Advanced Manufacturing Processes
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Module - 5
Other Advanced Process
Lecture - 3
Rapid Manufacturing, Applications and Advancements

Welcome to the session on rapid prototyping under the course advanced manufacturing processes. In the last session, we have discussed about few rapid prototyping processes, basics of rapid prototyping its features, major processes in rapid prototyping technology and their applications. In this session we will be discussing and studying few other processes, in rapid prototyping technology. They are basically thermo jet processes, ballistic parts manufacturing and rapid manufacturing in short R M process. We have already discussed the rapid prototyping technology is the followed of customers demand for speedy delivery of the products, this is not only from the customer side. But also the speedy delivery of different inputs to the subsequent stages in manufacturing shops also triggered the development of these processes.

So, these are some of the technologies that could compress the time in manufacturing. In other words we can say that the manufacturing lead time could be compressed and accordingly the product could be delivered either to the customer in the field, or to the subsequent stages in the manufacturing at rapid pace. But, there are different issues and different techniques involved how to go about it. In the last session we have already discussed there are number of techniques that can be employed for producing purge under this category are manufacturing that is rapid prototyping technologies.

We have already studied lacer centering process; we have already studied laminated object manufacturing processes and so on. And its process is slightly different from the order as for as the working is concerned, but basically all the processes are following the same principle to the extent that, this products are the parts are produced layer by layer putting one layer on top of the another, through different techniques. And these are directly being produced from the cad model than transforming this model into some other formats. And there by directly getting the 3-D part in the machine that is connected to the cad terminal. So, in other processes like laminated object manufacturing processes that also we have seen.

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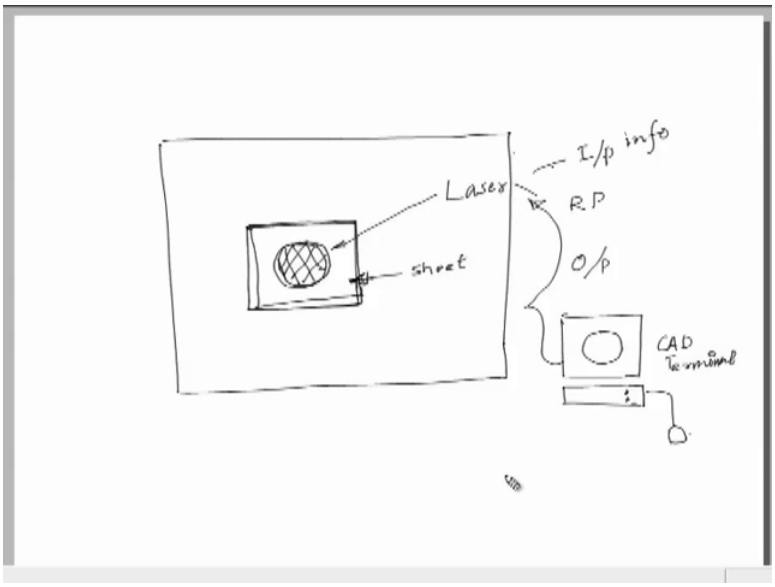

As we have already discussed in one of the previous session, that laser place an important role in this process. Say for example, in one of the processes, we have discussed if there is a sheet like this then laser can be applied to specifically curve out one object from this which is dictated by the cad drawing in the cad terminal. So, this can be walked out in the cad terminal here and this can be directly connected to the machine R P machine.

So, this is the output of the cad terminal this is the cad terminal and this can be given to the R P machine as the output of this cad terminal and for this R P machine this will be input information. And this will work on this input information and the final part will be built up in this machine depending on different principle, as per the working of the mechanisms. Now, let us look into another processes in this series this is called thermo jet process, let us discussed this thermo jet process first.

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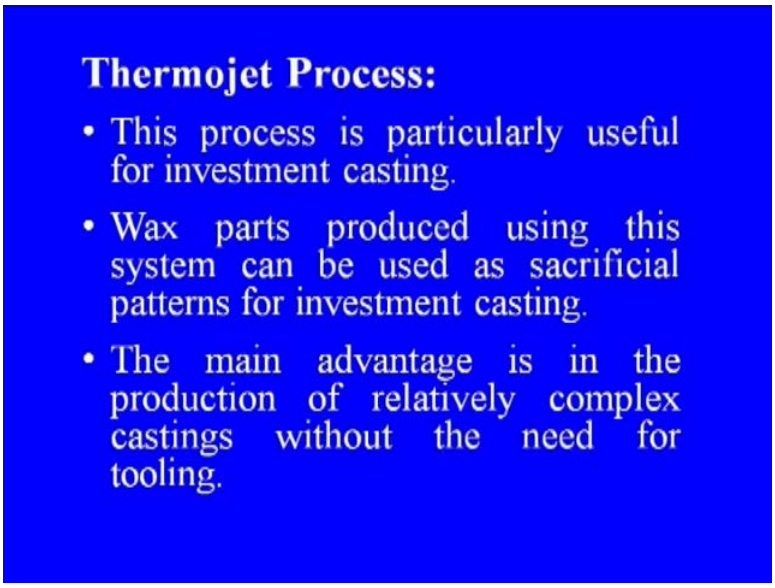

This process is particularly useful for investment casting process, as I have already indicated this rapid prototyping products are at many times intermediate input to some other processes, in the manufacturing shop. Say for example, in casting we need a pattern, this pattern can be produced very effectively and very economically by different rapid prototyping techniques, this is one of the processes is like thermo jet process which could be very, very useful in investment casting process.

Wax parts are produced using this system can be used as sacrificial patterns, for investment casting, as all ours know the basics of investment casting where the pattern is to be invested or sacrificed. Therefore, this wax are materials of the type whose melting point is much slower, which less heat it can get melted can be used as a pattern material in these type of processes. And on the other hand, this type of materials low melting point materials like wax extra are very good to be used in the R P processes. The main advantage is in the production of relatively complex castings without the need for tooling.

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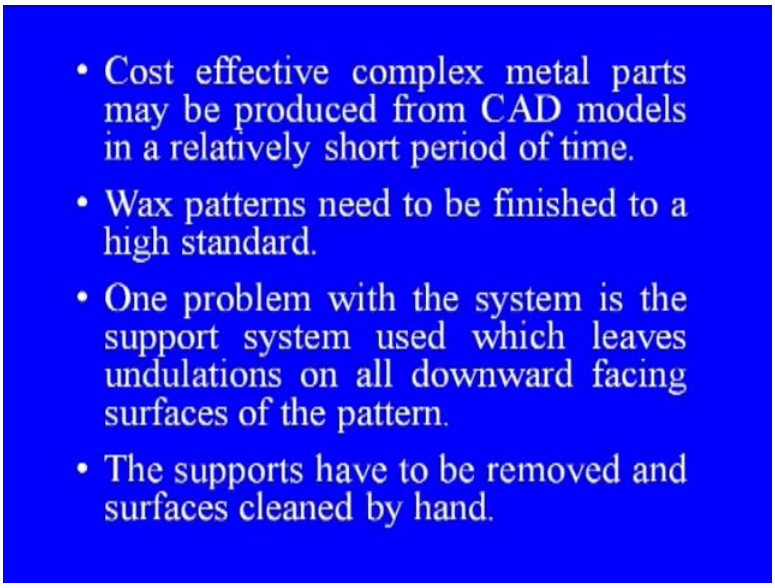

Coast effect if complex metal parts may be produced from cad models in a relatively short period of time, this is I have indicated at the beginning of this session even. Cad terminals can be used to produce the model very effectively within a very short time. Moreover first modification can be very rapid with the use of cad terminals, in a way that already there may be cad designs or cad models were available for a part is maybe to some extent similar to the present part is needed. Therefore instead starting from the scratches of the new part we can take the help of the basic model available in the cad database.

And then we can go on modifying the existing model together new model, and this model subsequently can be converted or transmitted in to other formats for subsequent processes of or steps of manufacturing. Generally wax patterns need to be finished to a very high standard, one problem with the system is the support system used which leaves undulations on all downward facing surface of the pattern. The supports have to be removed and surfaces cleaned by hand.

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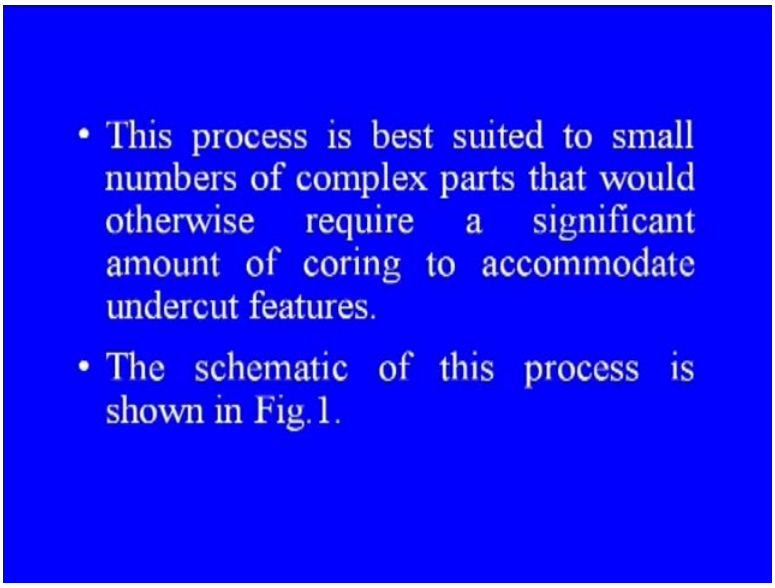

This process is best suited to small numbers of complex parts that would otherwise require a significant amount of coding to accommodate undercut features. The schematic of this process is shown in the figure; the process is shown in the screen the basic scheme of the thermo jet process.

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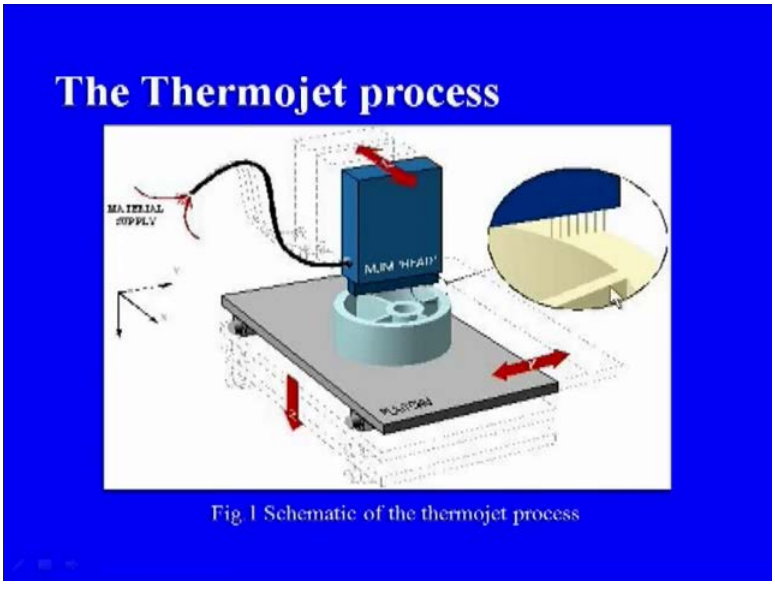

Here this is the platform and this is the object being manufacture and as I have indicated at the very beginning, this is the layer by layer manufacturing process in most of the cases. So therefore, the material is getting deposited on this product and this platform

will be lower in a stage, so that next layer can be deposited on top this and top of this. So, if was this layer is being produced then this is lower by a thickness equivalent to the next layer to be produced.

And therefore, the subsequent layer or the next layer will be deposited like this on top of this, and this x-y movement of this or the movement of this head. We can think of this is like a printing head as in the case of inkjet printers where inks are being deposited on top of the paper which of course, we see in the form of 2-D. But in this case since every time one layer is being produced, which is 2-D in nature obviously then the platform would be lowered by thus this distance. And one more layer will be produced with subsequent depositions like this differential performance 3-D object as shown on in this figure.

So, we can we can here control the movement of the plate form, as well as the head either we know this there are excellent facilities like computer numerical facilities are there, which can be integrated to any of the R P machines for controlling the x-y and z movements of the either the plate form or for the printing, or the deposition head. Now, let us move on to another process that is ballistic particle manufacturing process. In short known as the BPM process.

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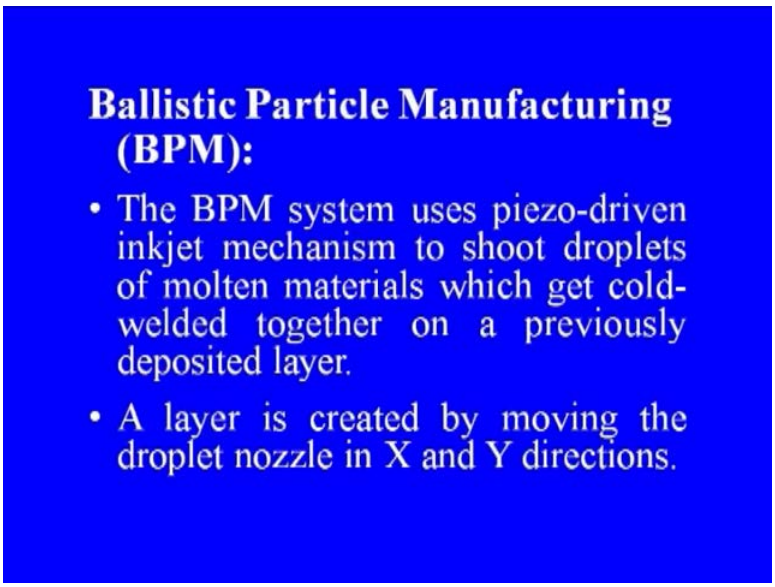

And the ballistic particle manufacturing system uses piezo-driven inkjet mechanism to shoot droplets of molten materials, which get cold welded together on a previously

deposited layer. A layer is created by moving that droplet nozzles in X and Y directions. So, this is in the sense a 3-D printing concept.

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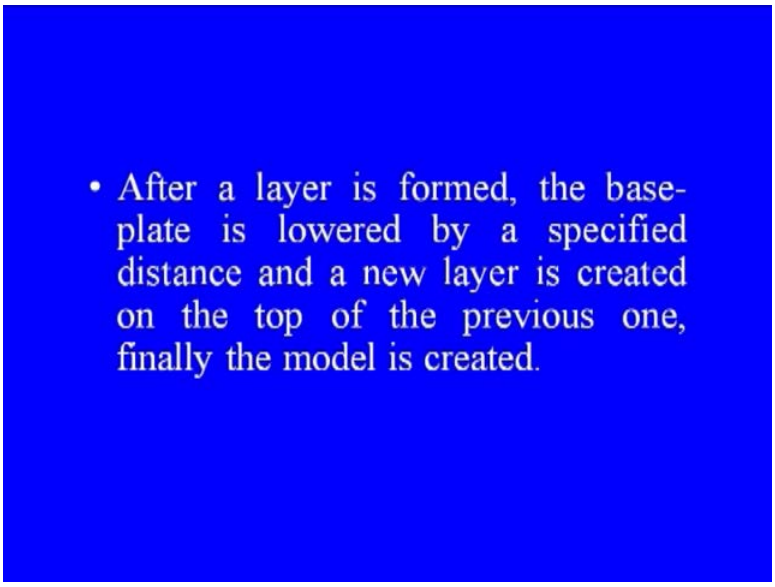

After a layer is formed the base plate is lowered by a specified distance and new layer is created on the top of the previous one. Finally, the model is created then the rapid manufacturing process R M process. So, this can be considered as an extension of rapid prototyping technology, it involves a automatic production of parts by instructions directly fed by the cad data which is modeled earlier.

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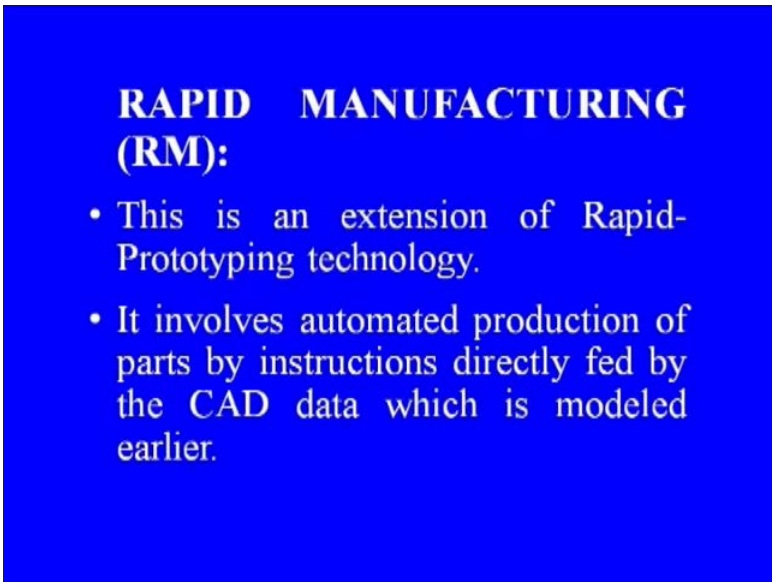

It is believed that the process of rapid manufacturing or the R M process will develop into a compelling market…

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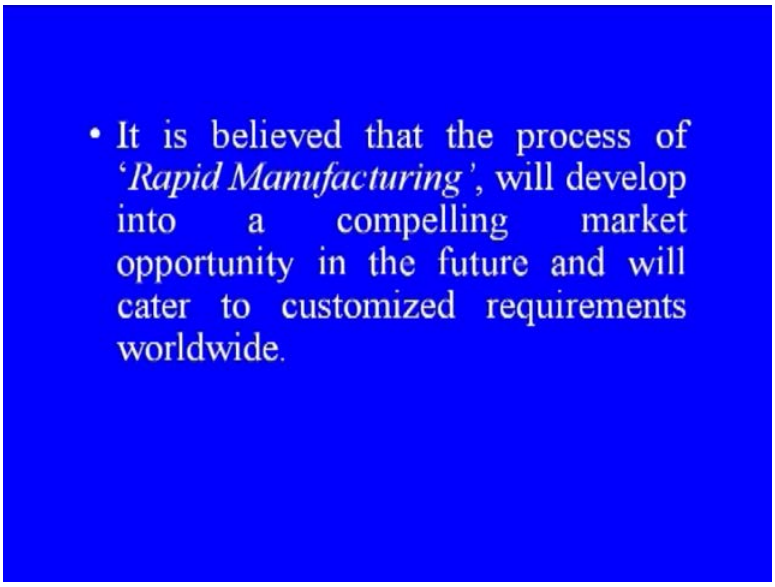

In future and will cater to customized requirements worldwide.

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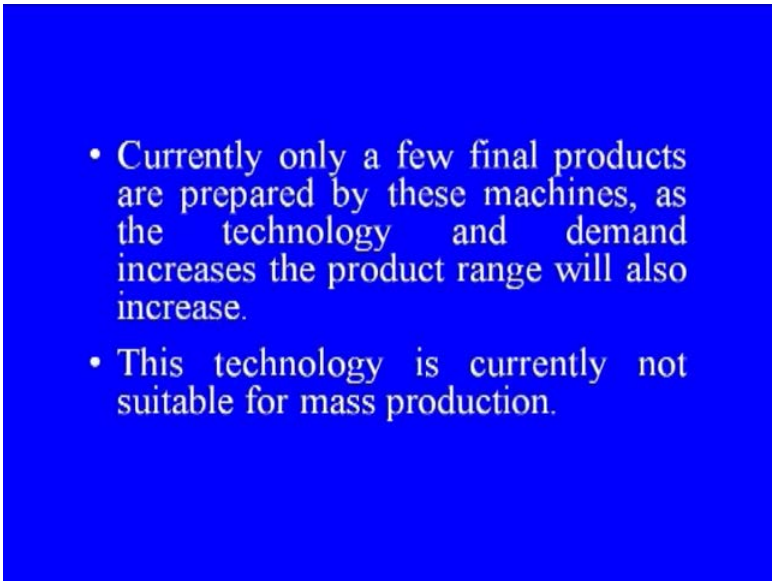

Currently only a few final products are prepared by this machines as the technology and demand increases, the product range will also increase it is expected. This technology is currently not suitable for mass production, it needs further development or further adaptation to make it more suitable for mass production and earn it. And unless this is

the process is economical, it will be hard to post forward the industries to adopt this process.

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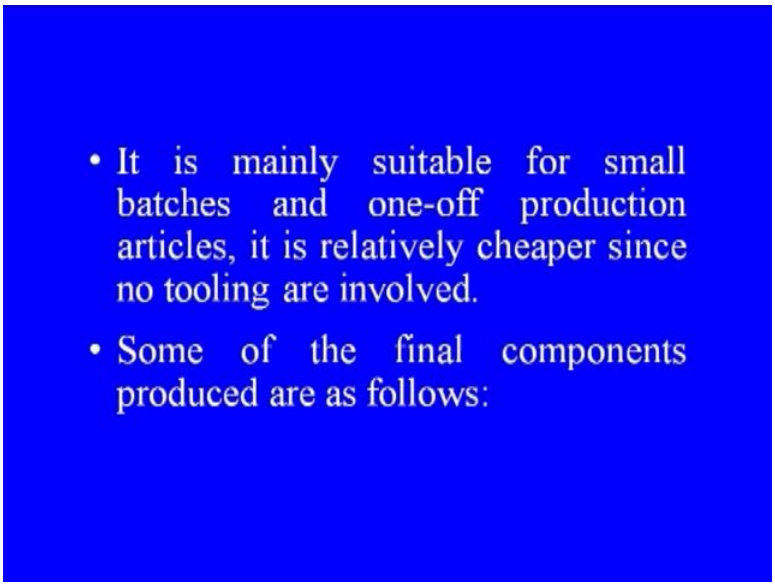

It is mainly suitable for small batches and one off production articles, it is relatively cheaper, since no tooling involved. Some of the final components produced are as follows.

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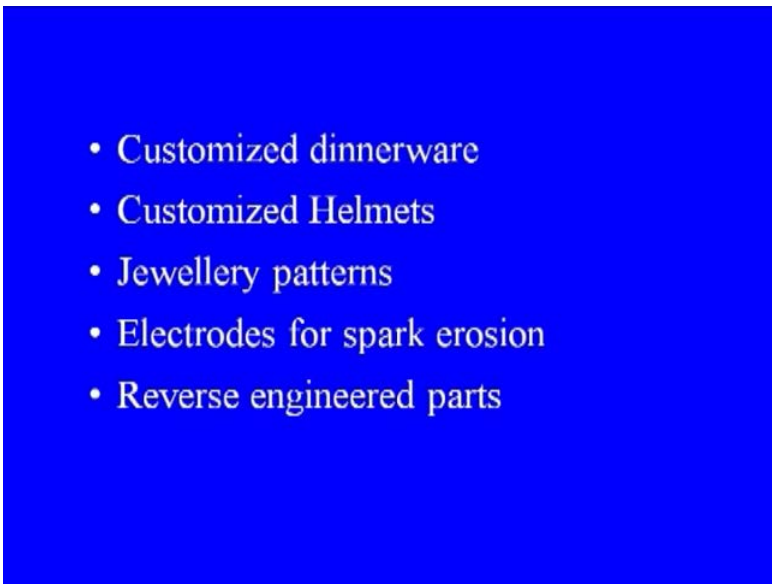

Customized dinnerware, customized helmets, jewelry patterns, electrons for spark erosion, reverse engineered parts extra. Now, let us see some common applications are rapid prototyping technologies.

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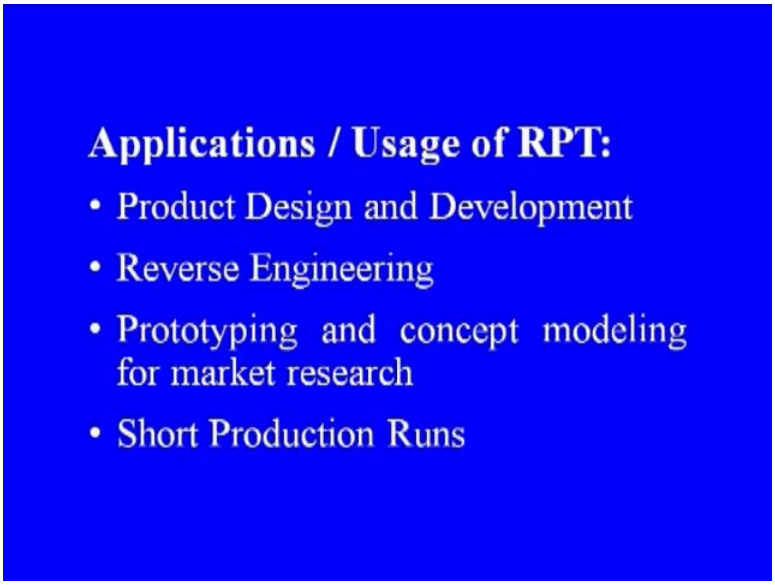

As I have already indicated they are very useful in product design and development in reverse engineering. Prototyping and concept modeling for market research then short production runs.

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Rapid tooling, models for stress analysis, industrial design and architectural modeling, jewelry design in medical applications, crafts and fine arts. Some product examples are rapid manufacturing can be listed like this.

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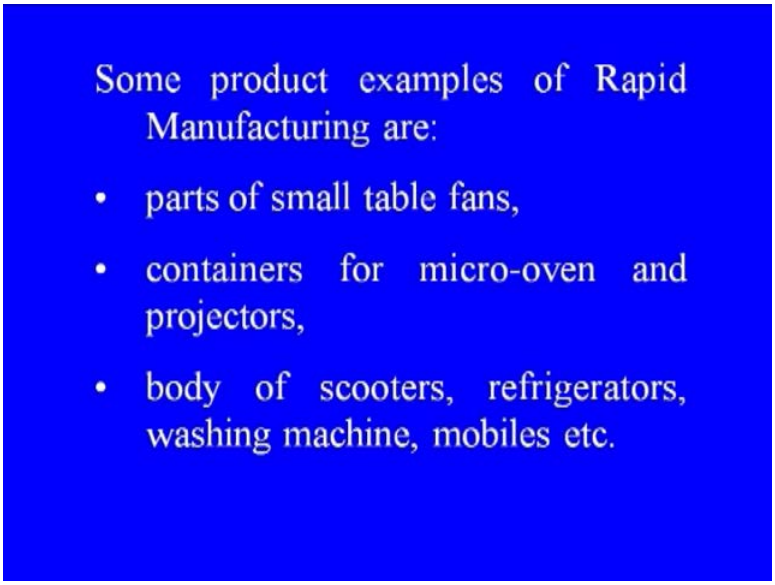

Parts of small table fans, containers per micro-oven and projectors, body of scooters refrigerators and washing machines mobiles extra. These are some of the products that can be produced.

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Some part of this can be produced very effectively and economically by applying the rapid prototyping technologies.

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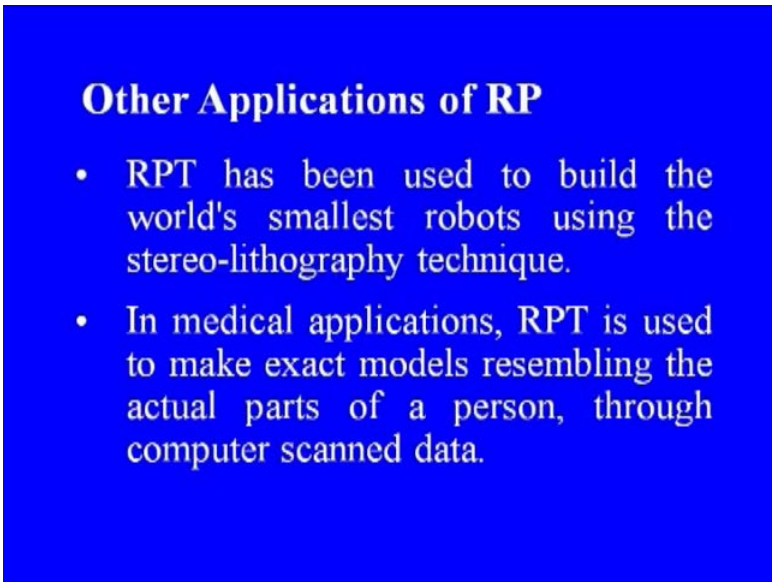

Some other applications of rapid prototyping include it has been used to build the world's smallest robots using the stereo-lithography technique. In the previous session we have discuss about stereo-lithography technique. In medical applications are rapid prototyping technology is used to make the exact models, resembling the actual parts of a person, through computers scanned data. This is one of the significant applications of the rapid prototyping technologies, now a day's medical sciences the advancement in medical sciences have given us the opportunity to scanned through, almost all the body parts.

Of course, this we can say is a reading of medical sciences and engineering, which is given rights to some of the techniques and the equipment, it can be used to scan each and every part of the body with minutest details. Say for example, if I need to scan this limb of my hand, this can be done by using some imaging equipment and the subsequent development in the processing of images as given rice to the technique, that the images can be again reproduced or put together to form a virtual model of the bone of this. That is exactly similar to that of inside my hand.

Therefore, by using this imaging and then processing this image. We can reproduce on all cad screen virtual image of the bone that is the inside my body, now for doing some

tests which the doctors can not in a life situation on my hand, going to different problems can be carried out on a model of the exact model of the bone that is existing in my hand. Which is the virtual model of which is already being produced in the cab model, thanks to the technology of imagining.

Now, we can rather have an exact replica of the bones or the virtual image that is showed in my computer or the cad terminal why using rapid prototyping technology, in the form of a 3-D model which can be got printed or produced as part of a as a rapid prototyping part, which is nothing but the exact replica of the bone. I am having now the doctor doctor's has the flexibility they have flexibility to walk up on, to examine different aspects related to this which will reduce my pains or my discomfort. If it would have been done or carried out in my body. So this is one of the very significant advantages or application of rapid prototyping technology.

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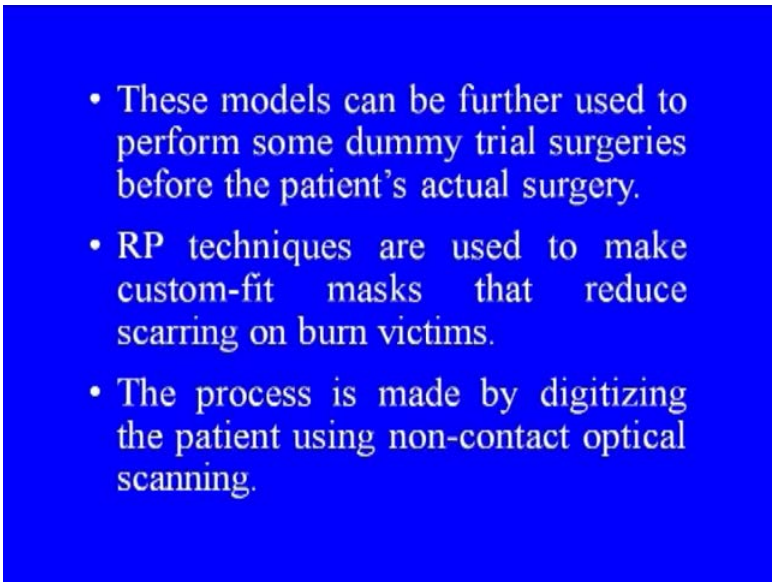

This model can be further use to perform some dummy trials, or even the trial surgeries before the patients actual surgery this is what I have already indicated, different tests can be carried out, different surgery dummy surgery can be carried out. Whether, it is visible or not whether it can be successful or not, which is not possible that experimentation. Whether it will be successful or not cannot be carried out in a leaving human being or this is not article as well, but which is possible. Now, this is possible to help of these technologies.

Rapid prototyping techniques are used to make custom fit masks that reduce scaring on burn victims, the process is made by digitizing the patient using non-contact optical scanning. This is another very significant applications as per as the human life is concerned, human comfort is concerned or advance in human treatment is concerned. We can reduce these sufferings of patient by using this technologies, which is very significant.

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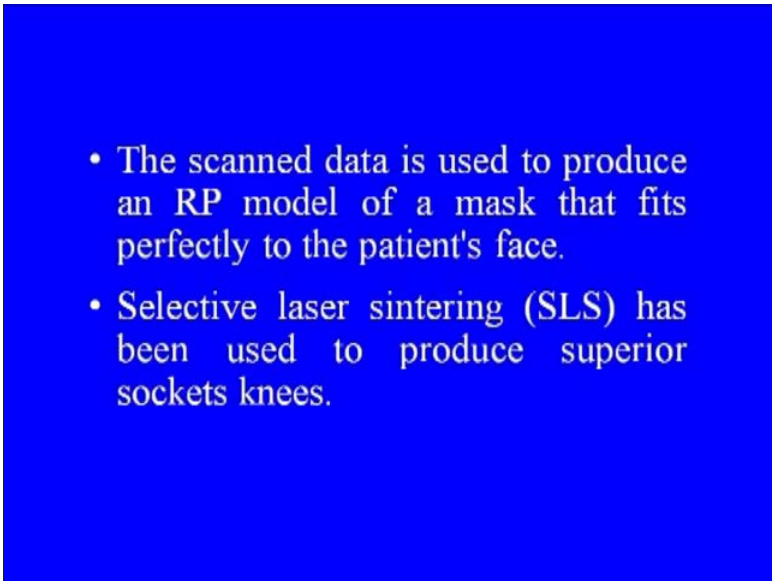

The scanned data is used to produce the R P model of the mask that fits perfectly to the person’s face, then the selective laser sintering SLS. Can be used to produce superior sockets knees extra this we have already discussed the SLS technique in the previous session.

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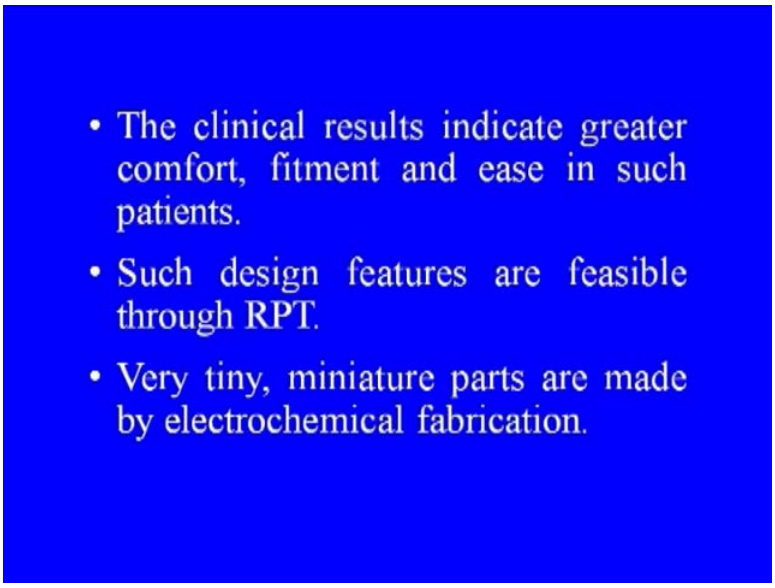

The clinical results indicate greater comfort, fitment and ease in such patients. Such a design features are feasible through rapid prototyping technologies. Very tiny, miniature parts are made by electrochemical fabrication, which also comes under rapid prototyping technologies.

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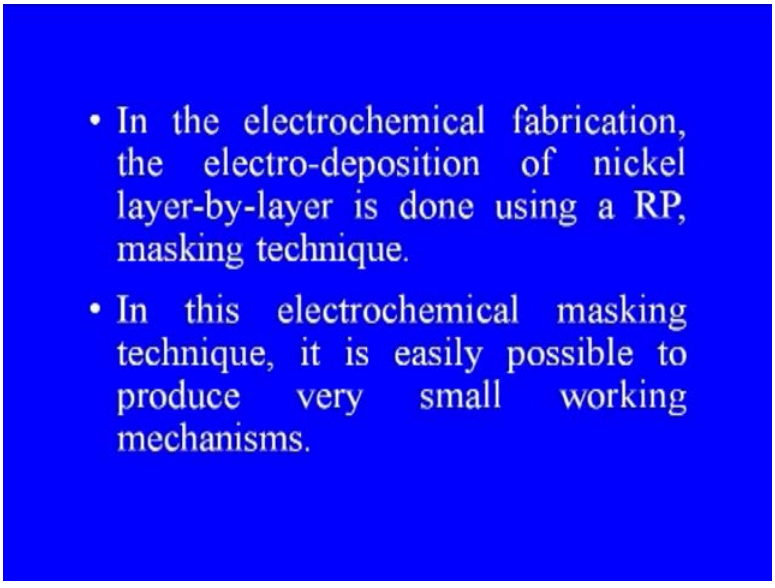

In electrochemical fabrication, the electrode deposition the nickel layer by layer is done using rapid prototyping masking technique. In this electrochemical masking technique is

it easily possible to produce very small working mechanisms. Let us discuss another application of this process this is vacuum casting.

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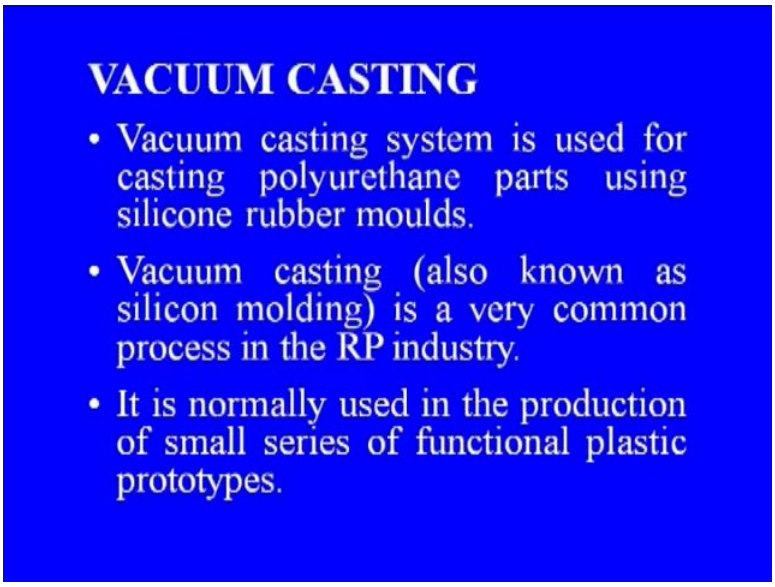

Vacuum casting system if used for casting polyurethane parts, using silicon rubber moulds. Vacuum catching, which is also known as silicon moldings as a very common processing the rapid prototyping industry. It is normally used in the production of small series of functional plastic prototypes.

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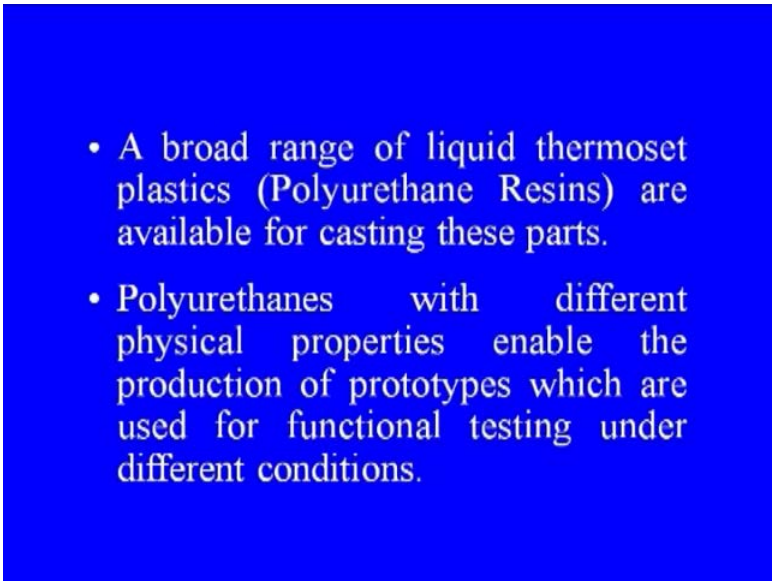

A broad drains of liquid thermo a jet plastic that is nothing but polyurethane resins are available for casting these parts. Polyurethanes with different physical properties, enable the production of prototype, which are used for functional testing under different conditions.

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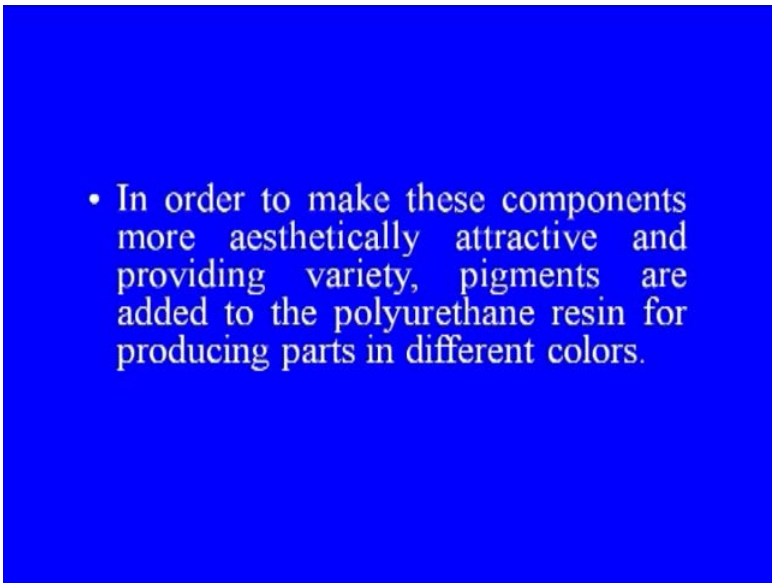

In order to make these components more aesthetical attractive and providing variety pigments are added to the polyurethane resin, for producing parts in different colors also. Now let us note few developments in rapid prototyping technologies, the directions, new directions extra.

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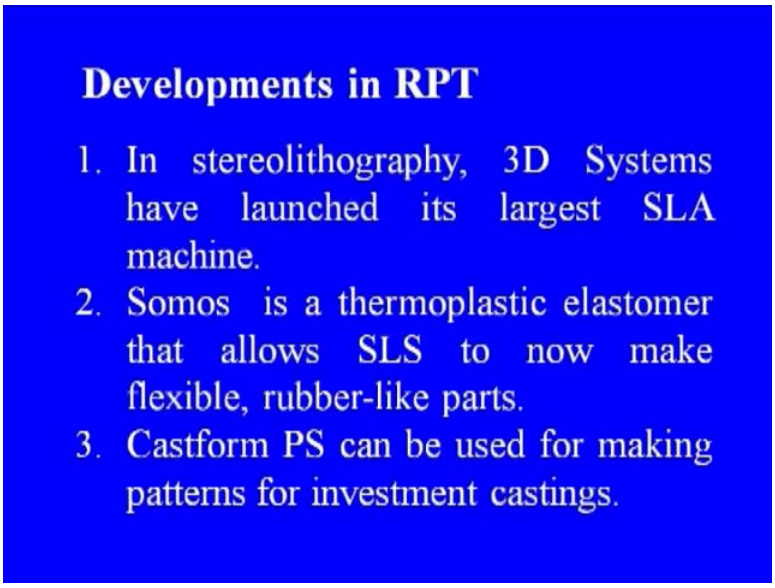

In stereolithography 3-D systems have launched its largest SLA machine free the systems is a company which is very premier in rapid prototyping technologies. So, they have introduced one of the largest SLA machines. Somos is a thermoplastic elastomer that allows SLS to now make flexible rubber like parts. These are some of the advancements in the field. Castform PS can be used for making patterns for investment castings.

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Stratasys unveiled the new FDM maximum machine, which operates that is few deposition modeling in machine, which operates fifty percent faster than previous FDM systems, which is quite impressing. It also offers one of the largest build envelopes in the R P industry. The new FDM maximum machine accommodates either very large parts or numerous smaller parts.

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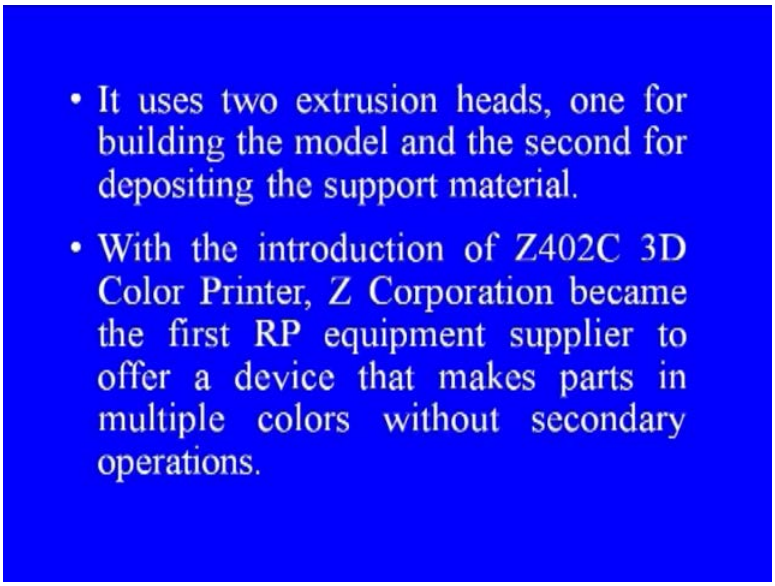

It use to extrusion heads one for building the models under second father depositing the support material. With the introduction of Z42C, 3-D color printer Z corporation became the first R P equipment supplier to offer a device, that makes part in multiple colors without any secondary operations. This is a significant state as we have already discussed in the previous session that sometimes, secondary operations mostly the finishing operations may be required following the rapid prototyping production of any part, depending on the requirements at the application end.

This is because it leaves some of the steps, step like structures at the outer ages or the outer periphery of the outer surface of the part, as it goes on building up the layers. However, if this can be eliminated then the cost of the operation of the secondary processing, as well as the time involved in the secondary processing can be eliminated thus making the entire process more productive.

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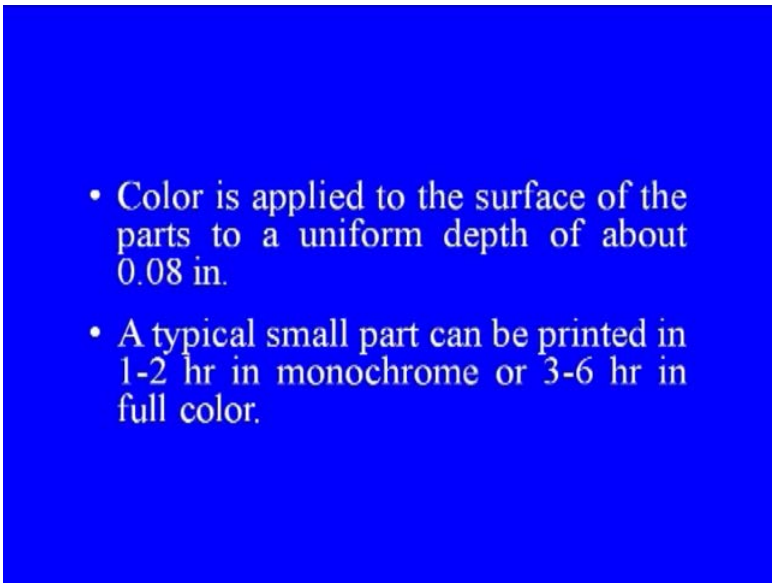

Color is applied to the surface of the parts to a uniform depth of about point naught eight inches in this type of systems. A typical small part can be printed in one to two hours in monochrome or three to six hours in full color. Now let us see if you future developments in this technologies.

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As the rapid prototyping technology gets further advanced with better and new techniques becoming feasible and practical, it can lead to substantial reduction in buildup

time for manufacturing. This will make rapid manufacturing economical far wider variety of products.

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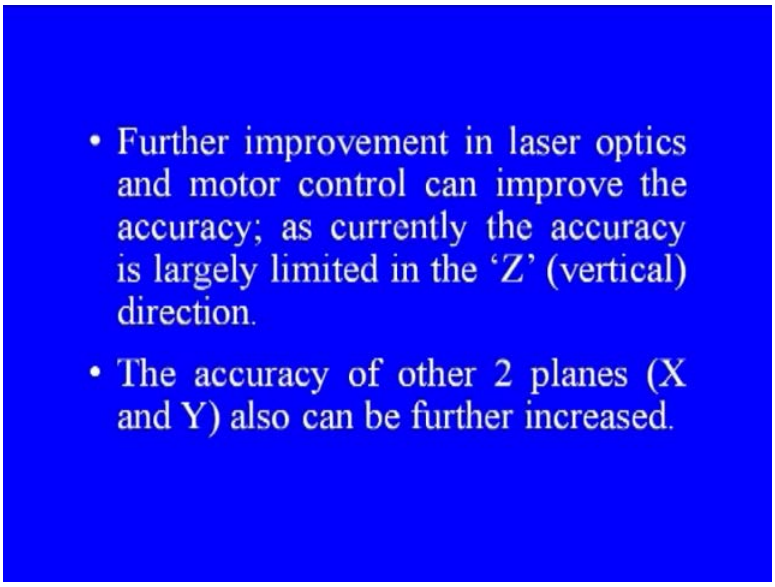

Further improvement in laser optics and motor control can improve the accuracy as currently, the accuracy is largely limited in the Z direction or the vertical direction z direction is generally considered, as the vertical direction X and Y and this is considered as the Z direction. The accuracy of other two planes X and Y can also be increased further with the improvements in CNC technology, or with the improvement in the motor control system because as we know the motors are responsible for giving the motion to the table, or the printing head, or the laser head.

Because the movement of the either the laser head or the movement of the table, this table X-Y movement or the Z movement as we have been talking about each time one layer is completed it is lowered by distance. Now if this X, Y and Z this movements can be fine tunes say for example, the minimum distance moved can be achieved is a 0.1 micron. If it can be reduced to point naught one micron then the accuracy of producing, this parts will enhance. This can be explained like this.

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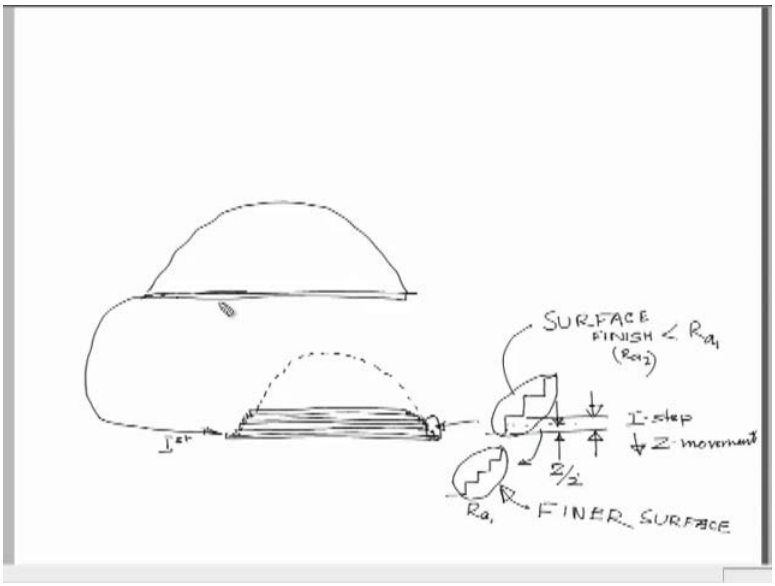

Say for example, this is the parts to be produced now this part will be produced in the rapid prototyping concept, like this first one layer will be produced. On top of this so this layer first layer is being produced, this is a first on top of this the next layer can be produced. So, next layer will be produced, say like this. Next layer will be produced, like this next will be produced on top of this like this.

So, ultimately so this will be the profile of producing the part, so this is what the layer by layer producing. Now, here as we can see this exit for this surface is nothing but it is something like step like cell, if we see this part only magnified scale it is something like this. And this is because we are produced one layer in this state, or we can say this is the this is nothing but one or one step. And correspondingly this is the Z movement, Z movement. Now, my point is that if this Z movement we can bring it down to this, say for example, so this will be say Z by 2 therefore, then this step height we also be reduce to something like this.

So, this result this will result in a step height something like this and this is much finer surface, finer surface than this surface, surface finish which is poor than this is say R a 1 and this is say R a 2 this is poor than R a 1. Now, this Z by 2 we can achieve only by the mechanism or the designing of still finer motors are order mechanisms responsible for lowering this device. So, is the case with other control of X and Y direction directions as

well, in those directions also the motor control place of vital role as for as this accuracy is concerned. So, this is the case of accuracy as for as the surface finish is concerned.

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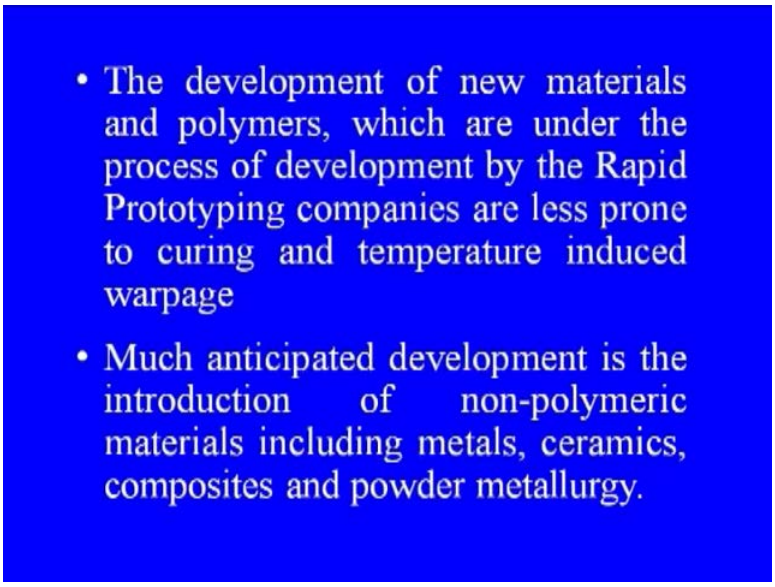

The development of new materials and polymers, which are under the process of development by the rapid prototyping companies are less prone to curing and temperature induced warpage. Much anticipated development is the introduction of non-polymeric materials including metals, ceramics, composite and powder metallurgy. This is another significant development when first rapid prototyping technologies were developed and it were the techniques where put into use, then it was found at mostly the low melting point materials are suitable for this processes.

Therefore, like polymer best mostly the polymer best materials, where we used for making the patterns etcetera or simple parts, but in the industries as we know most of the parts are made from some engineering materials like metal base materials, alloys ceramics extra. Therefore, as the technology got improved, when it was found at the material powders or the ceramic powders could also be used in these machines. It was considered to be big metro or significant development in these technologies.

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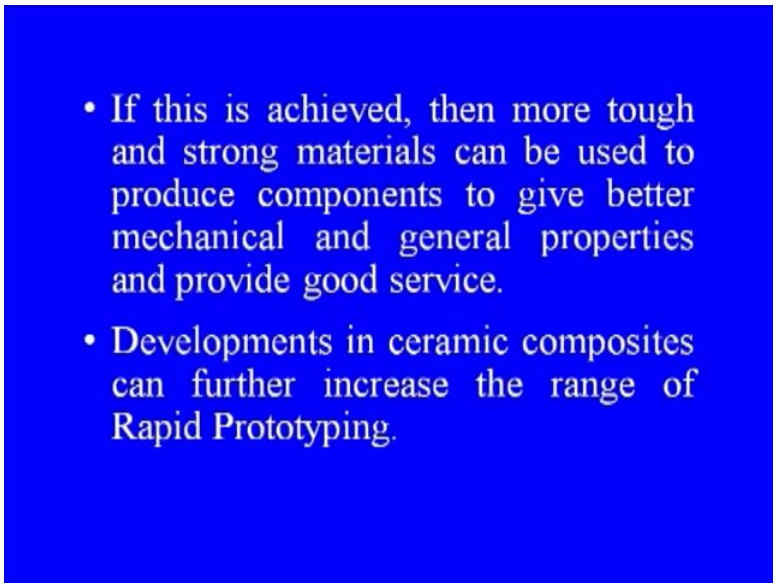

If this is achieved then more tough and strong materials can be used to produce components to give better mechanical and general properties and providing good services. Developments in ceramic composite can further increase the range of rapid prototyping.

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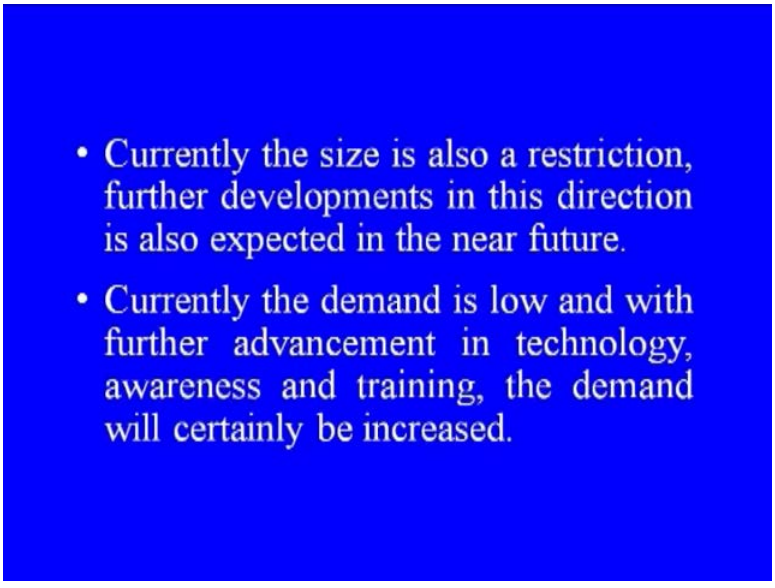

Currently the site is also restriction further developments in this direction is also expected in the near future. Mostly this process is suitable for small parts like we have discussed the parts that are being in some of the forming processes, which are used in

dimension these are generally not possible as because of the limitation of the machine operation of the machine. So, if some more advancements with some researchers in this direction it can produce or you can come up with some such use joint machines, then probably the used parts can also be produced. Currently the demand of this products manufactured by RP technologies is low, but with further advancement in technology, further awareness level and training is that demand will certainly be increased this expected.

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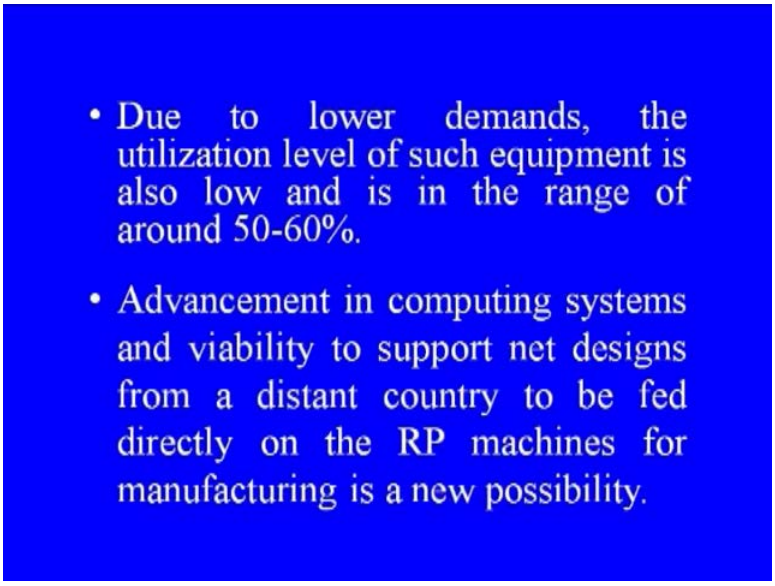

Due to lower demands, the utilization level of such equipment is also low and is in the range of around 50 to 60 percent, which is industrially not very encouraging. Advancement in computing systems and viability to support net designs from a distant country to be fed directly on the R P machines, for manufacturing can be a new possibility. The engineer or the product designer can sit in one country and can operate or the produce the part, where exactly it is needed which may be in another country.

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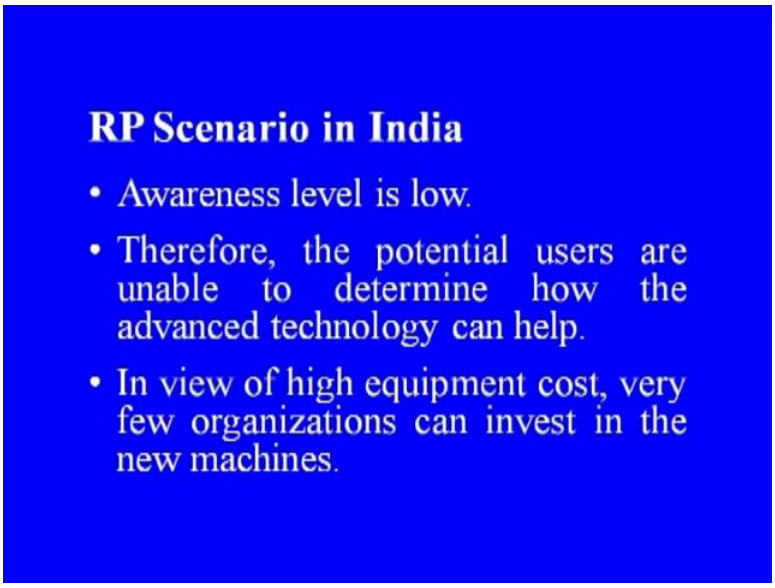

Let us talk about the R P scenario in India, as I have already indicated over awareness level regarding this technology is not very high. And so is the case in India therefore, the potential users are unable to determine how the advanced technology can help. In view of high equipment cost very few organizations can invest in the new machines, that is how the use of application of rapid prototyping technology as for as India is concerned is still very limited. Now, very quickly let us not few limitations and challengers as far as the rapid prototyping technology is concerned.

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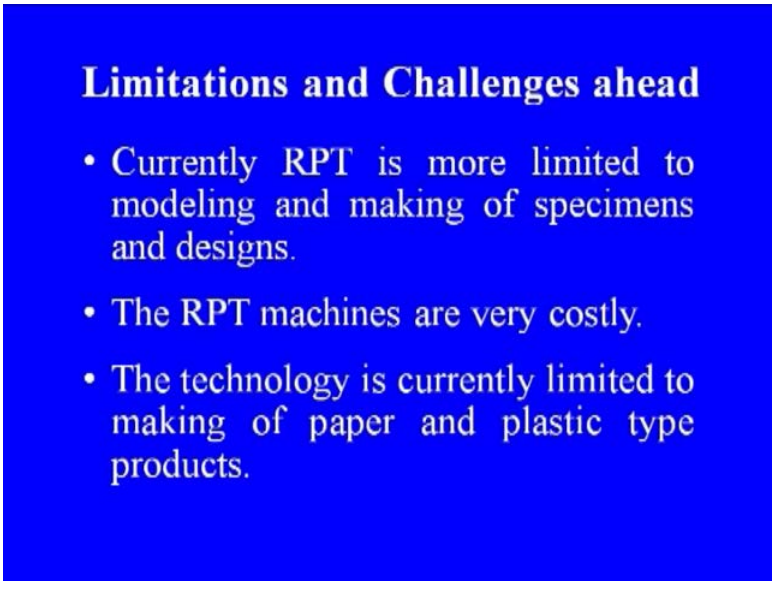

Currently rapid prototyping technology is more limited to modeling and making specimens and designs. Rapid prototyping machines are very costly. Number three the technology is currently limited to making of paper and plastic type of products, it is yet to go towards the metals alloys and ceramics in a big way.

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Replacing steel by composite is still not easy and people fear its implications. If this becomes a reality for non- strength requiring applications and nonstructural applications, than RPT will grow in this area as well.

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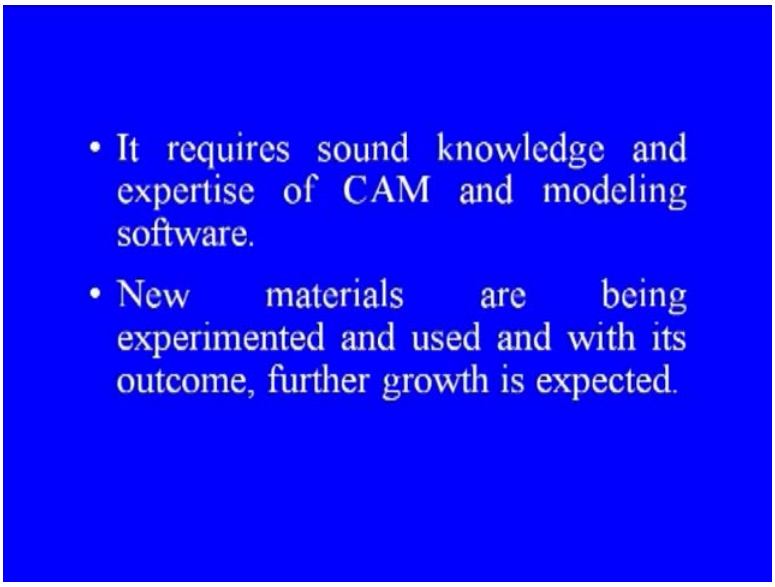

It requires sound knowledge and expertise of cam and modeling software, this technology is we can say is based on the modeling analysis and of course, the cam knowledge are also. New materials are being experimented and used and with its outcome further growth is expected in a future.

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Manufacturing of tools products by composite material through RPT is a challenging field in the manufacturing area this can become a reality in a future. Rapid prototyping is not immune to the wide-ranging obstacles that limit the growth of new products and technology.

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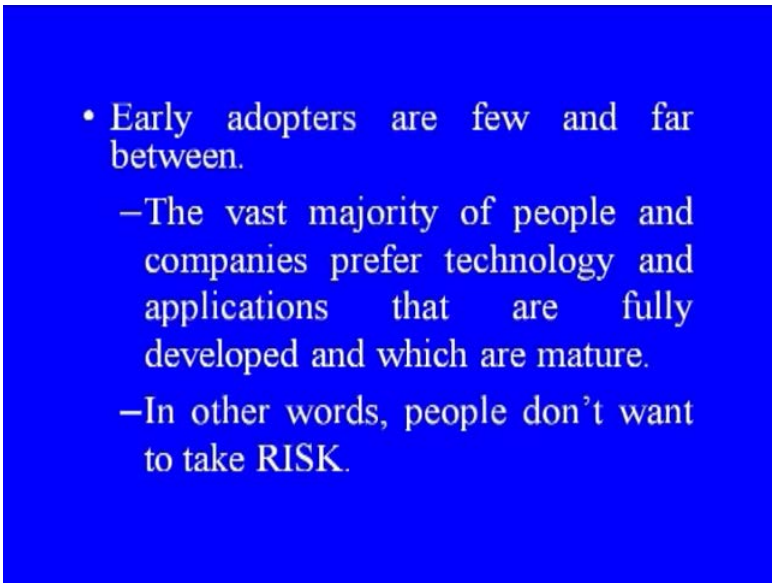

The vast majority of people and companies prefer technology and applications that are fully developed and which are mature in nature. However rapid prototyping technology as it is considered now is yet to mature. In other words people do not want to take any risk, this is another challenge unless we go ahead with adopting the technology bravely experiment it out, with a new developments. Even the developments do not get triggered.

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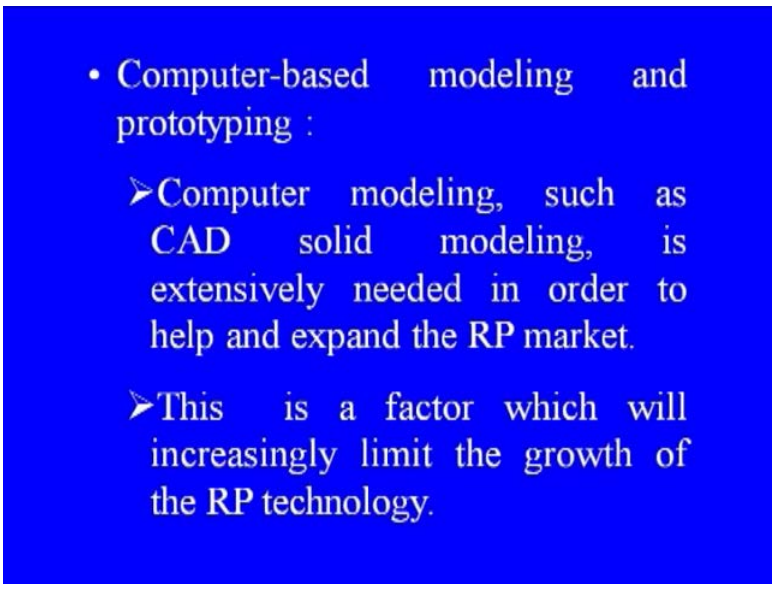

Computer-based modeling and prototyping is another challenging task here. It needs a high-speed computing facilities and high skills in modeling.

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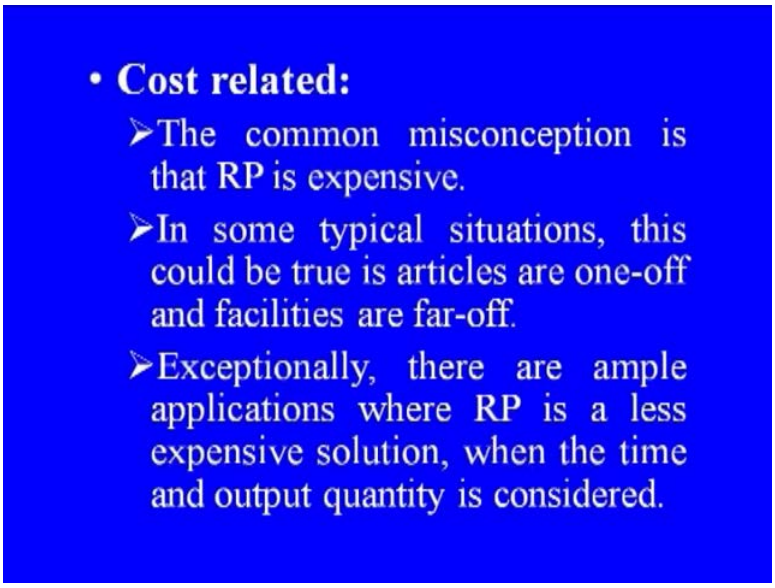

Then the cost related challenge is the common misconception is that R P is an expansive technology. In some typical situations this could be true, but if articles are one-off and the facilities are far-off. Exceptionally there are ample applications where R P is a less expensive solution when the diamond output quantity is considered.

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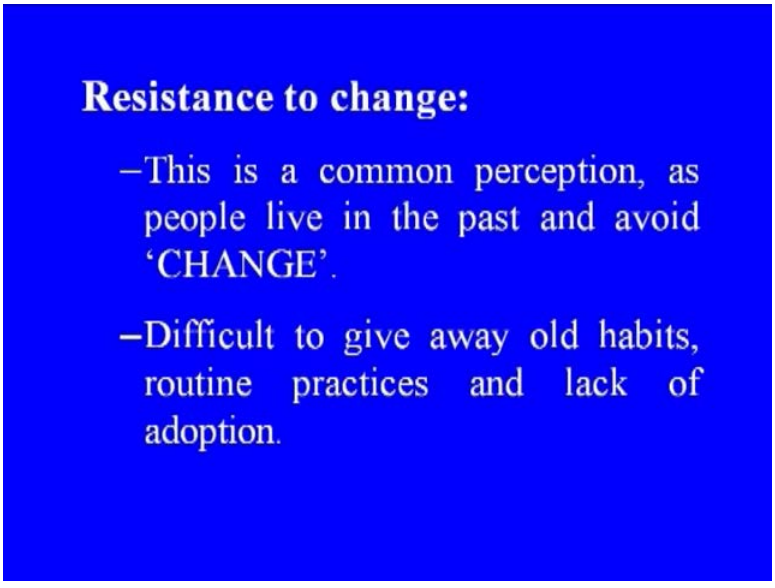

Another important factor is the resistance to change this is a common perception as people leaving the past and avoid change. Difficult to give away old habits routine

practices and lack of adoption that is how R P is also facing a resistance from the traditional gods or traditional lovers.

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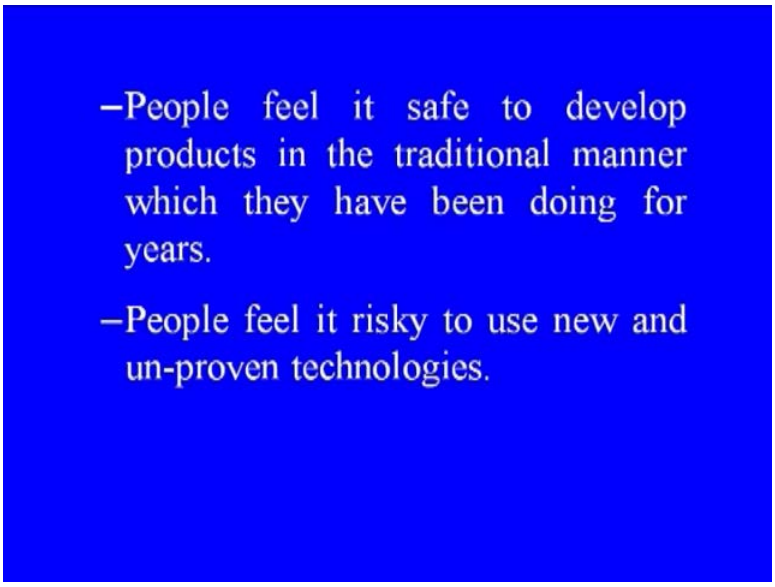

People feel safe to develop products in the traditional manner they have been doing for year's people feel risky to use new and unproven technologies.

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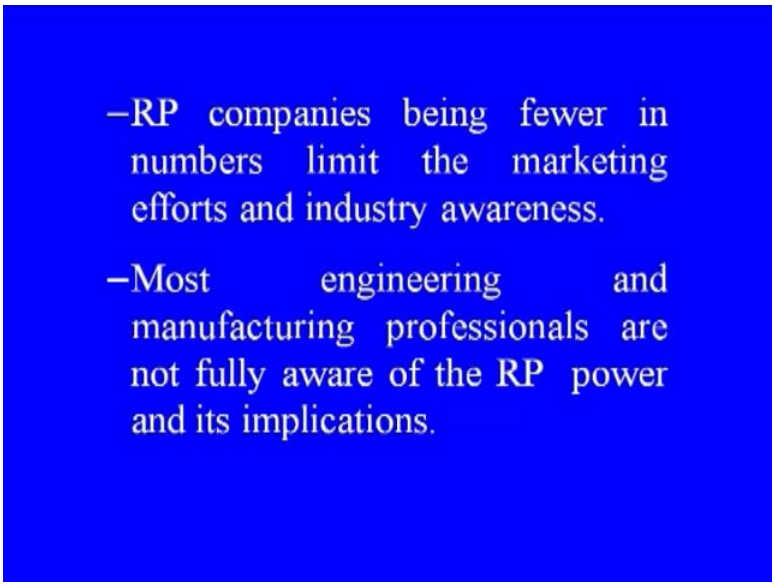

R P companies being fewer in number limit the marketing efforts and industry awareness. Most of the engineering and manufacturing professionals are not fully aware of the R P power and its implications. This is also another factor that needs to be started

out for full pleasured applications are adoption of R P technologies. Now, let us summarized what we have discussed, in this session. In this session particularly we have focused on rapid prototyping applications, few variants of rapid prototyping technologies. Like rapid manufacturing technology, then the limitations and challenges of this rapid prototyping technologies, and new developments in this technologies. We hope this session was informative and interesting.

Thank you.