MECH 542: CAD/CAM Principles and Practice

Project #1 : PART B – Linkage Model Siemens NX

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Section 1 : Introduction

The requirement was to perform 3 sequential design changes on the NX project file that was submitted for Part A of MECH 542 course. And to satisfy the critical dimensional changes and modify the rest of the model to match the images provided. Each iteration was built one upon the other making it important to get all the steps absolutely correct. Care was taken and all the requirements in the three design iterations were completely achieved. The design iteration 1 and 2 required almost minimal changes i.e just changing the dimensions of certain values, however, the design iteration 3 required some updating in sketches and features as I couldn't accommodate with existing design intent for which the model was developed.

Images have been attached that clearly show the critical dimensions and design standards maintained for modifying the changes. Issues which I encountered while applying the changes in design iterations and design approaches used have been explained in the subsequent paragraphs.

Section 2 : Development

2.1 Design Iteration 1

The design iteration 1 had two main changes which were to be performed, one was the change in the overall length of linkage part and other was the change in length of linkage part ledge dimension, which were achieved as per requirement.

Approach used for the changes made:
- For changing the length from centre to centre was very easy as I only had to modify the single dimension from previous 26.5mm to new 326.5mm *(refer figure 1)*.
- For changing the ledge dimension from the previous 146.4mm to new 196.4mm was very easily carried out by just changing the dimension of rectangle side in reference to edge of linkage part *(refer figure 2)*.
- Also, I have used comments for dimensions to make critical dimensions easier to find out in expression table and if a new person opens the model, changes can be easily applied.

Strategies/techniques which helped in recreating mode:
- By ensuring that the front face was made first which was used as base block ensured that any changes in length and width of linkage part can be easily implemented by just changing one dimensions without affecting any of parent/child relationships.

What if I knew these changes before?
- I had actually considered these possible changes in my design intent which is why I could very easily implement changes in design iteration without any struggles.
- However, one possible addition is creating multiple configurations based on the design changes may be useful in the future.

*********All critical dimensions are highlighted in Red Rectangular Box********

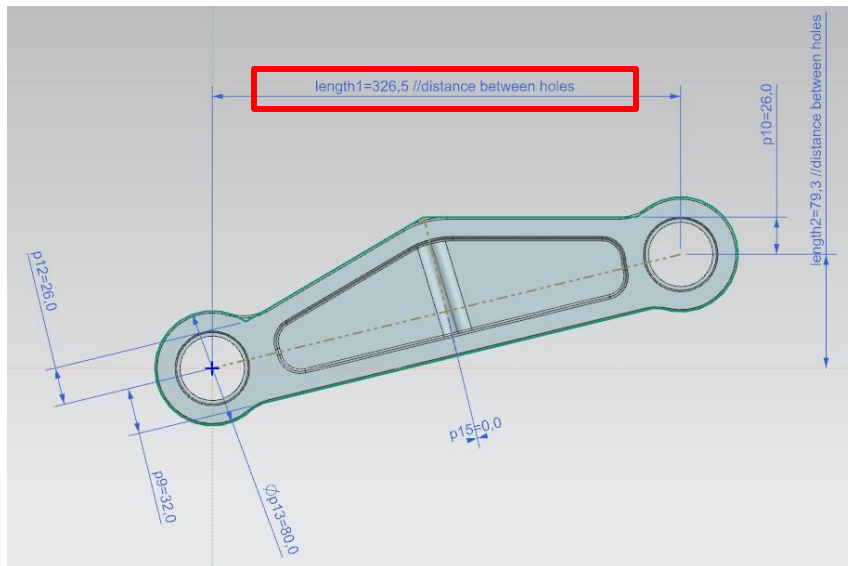*Figure 1: This the critical dimension of 326.5mm which is distance between hole centre*
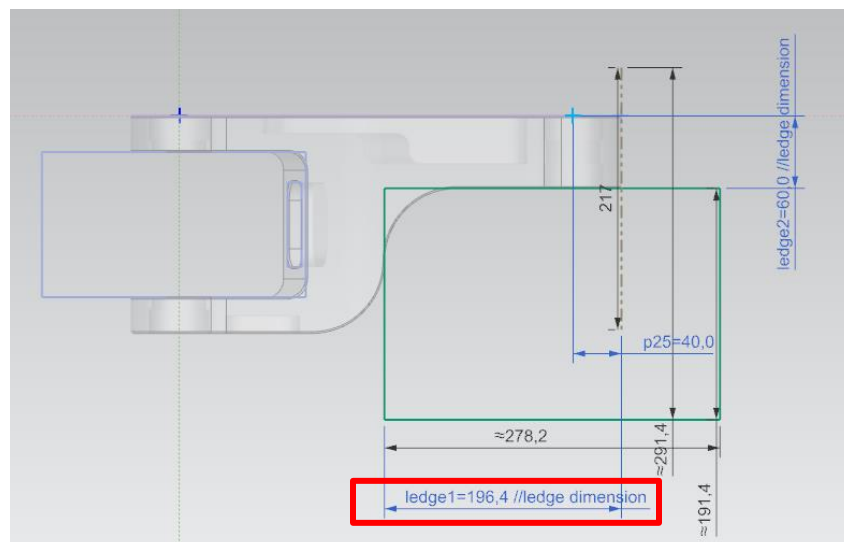

Figure 2: This shows the critical dimension of 196.4mm which is the ledge length
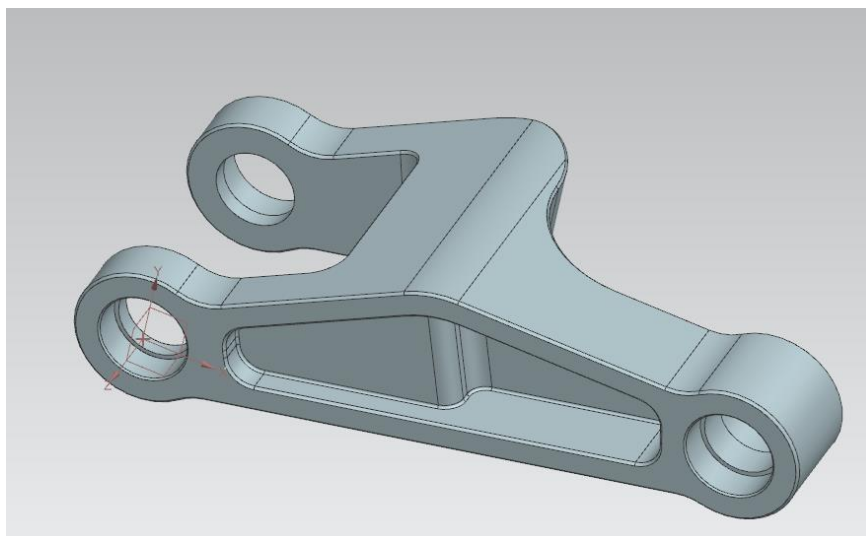

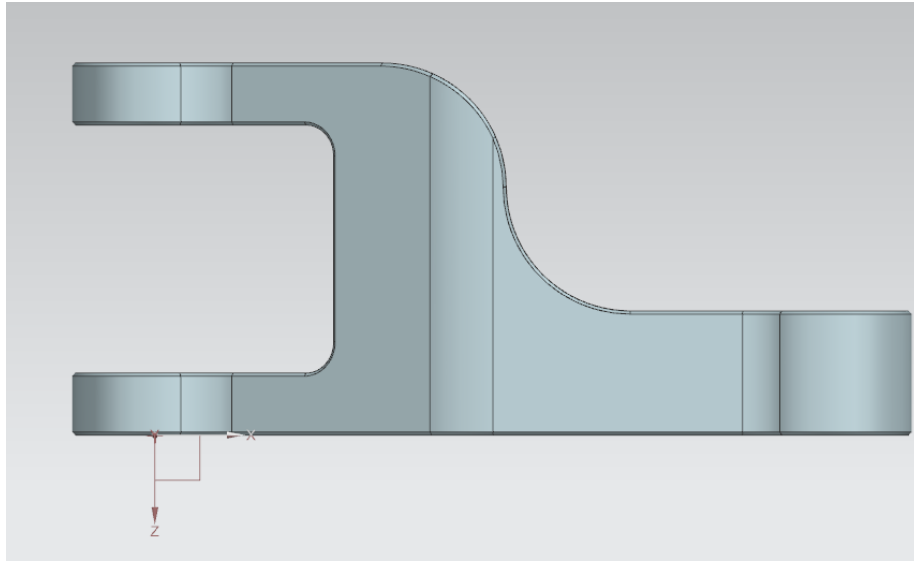*Figure 3: This is an isometric view of model after design iteration 1*

Figure 4: This is the top view of model showing the extended ledge length and overall length of linkage part
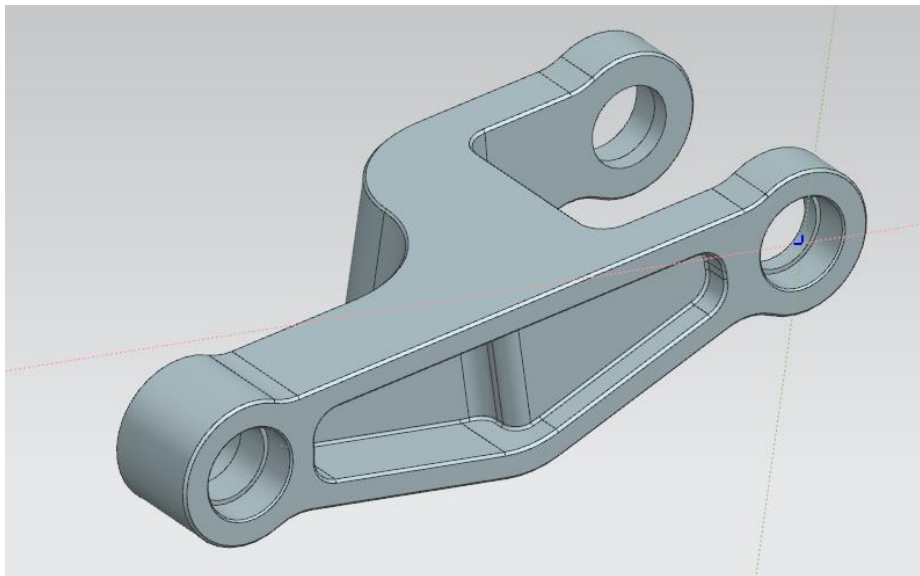

Figure 5: Design Iteration 1 Final Model View

2.2 Design Iteration 2

The design iteration 2 had two changes in critical dimensions, one was to increase the overall width of linkage part and another minor change in the edge blend.

Approach used for the changes made:
- For changing the overall width of linkage part from previous 180mm to 195 mm was very easily carried out. The extrude option was edited to apply the changes specified *(refer figure 6)*.
- The other dimension of 15mm was never applied as the overall width increased by 15mm, there was a small section generated *(refer figure 8)* automatically and the dimensions have been verified as 15mm *(refer figure 7)*

Strategies/techniques which helped in recreating mode:
- Since the design iteration 2 was a fundamental change in the base block, it was easily implemented. The width of 30mm for linkage arm were defined w.r.t centre of linkage part and width of 60mm for other linkage arm was also defined w.r.t one of the faces. This ensured that once the overall width was changed, the arm width would remain as 30mm and 60 respectively.
- Hence, only one dimension which is increasing the extrude length from 180mm to 195mm was applied and no other changes were made.

What if I knew these changes before?
- These changes were already considered in my previous design intent and hence I would use the same approach which was defined in my report 1.
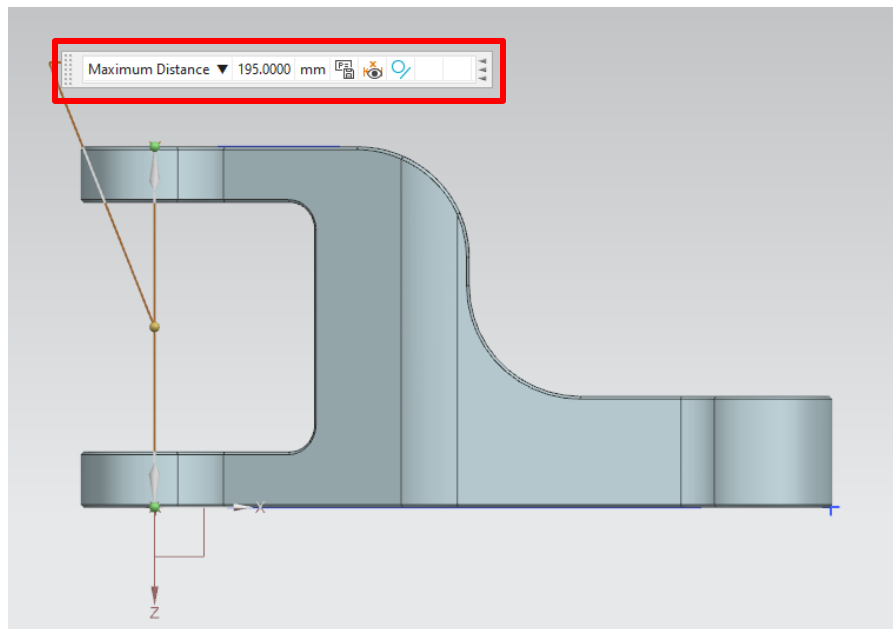

Figure 6: This shows the critical dimension 196mm which is the perpendicular distance between two arm faces of linkage model

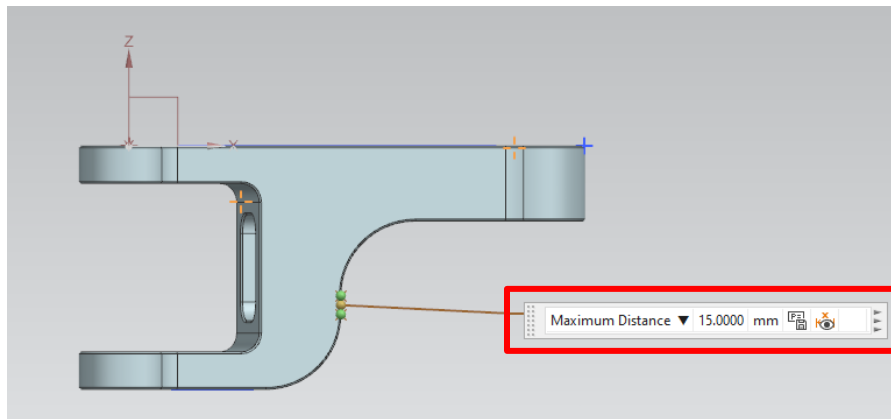*Figure 7: This shows the critical dimension 15mm which is the length of small section from top view.*
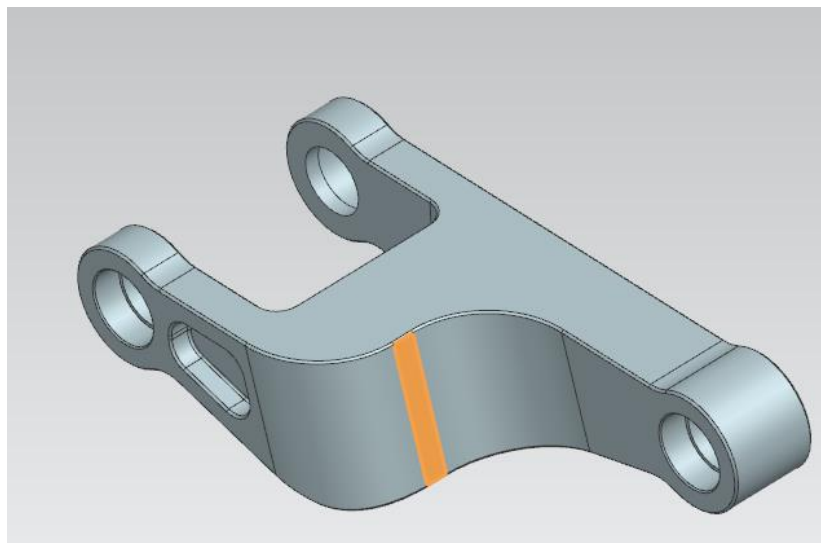

Figure 8: The highlighted region indicates the newly created region whose width was indicated in previous figure as 15mm
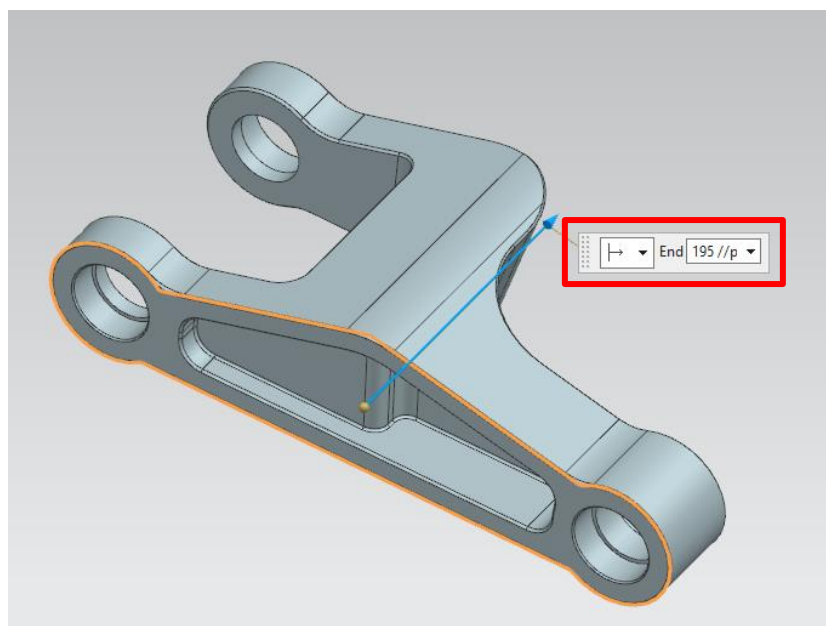

Figure 9:This shows the total extrude of 195mm which was carried out as part of design iteration2. Highlighted yellow portion indicates the face from which 195mm was extruded.

2.3 Design Iteration 3

The design iteration 3 had changes in dimensions which required modifications in design of pocket, edge blends, chamfers, and also angle of inclination of base sketch. Although, I was able to update the model to match design iteration 3 without having to re-do the model entirely again, I believe some key considerations in design intent would have made the process much more simpler, that have been explained below.

Approach used for the changes made:
- For changing the distance between centre of circle and base of linkage main body, I had to modify the sketch which was my step 1 in previous design (Part A). This meant that some of the parent/child relationships were unrecognized and suppressed. The error was *'Parent of the point is either suppressed or modelled away'*.
- In order to rectify this error, I had to redefine the references for certain operations. To perform this *'edit sketch with rollback'* option and *'reattach'* options were used. Once the missing references were properly defined, the *'alerts in part navigator'*, disappeared.
- The major modifications include, updating the sketch, redefining the reference planes, reapplying the edge and chamfers to new edges generated.
- For the 15mm additional cut-out *(refer figure 11)* on one face of linkage arm meant that new extrude operation was used and all critical dimensions were finally achieved as per requirement.

Strategies/techniques which helped in recreating mode:
- The design iteration 3 had changes which were not considered in my previous design intent. However, I was still able to incorporate the changes by modifying the references and sketch as explained before. In order to achieve the critical dimension of 21mm *(refer figure 13),* the sketch had to be updated to match requirements.
- Since the changes in design iteration 3 were on one side of linkage part meant that, I simply had to update the sketch in the beginning and redefine the references.

What if I knew these changes before?
- My previous design intent required some changes for me to incorporate the design requirements of iteration 3. The problem was that, in iteration 3 the pocket cut-out had one additional side and the angle of inclination was applied for the bottom face *(refer figure 12)*. However, in part 1A, the bottom face was flat and had no angle of inclination.
- This required me to redefine the references as part/child relationship was affected and other necessary changes had to be incorporated to make the sketch constrained. By knowing these changes beforehand, I could have split the bottom face into two halves, and defined an angle of 180º degrees. Whenever any subsequent changes were needed, it could have been easily implemented by varying the inclination angle.
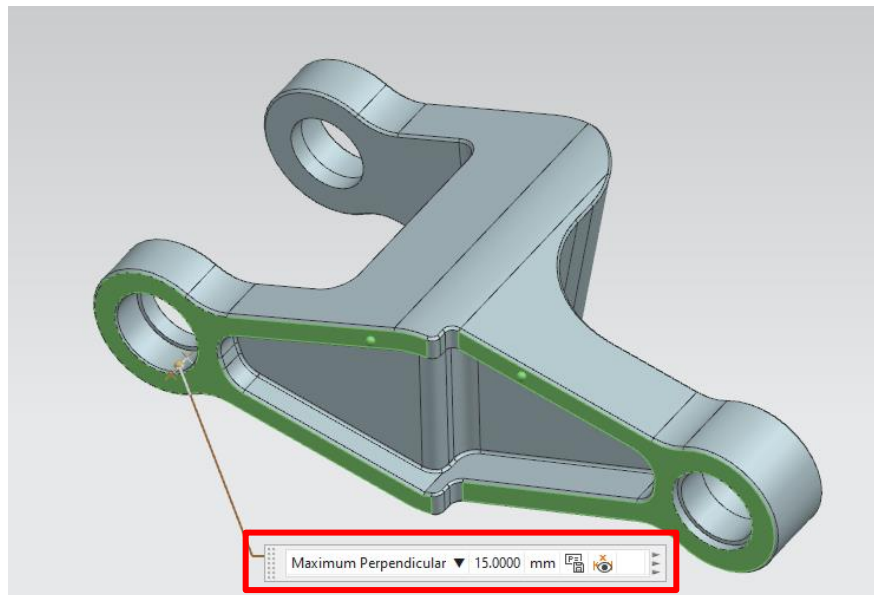
Figure 10: This shows the critical dimension of 15mm which is the perpendicular distance between faces of linkage part i.e retracted
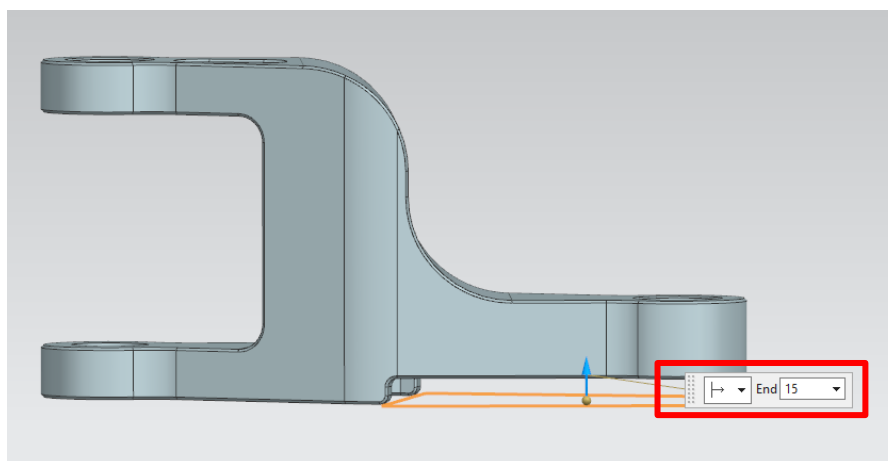

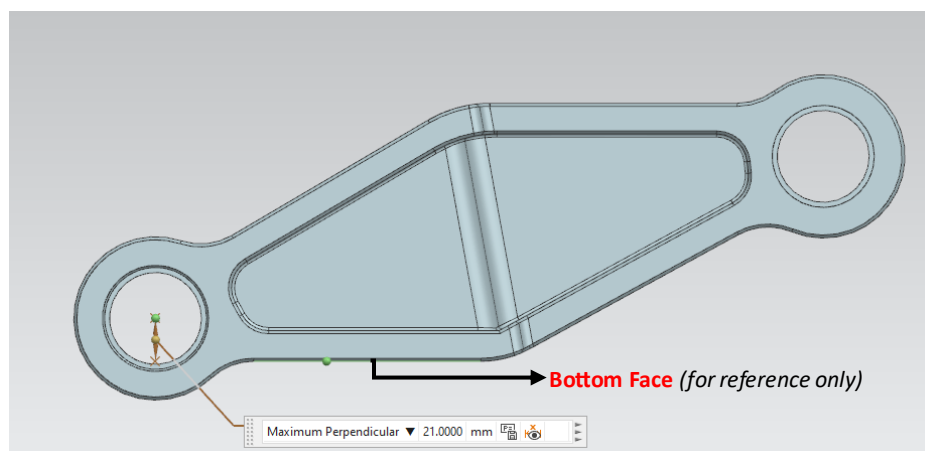*Figure 11:Top view clearly showing the retracted 15mm of linkage arm*

Figure 12: This shows the perpendicular distance of 15mm from centre of circle and base of linkage arm
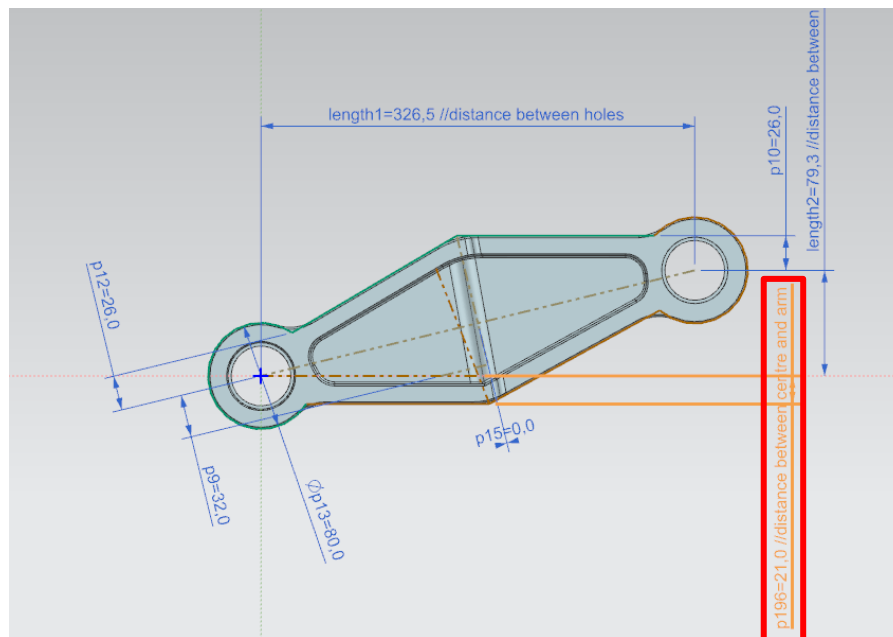
Figure 13: The highlighted dimension in below indicates the dimension of 15mm changes as per iteration 3

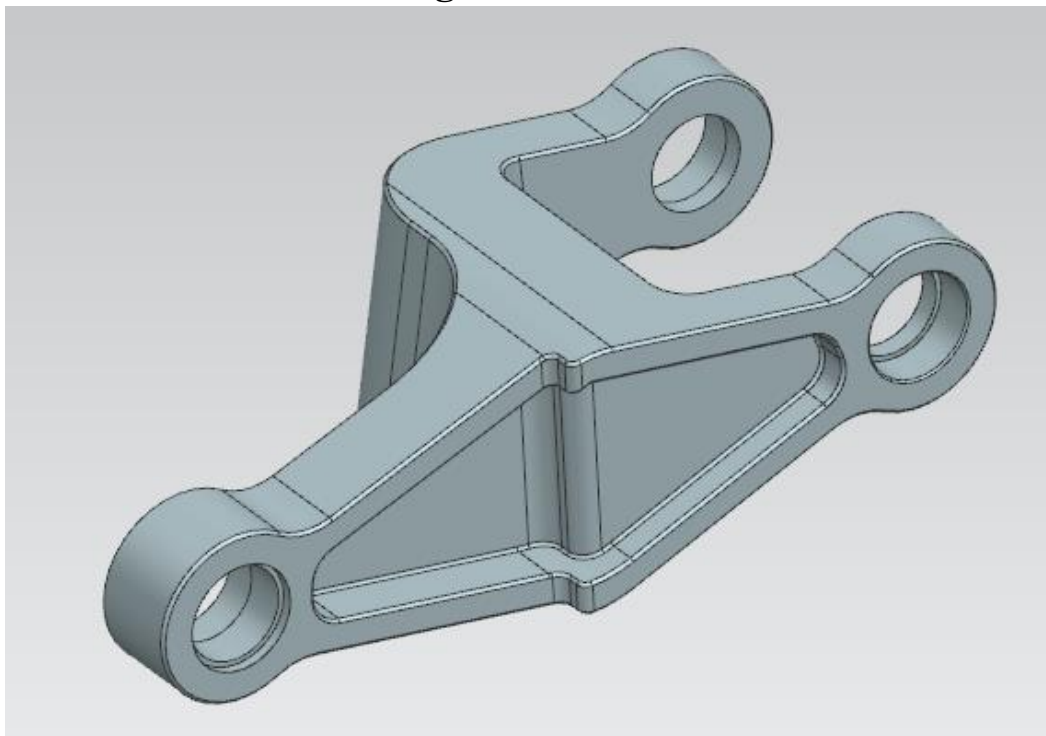# Section 3 : Final Model Images

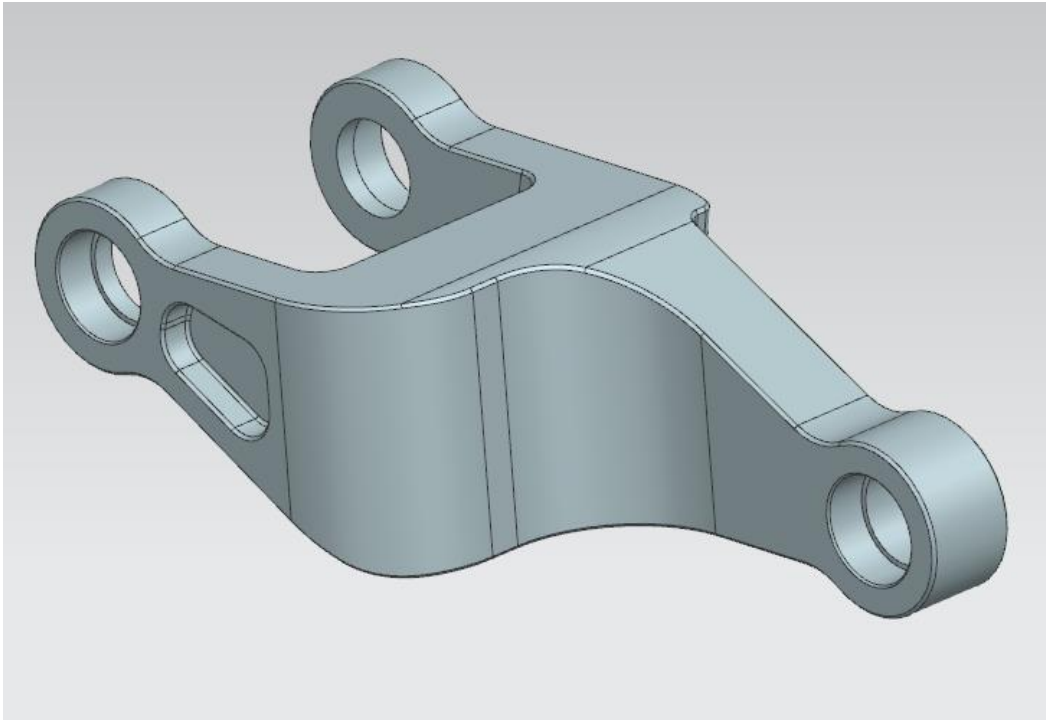*Figure 14: Final IsoView of linkage model after all changes applied.*

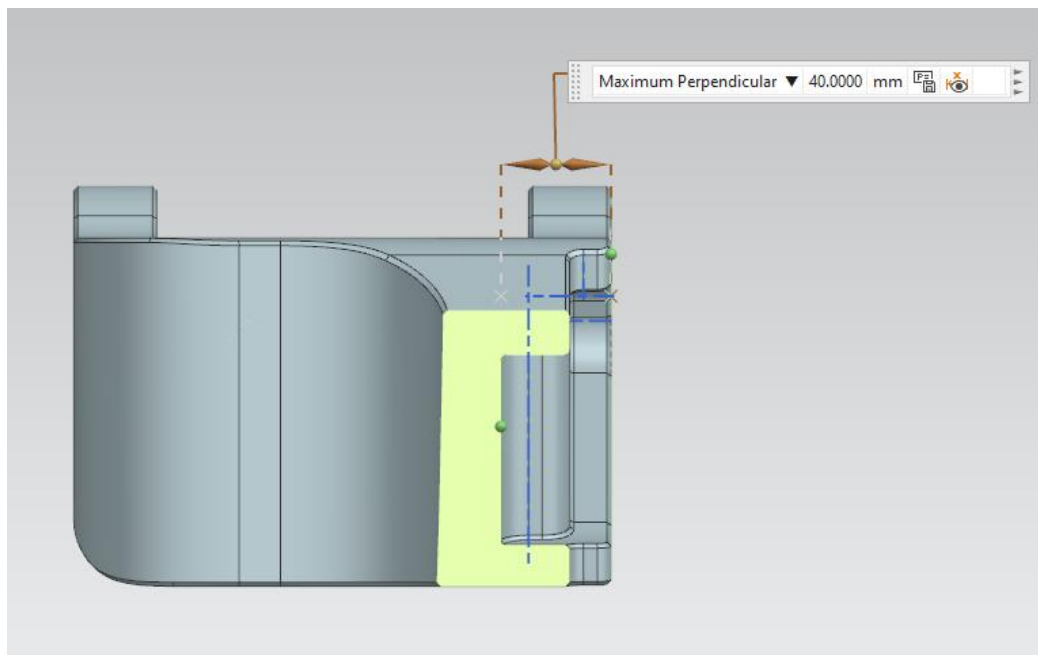*Figure 15:Final Isoview of linkage model after design iteration 3*

Figure 16: Section view of final iterated model that shows the dimensions of 40mm between face of linkage part and face of retracted pocket as indicated in requirements.

Section 4 : Conclusion

The changes in design iteration 1 and 2 were easily implemented, although design iteration 3 required revising the drawing and model references. The design goal and methodology, however, could have been simply adopted to enable any future modifications if these changes had been taken into account in advance. Eventually, all of the design criteria were satisfied, and all adjustments were made without having to start over with a new model. It is of my opinion that any part changes may easily be incorporated by preventing overworking or reworking in the future, if we apply an appropriate design strategy and are aware of all future use cases. This may not always be possible because design is an iterative process and not all use cases are clearly defined ahead of time. But also, by adhering to some fundamental design principles and keeping the number of operations simple and less in number means even if there is significant re-work it can still be implemented by the designers.

This project has taught me the value of design intent and how important it is for designers to anticipate future changes and incorporate them into their design process for smooth transitions in future model revisions.