (N+2)/P

Cordial Thickness (T) = D1sin(90/N)

Work piece diameter 50 mm

For this work piece if number of teeth 18 then the gear parameters will be

1) Outside Diameter D = (N+2)/P

Outside Diameter D = 50 mm

Teeth number = 18

50 = (18+2)/P

P = 20/50

= 0.4 mm

2) Pitch Diameter D1 = N/P

P = 0.4

D1 = 18/0.4

= 45 mm

3) Addendum a = 1/P

= 1/0.4

= 2.5 mm

4) Dedendum d = w-A

5) Whole Depth W = 2.157/P

= 2.157/0.4

= 5.3925

D = 5.3925 – 2.5

= 2.8925 mm

6) Circular Pitch CP = 3.1416/P

= 3.1416/0.4

= 7.854 mm

7) Tooth Radius R = ¾(CP)

= ¾ (7.854)

= 2.94 mm

8) Module m = D1/N

= 45/18

= 2.5

9) Chordal thickness T = D1 sin(90/N)

= 45 sin (90/18)

= 3.922 mm

Work piece diameter 50 mm

For this work piece if number of teeth 24 then the gear parameters will be

1) Outside Diameter OD = (N+2)/P

Outside Diameter = 50 mm

Teeth number = 24

50 = (24+2)/P

P = 26/50

= 0.52 mm

2) Pitch Diameter D1 = N/DP

P = 0.52

D1 = 24/0.52

= 46.15 mm

3) Addendum a = 1/DP

= 1/0.52

= 1.92 mm

4) Dedendum d = w-A

5) Whole Depth W = 2.157/P

= 2.157/0.52

= 4.15 mm

d = 4.15 – 1.92

= 2.23 mm

6) Circular Pitch CP = 3.1416/P

= 3.1416/0.52

= 6.04 mm

7) Tooth Radius R = ¾(CP)

= ¾ (6.04)

= 4.53 mm

8) Module m = D1/N

= 46.15/24

= 1.922

9) Chordal thickness T = D1 sin(90/N)

= 46.15 sin (90/24)

= 26.38 mm

## MODEL DEVELOPMENT

The mode was developed by Solid works software and is imported to ANSYS software for carrying out further analysis and it is shown below.

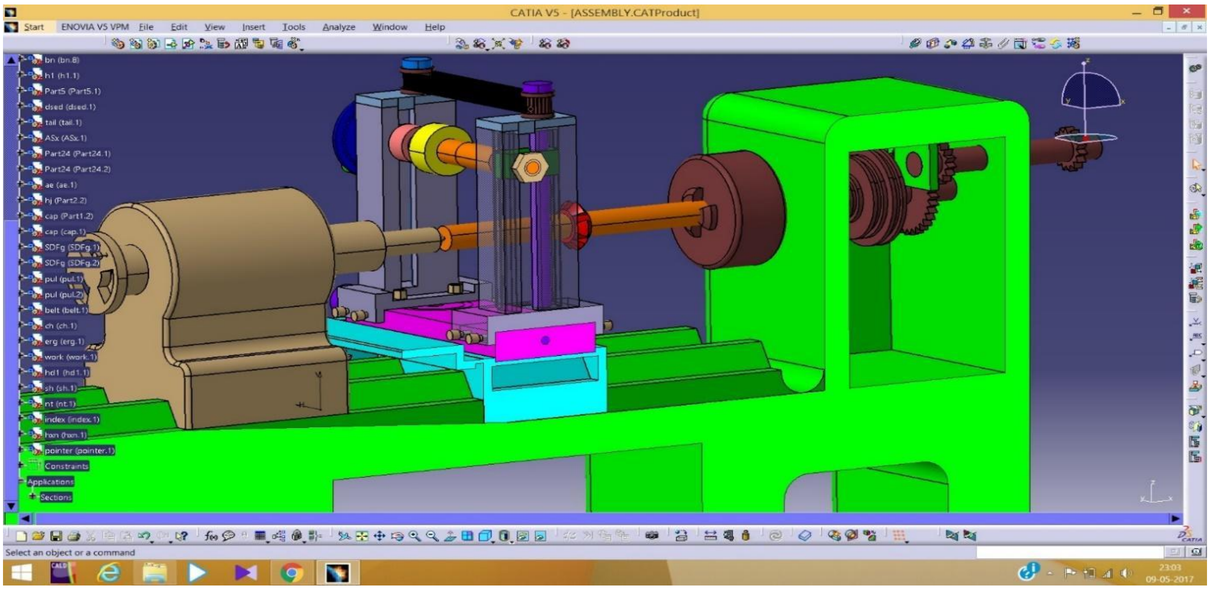


**Figure4.** *Modified model*

## MOTION SIMULATION

All motions are applied to the assembly parts and the final animated video was recorded.Motions applied to the assembly parts are illustrated in below table.

**Table1.***Motion simulation details*

| S.NO | PARTS | X linear (mm) | X rotation (RPM) | Y linear (mm) | Y rotation (RPM) | Z linear (mm) | Z rotation (RPM) |
|---|---|---|---|---|---|---|---|
| 1 | Cross slide | -200 | 0 | 0 | 0 | 0 | 0 |
| 2 | Centers | 0 | 0 | 0 | 0 | -100 | 0 |
| 3 | Cross slide | 0 | 0 | 150 | 0 | 0 | 0 |
| 4 | chuck | 0 | 600 | 0 | 0 | 0 | 0 |
| 5 | other | 0 | 0 | 0 | 0 | 0 | 0 |

All parameters are taken from general purpose lathe and milling machine now these values will be applying on the modified model assembly structure and analyzed by using ansys software.

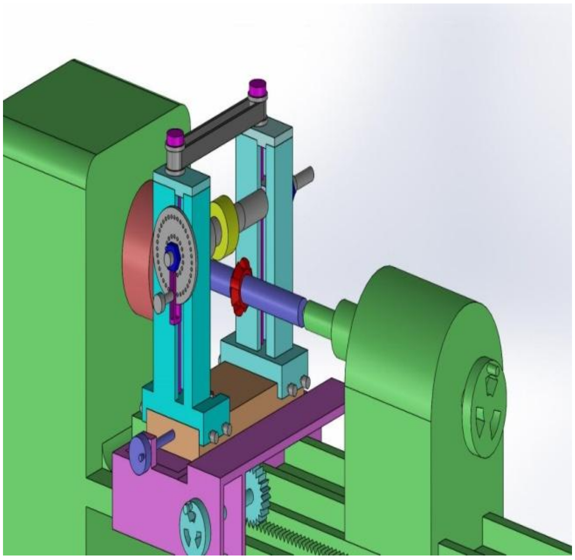

**Figure5.** *Simulation frame image A*

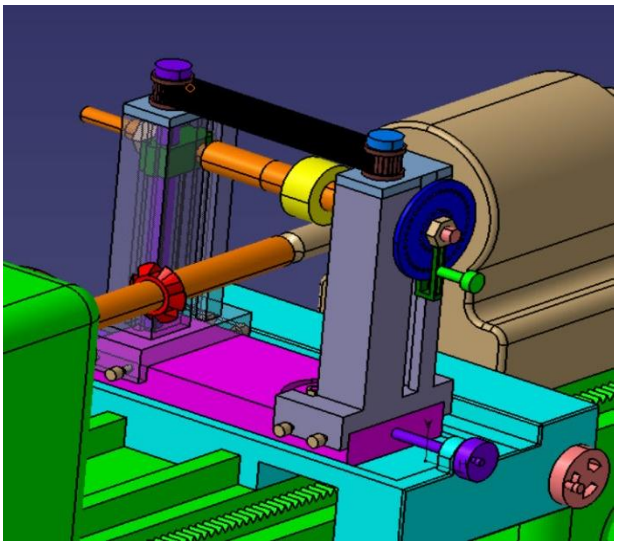

**Figure6.** *Simulation frame image B*

## SIMULATION CALCULATIONS

Hence stress concentration factor $F_1(\alpha_{\circ}) = \frac{\sigma_{max}}{\sigma}$

$$= \frac{247}{7.76} = 31.8$$

Hence stress concentration factor $F_2 (\alpha_{\circ}) = \frac{\sigma_{max}}{\sigma}$

$$= \frac{247}{77.87} = 3.17$$

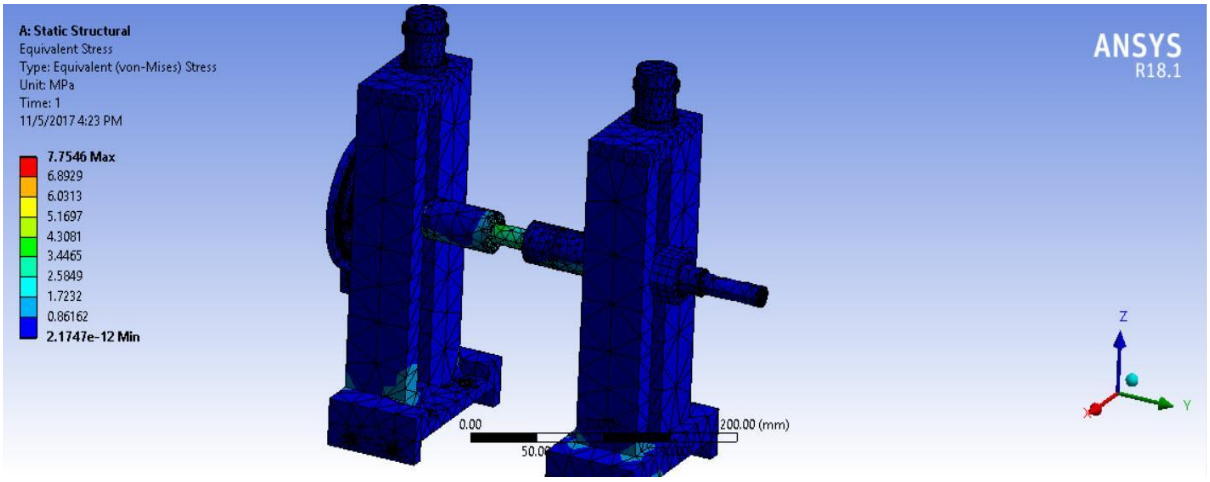


**Figure7.** *Equivalent elastic stress in MPa*

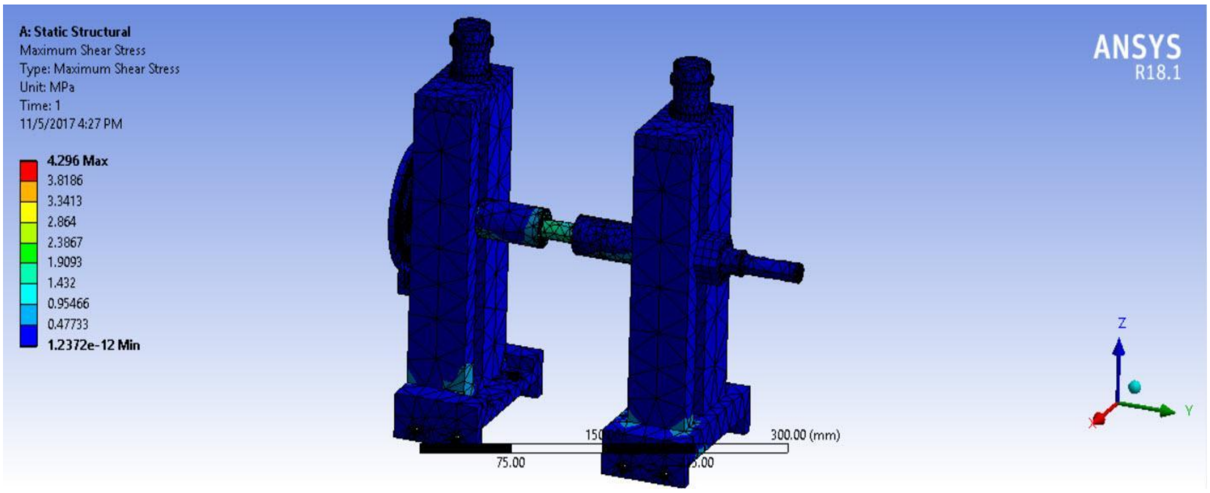


**Figure8.** *Max shear stress in MPa*

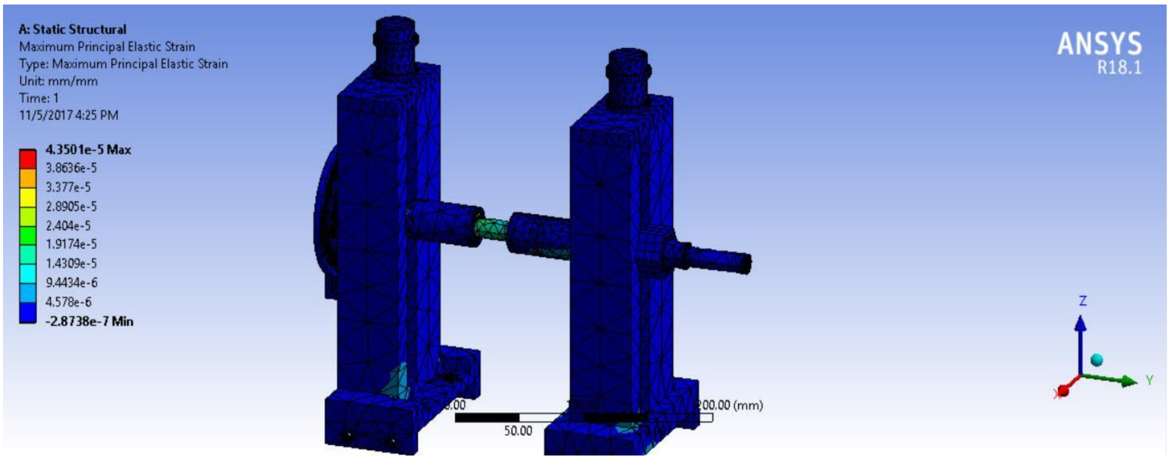


**Figure9.** *Maximum principal elastic strain*

## CONCLUSION

The following conclusion can be drawn

- A lot of investment is saved instead of buying a milling machine.
- Produced samples might competitive with milling accuracy.

- Cost of manufacturing is also reduced.
- Floor area requirement is also reduced.
- Tool life and productivity can be increased.
- Flexible in operation.
- Simple in operation and no need for a skilled operator.
- Good accuracy can be achieved.

## FUTURE SCOPE

- Other operations can also be incorporated in to the machine.
- Cost can also be reduced to some extent by manufacturing it on a mass scale.

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