SSG 511 Simulation & Analysis
Connecting Rod Design

Instructor: OA Fakinlede
oafak@unilag.edu.ng, oafak.com
Department of Systems Engineering
University of Lagos

Simulation & Analysis

- Based on the components we have created already, we will now engage the simulation and analysis facilities in Fusion 360.
- We will use three simple examples for this purpose:
  1. The Hinge that we have been looking at
  2. Simple connecting rod
  3. Blade and fork type connecting rod

NASTRAN, FEA, etc

* The major means for carrying out your analysis in Fusion 360 is the Finite Element Method. The Industry standard NASTRAN FEA package is reachable from the Fusion 360 environment.
* Other information needed on your models and components are readily available.
    1. Surface area, volume, moment of inertia, etc can be obtained by right-clicking the component and selecting …
    2. Material selection, surface interaction, loading, constraints, etc., are available in the simulation section.

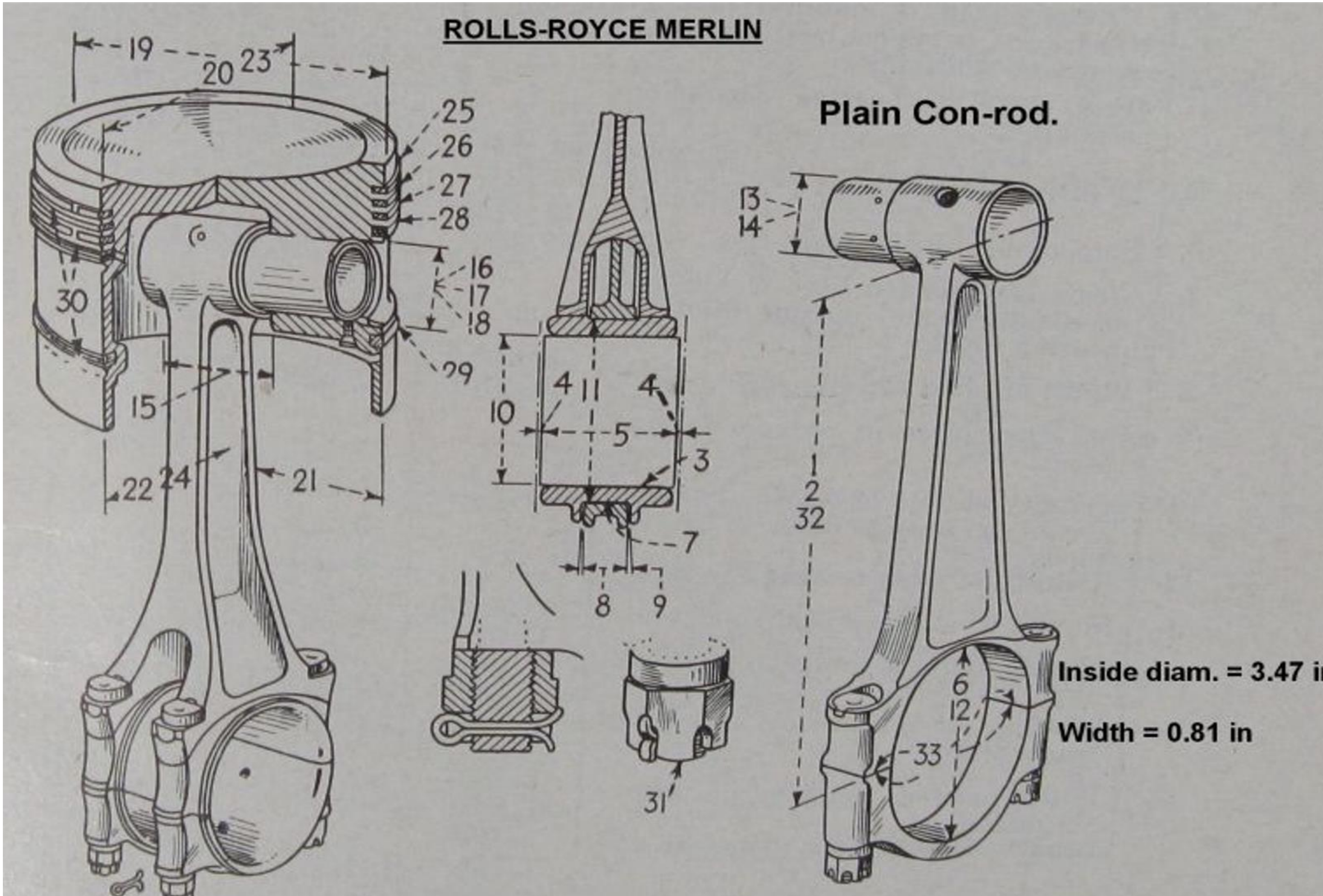
Governing Equations

* FEA packages are specific numerical solutions to the governing equations. It is IMPORTANT to be conscious of what is happening as you engage the FEA packages because you will be in for a surprise and possible frustrations and failure if you think it works by magic!
* In fact, any knowledge of these equations especially in the solution of them that are given in courses in various continuum mechanics courses, will go a long way. However, in today's lecture, we will at least look at the equations.

Other Connecting Rod Models

* Having used the Hinge and Internal Combustion Engine examples to familiarize ourselves with the 3D parametric modeling power of Fusion 360, we start the excursion into the simulation arena with the concrete example of the Blade and Fork Connecting Rods.
* This is a novel Internal combustion engine connecting rod design inspired by the specification from an old Rolls Royce engine design for a propeller driven plane.

* We shall be using the embedded NASTRAN Finite Element package in this simulations. Before we go on further, it is important to first have a look at the differential equations we shall be solving by this numerical procedures.
* We are assuming linear elasticity and, for now, static analyses of the forces acting on the respective components. We are also ignoring heat loads.
* Next slide shows the actual blueprint of the Fork and Blade connecting rod design.


ROLLS-ROYCE MERLIN
Plain Con-rod.
Inside diam. = 3.47 in
Width = 0.81 in

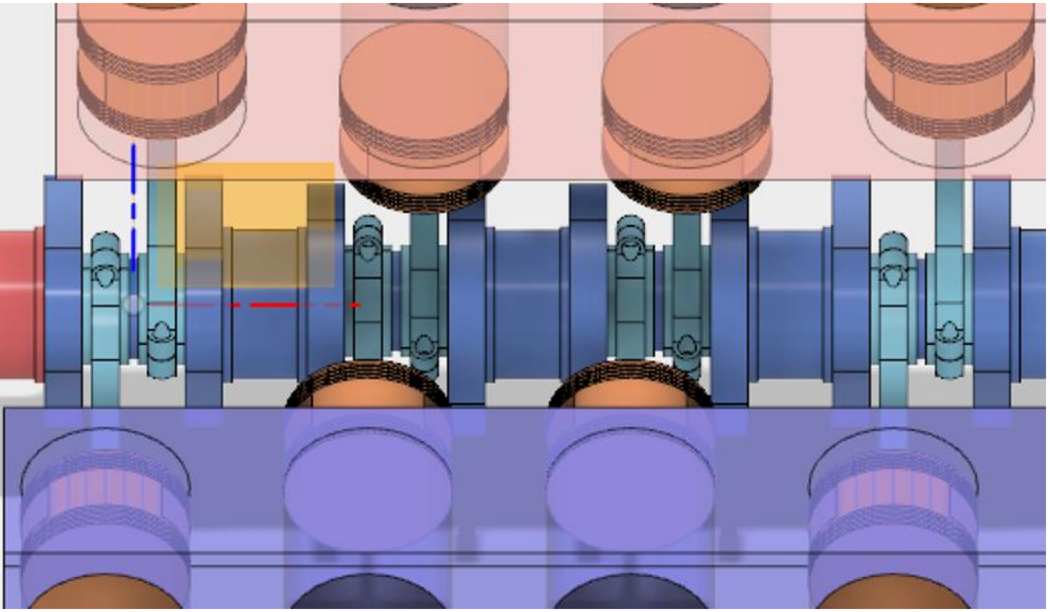
The Blade & Fork Design

* From cursory look at the V-type engine shown in the videos we notice the following:
  1. The power density per length of the crankshaft of the V engine is higher as we can place more connecting rods in a shorter span
  2. Two sides of the V-engine is in an offset alignment to the other.

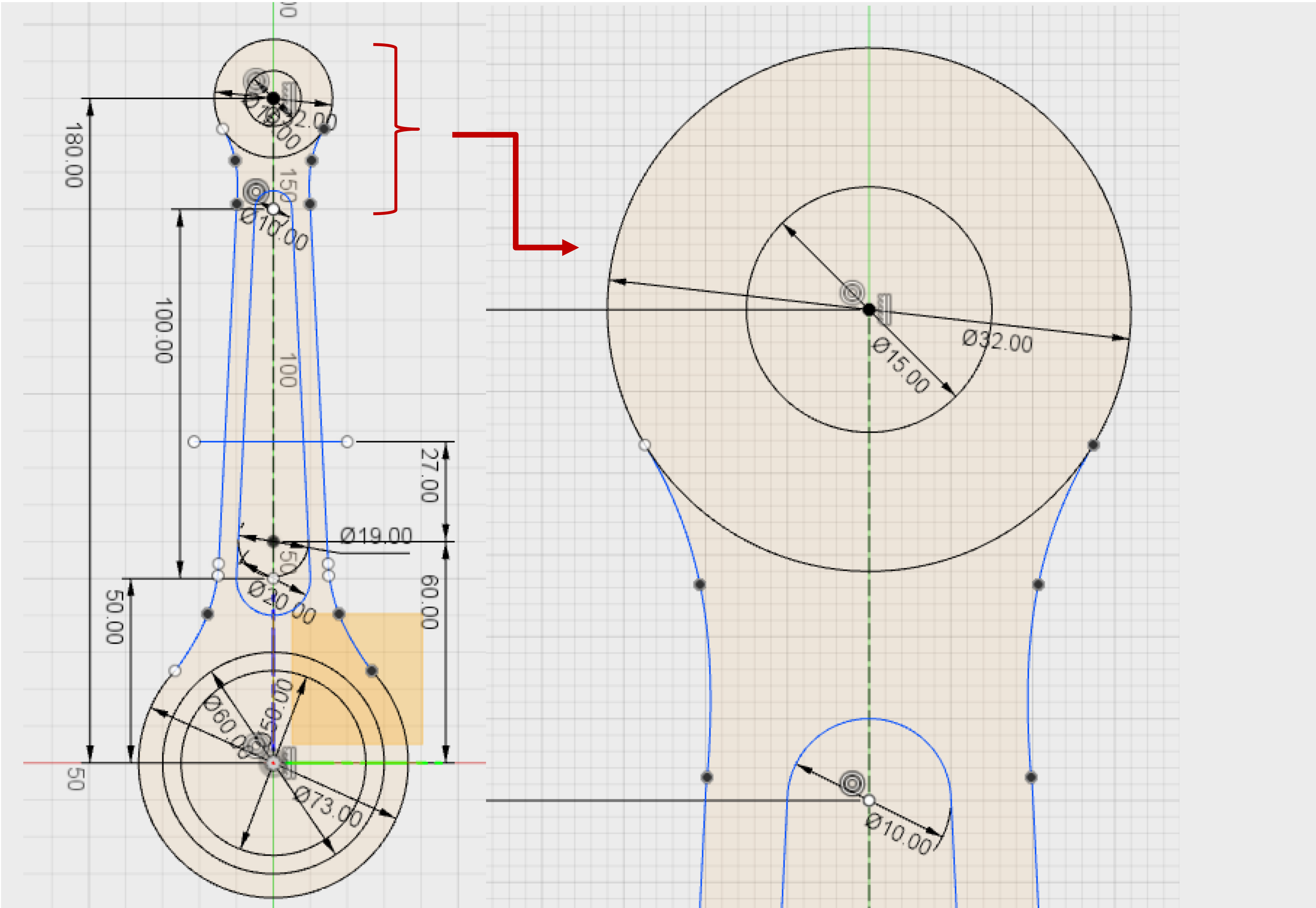
  Below is a picture of the offset connecting rods and cylinders on two sides of a V8 Engine:

Opposite Cylinders Offset

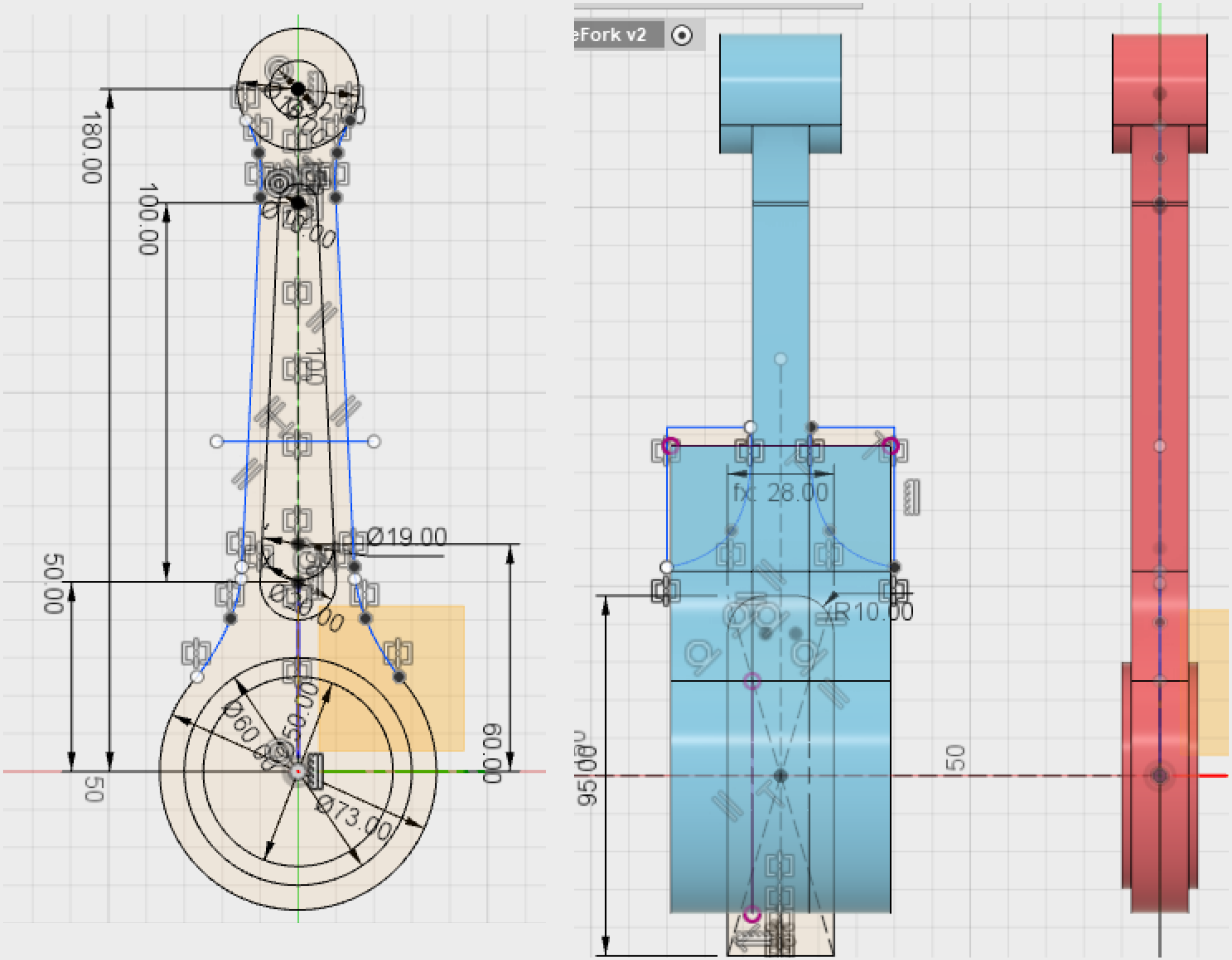
* As the picture below shows, the offset is caused by the displacement of the two connecting rods sharing the same crankshaft pin.



One idea that attempts to overcome this offset problem is the fork and blade pair of connecting rods that was once used in the design of propeller engines for aircraft. See possible implementation of the Fork&Blade below:



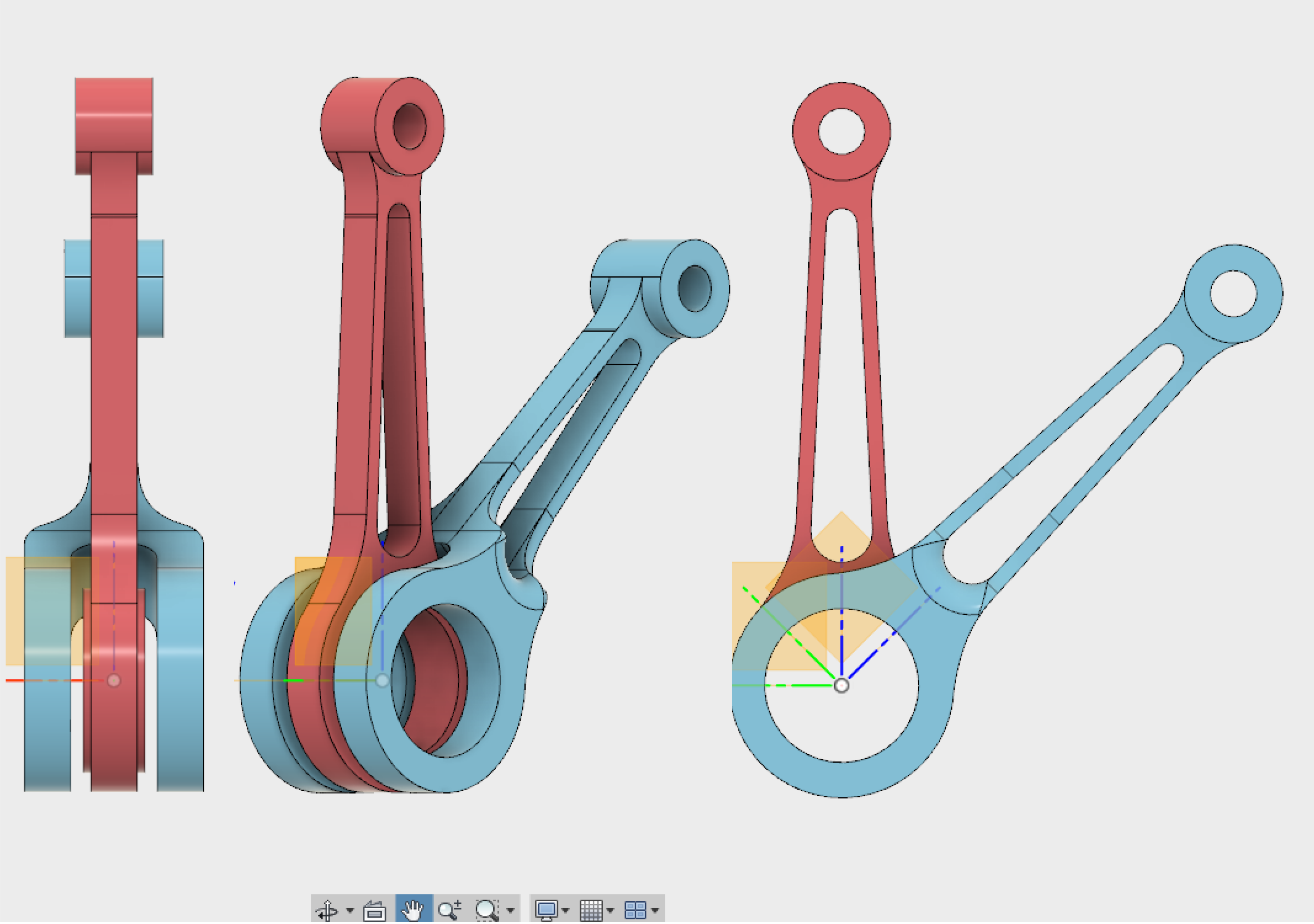
180.00
100.00
50.00
27.00
60.00
Ø19.00
Ø20.00
Ø10.00
Ø60.00
Ø73.00
Ø32.00
Ø15.00
Ø10.00



180.00
100.00
50.00
50
Ø19.00
Ø60.00
Ø73.00
60.00
eFork v2
fx: 28.00
R10.00
50

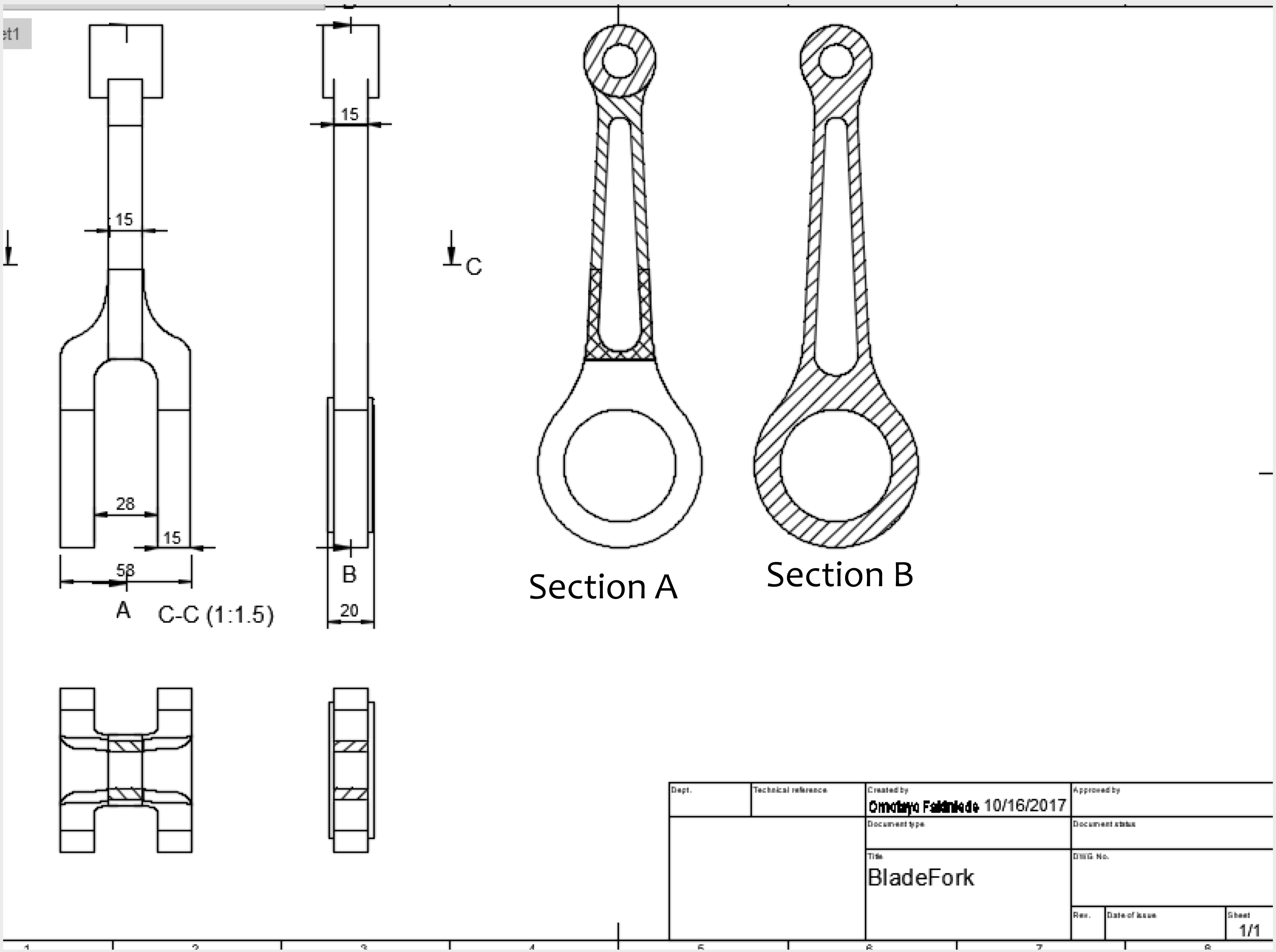
Two extrusions

* From the same profile, we begin with two extrusions:
  1. The first, is essentially the same extrusions we have had previously except for a reduction in the width of the larger circle in the connecting rod.
  2. The other, extruded at an offset plane, 100 away from the origin, has the first half exactly the same as the first, but having a larger lower section as shown in the middle object above. The cutting profile sketch is effect on it to obtain the figures below:



Shop Drawings

- Shop drawings of the sections of these two are as shown in the diagram below.
- Section A comes from the fork while B is from the blade as shown.


15
15
C
28
15
58
A
C-C (1:1.5)
B
20
Section A
Section B
Dept.
Technical reference
Created by
10/16/2017
Approved by
Document type
Document status
Title
BladeFork
DWG. No.
Rev.
Date of issue
Sheet
1/1

Model Parameters

Parameter	Expression	Present Value
Footing	45	45
Groove	16	16
wfork	Footing/3	15
wblade	$\frac{1}{2}(\text{Footing } - \text{wfork}/3)$	20
weach	Grove/4	4