

Razvoj funkcionalnog 3D modela stanice za sortiranje i distribuciju

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VELEUČILIŠTE U BJELOVARU
PREDDIPLOMSKI STRUČNI STUDIJ MEHATRONIKA

**Razvoj funkcionalnog 3D modela stanice za sortiranje i
distribuciju**

Završni rad br. 11/MEH/2019

Zdravko Kovačić

Bjelovar, Listopad 2019.



Veleučilište u Bjelovaru

Trg E. Kvaternika 4, Bjelovar

1. DEFINIRANJE TEME ZAVRŠNOG RADA I POVJERENSTVA

Kandidat: **Kovačić Zdravko**

Datum: 15.07.2019.

Matični broj: 001235

JMBAG: 0314011987

Kolegij: **VIRTUALNO OBLIKOVANJE MEHATRONIČKIH SUSTAVA**

Naslov rada (tema): **Razvoj funkcionalnog 3D modela stanice za sortiranje i distribuciju**

Područje: **Tehničke znanosti**

Polje: **Strojarstvo**

Grana: **Proizvodno strojarstvo**

Mentor: **Tomislav Pavlic, mag.ing.mech.**

zvanje: **viši predavač**

Članovi Povjerenstva za ocjenjivanje i obranu završnog rada:

1. **dr.sc. Stjepan Golubić, predsjednik**
2. **Tomislav Pavlic, mag.ing.mech., mentor**
3. **Danijel Radočaj, mag.inž.meh., član**

2. ZADATAK ZAVRŠNOG RADA BROJ: 11/MEH/2019

U radu je potrebno:

- opisati značajke najčešće korištenih CAD programskih alata dostupnih za korištenje studentima
- opisati glavne značajke projektiranja i digitalne proizvodnje na primjeru mehatronike
- navesti važnost CAD baza proizvođača mehatroničkih komponenata u procesu razvoja novih proizvoda
- za definirani mehatronički sklop izraditi popratnu (digitalnu) dokumentaciju
- izraditi upute za održavanje i rukovanje zadanim sustavom
- izraditi interaktivnu elektro i strojarsku dokumentaciju sustava
- opisati i izraditi animaciju i simulaciju kompletnog sustava

Zadatak uručen: 15.07.2019.

Mentor: **Tomislav Pavlic, mag.ing.mech.**



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1. Uvod

Zadatak ovog završnog rada je objasniti značajke najčešće korištenih CAD programskog alata SolidWorks te opisati njegove module koji su upotrebljavani u izradi 3D modela stanice za sortiranje i distribuciju. U navedenom radu prikazani su koraci modeliranja pojedinih modela i sastavljanje istih u cjelokupni sklop, izrada animacije sastavljanja cjelokupnog sklopa i animacija simulacije kompletnog sustava. Svi koraci izrade pojedinih modela, rendera, cjelokupnog sklopa i njegovih animacija popraćeni su slikovnim prikazom.

2. 3D alat SolidWorks

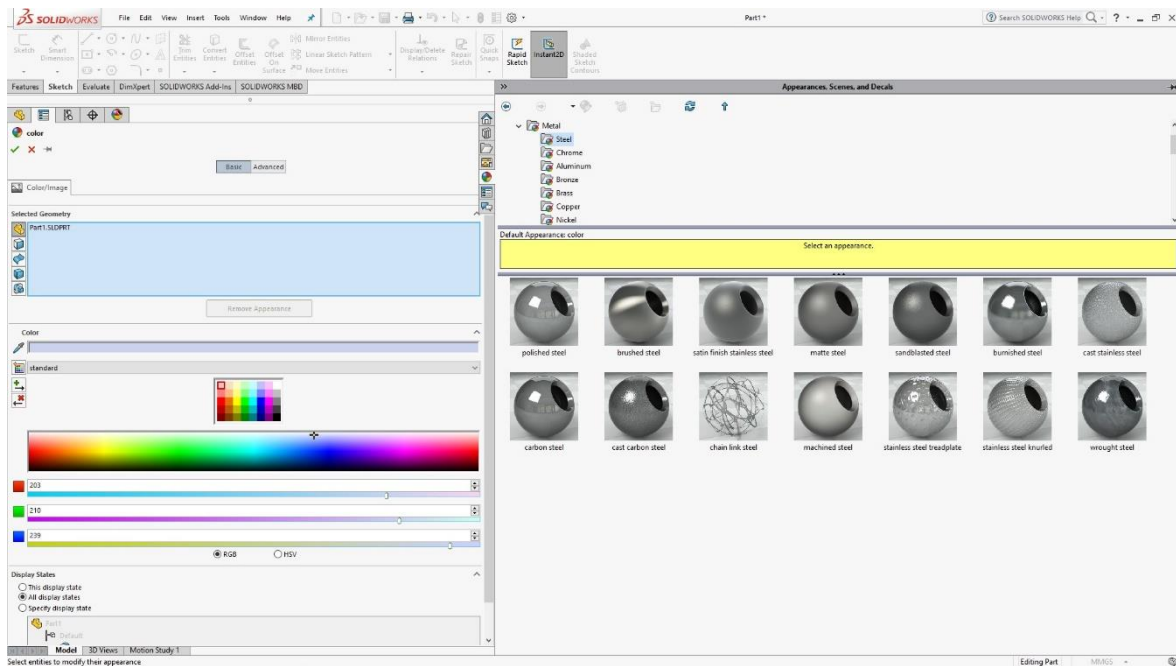
SolidWorks je program kojim se može proizvesti parametarski model sklopova i crteža. Radi na principu veze gdje su elementi postavljeni u ovisnosti jedan o drugom. Elementi se spajaju u module u pojedinim koracima te s time garantiramo obradu prethodnih koraka u bilo kojem trenutku. Na taj način izrađujemo dijelove koji se koriste u sklopovima, a ti dijelovi se mogu pretvoriti i u crteže.

3. MotionManager

MotionManager je integrirano programsko rješenje u SolidWorks-u. Služi za izradu animacija SolidWorks sklopova, da bi se moglo predočiti kako se neki sklop ponaša. MotionManager može također raditi sa PhotoView-om za izradu foto-realističnih animacija za dodavanje vizualnih utjecaja na prezentacije i samu dokumentaciju. Kao MotionManager, PhotoView360 je isto integrirano programsko rješenje u SolidWorks-u.

4. PhotoView360

Korištenje PhotoView360 za izradu animacija je jako dugi proces. Ovisno o kompleksnosti sklopa i procesa izrade animacije može trajati i do nekoliko dana, a uvjetovano je i dobrom konfiguracijom računala - radna memorija i grafička kartica igraju jako veliku ulogu u tom procesu. PhotoView360 služi za izradu fotorealističnih slika ili rendera. Pri izradi rendera je važno obratiti pažnju na sklop koji želimo renderirati. Sklop treba biti završen 3D model, te na njemu moramo dodati poseban materijala koji će opisivati njegove karakteristike. Za određivanje takvog materijala ide se u Menu Appearance, te se tamo može odabrati koji materijal će biti naš model. [1]



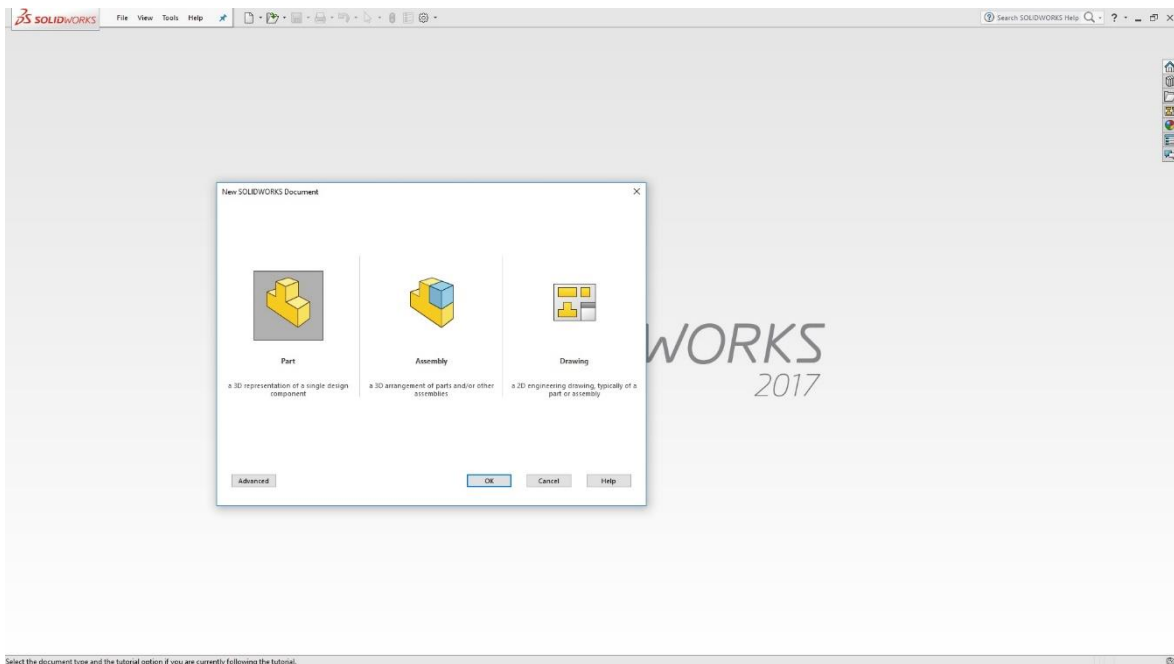
Slika 4.1: Odabir materijala

5. Sučelje SolidWorks-a 2017

Pri pokretanju programa SolidWorks odmah se susrećemo s početnim zaslonom. Kako bismo mogli započeti izradu sklopa ili modela potrebno je otići na File (mapa), New (novo), Part (dio).

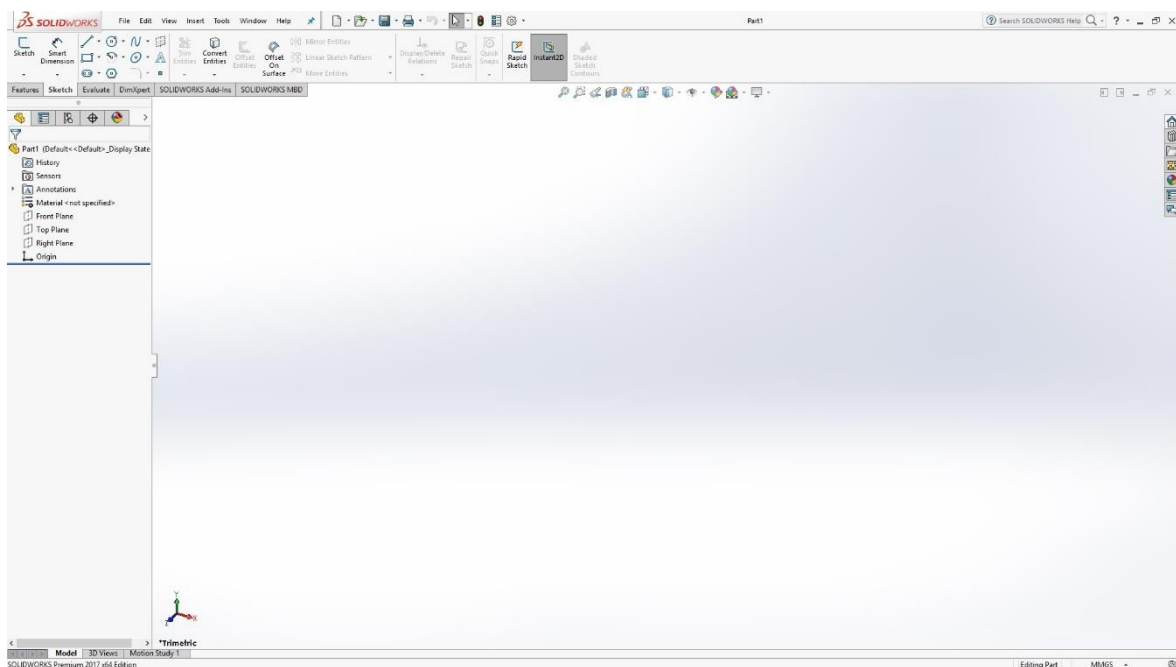


Slika 5.1: Početni zaslon SolidWorks-a



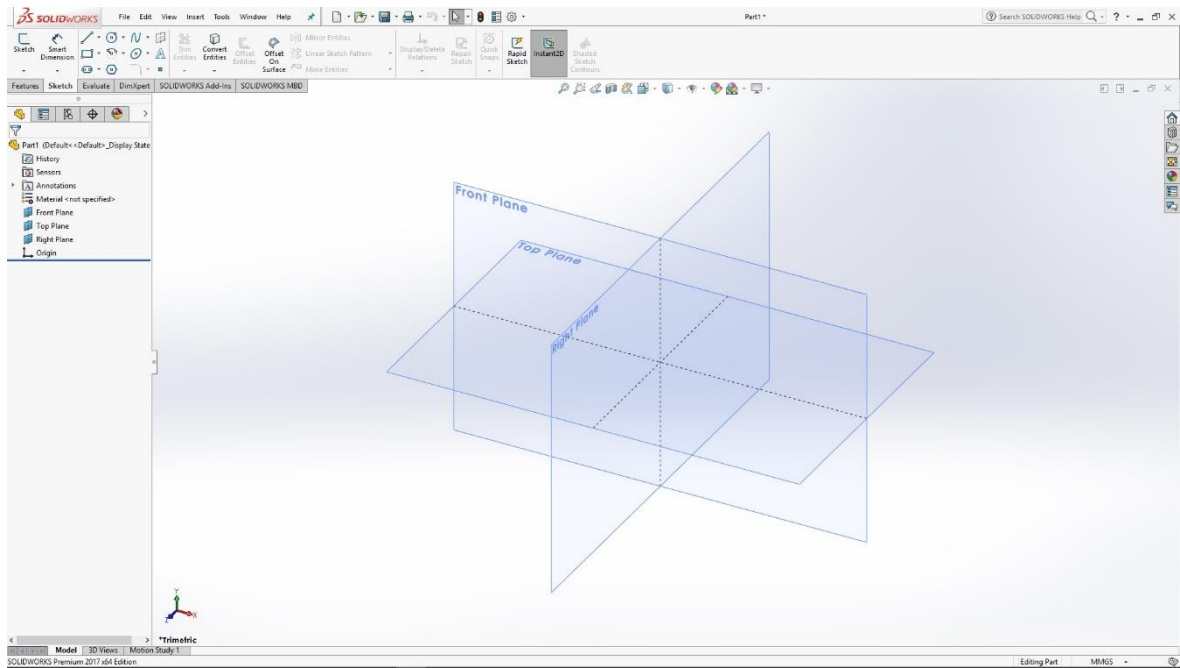
Slika 5.2: Odabir SolidWorks dokumenta

Ikona Part predstavlja rad ili izradu jednog sklopa ili modela dok ikona Assembly nam otvara radni prostor gdje možemo pozvati unaprijed napravljene sklopove, te ih možemo spojiti u jedan cjelokupni sklop. Ikona Drawing nam daje mogućnost izrade tehničkog crteža iz samostalnog modela ili cjelokupnog sklopa.



Slika 5.3: Radni zaslon Part dokumenta

Na radnom zaslonu prvo što moramo napraviti je kliknuti na Front, Top, Right plane, te zatim na ikonu Show (pokaži) kako bismo aktivirali pomoćne ravnine za izradu sklopa.

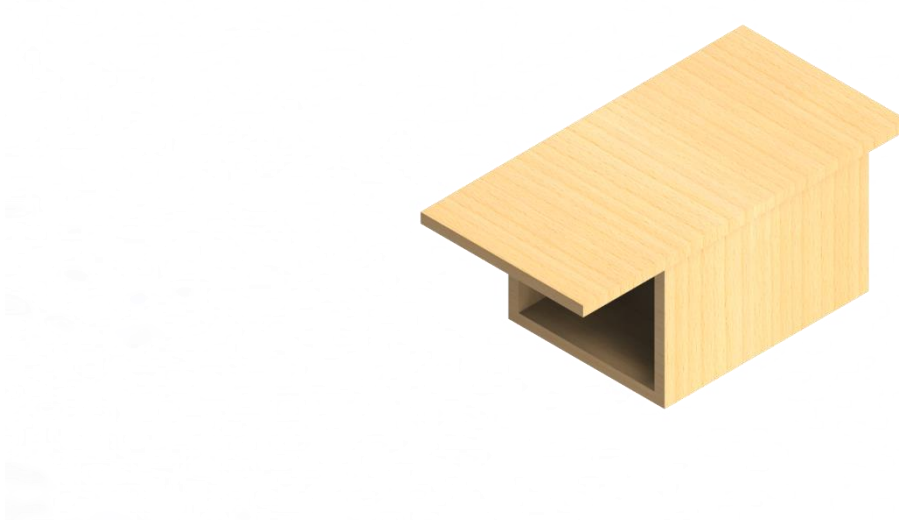


Slika 5.4: Pomoćne ravnine u Solidworks-u

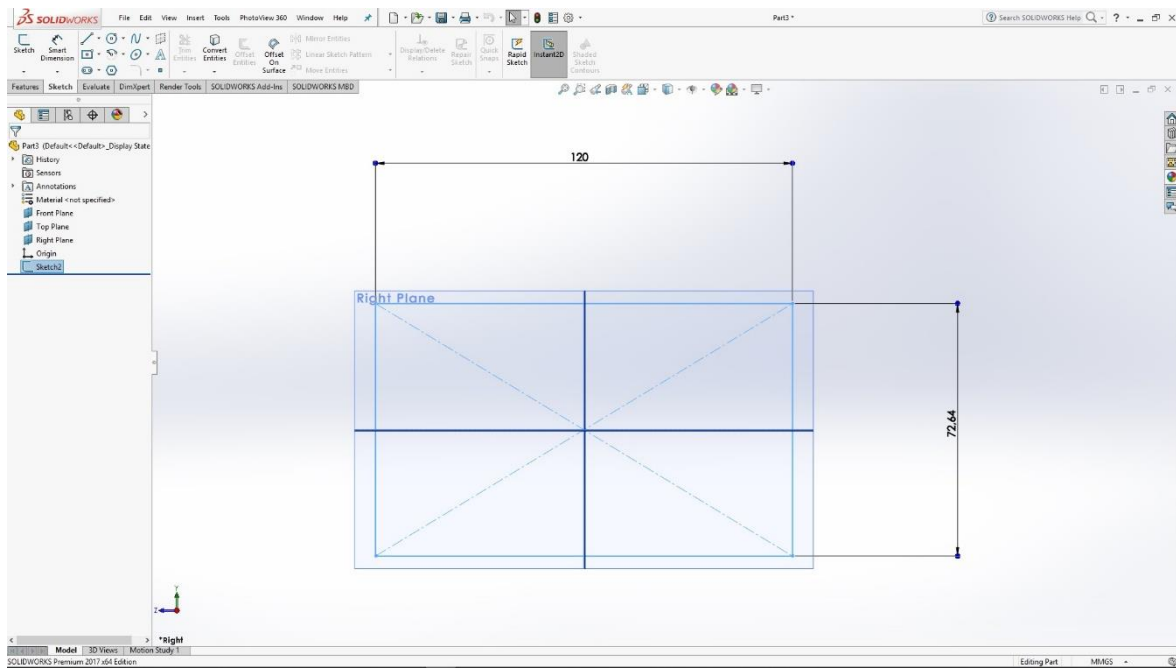
6. Izrada modela

Kako bismo dobili gotov cjelokupni sklop Mehatroničkog didaktičkog stola, potrebno je započeti modeliranje njegovih pojedinih sklopova u programu SolidWorks. U nadolazećem tekstu biti će objašnjeno sam proces modeliranja pojedinih dijelova i cjelokupnog sklopa.

6.1 Bočna klizna traka

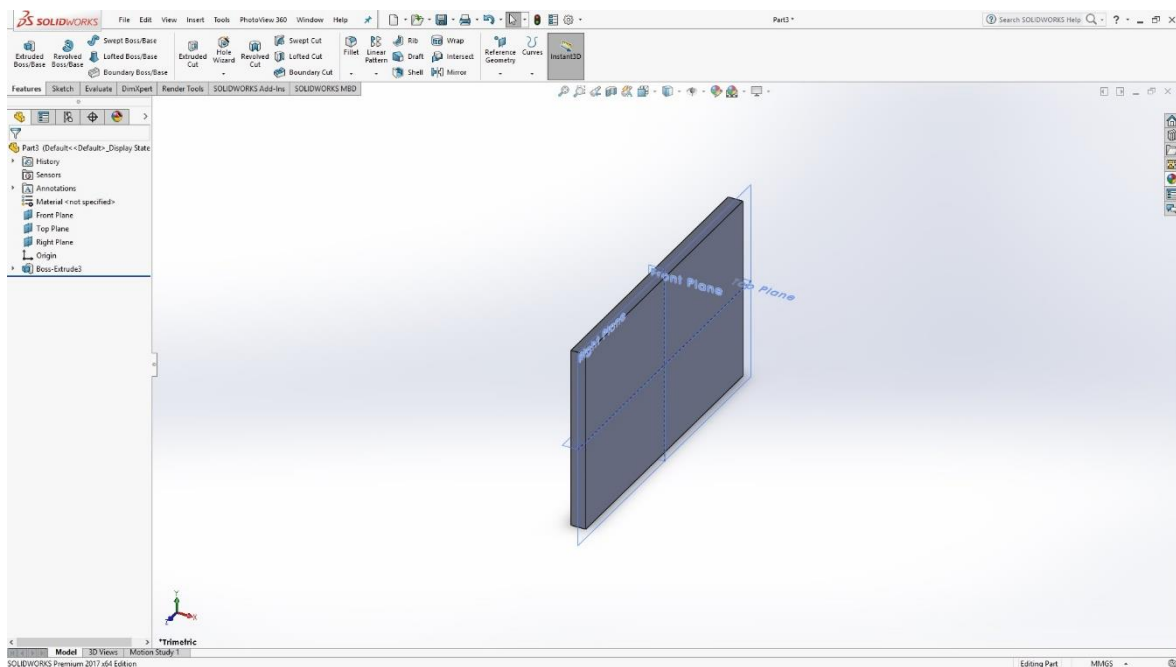


Slika 6.1: Render bočne klizne trake

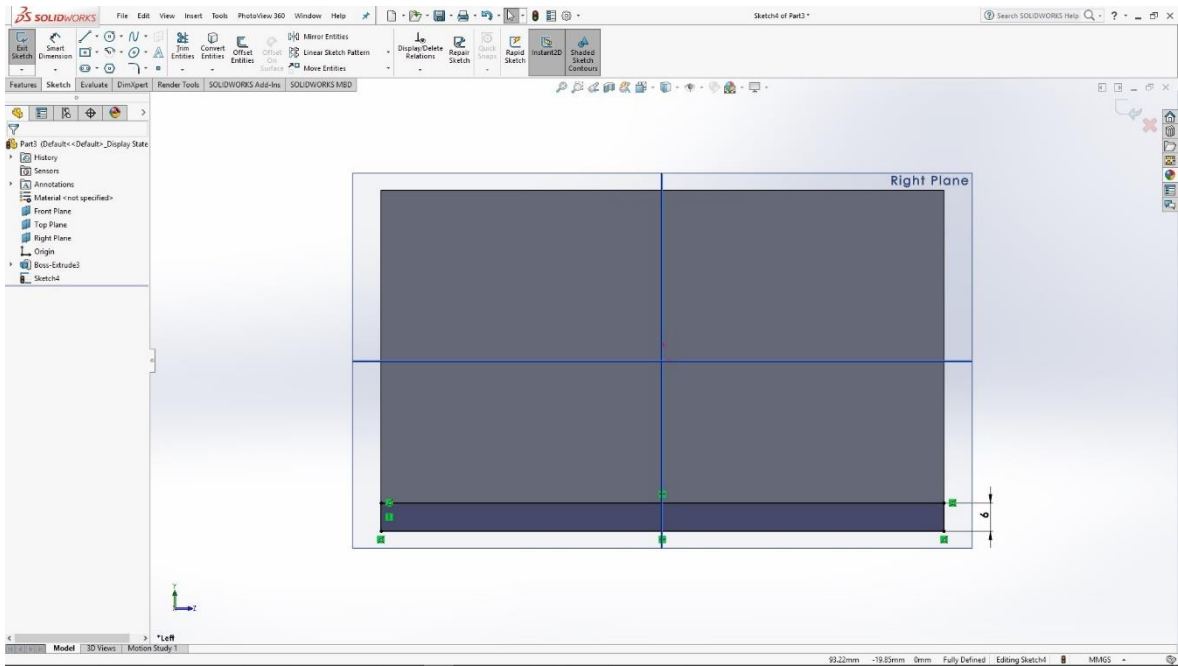


Slika 6.2: Desni brid sklopa

Izradu bočne klizne trake započinjemo u desnoj ravni gdje skiciramo pravokutnik koji ćemo opcijom Extrude izvući te dobiti 3D model pravokutnika.

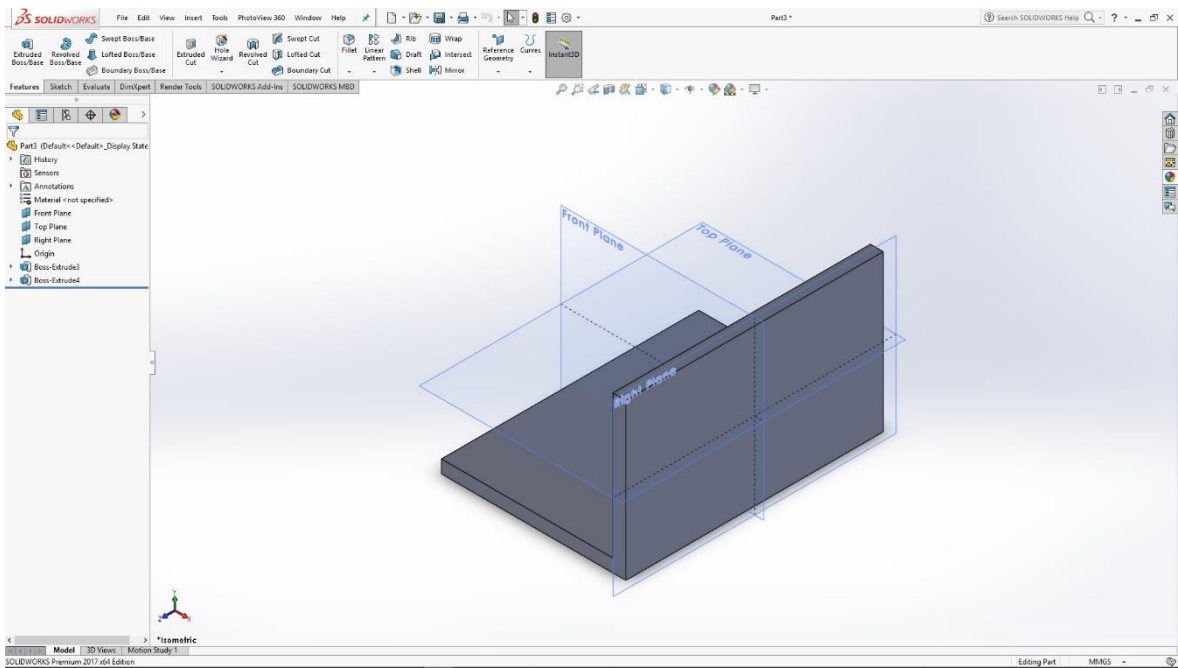


Slika 6.3: 3D model pravokutnik

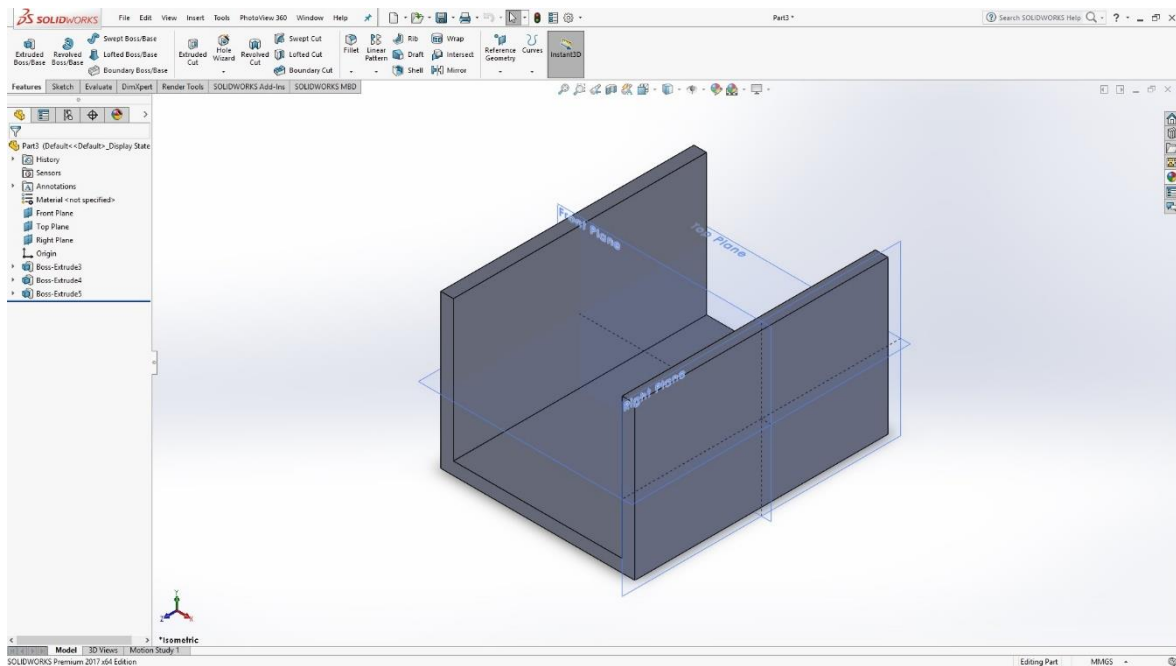


Slika 6.4: Donji brid modela

Na desni brid crtamo novi pravokutnik koji ćemo naredbom Extrude izvući, te dobiti donji brid modela.

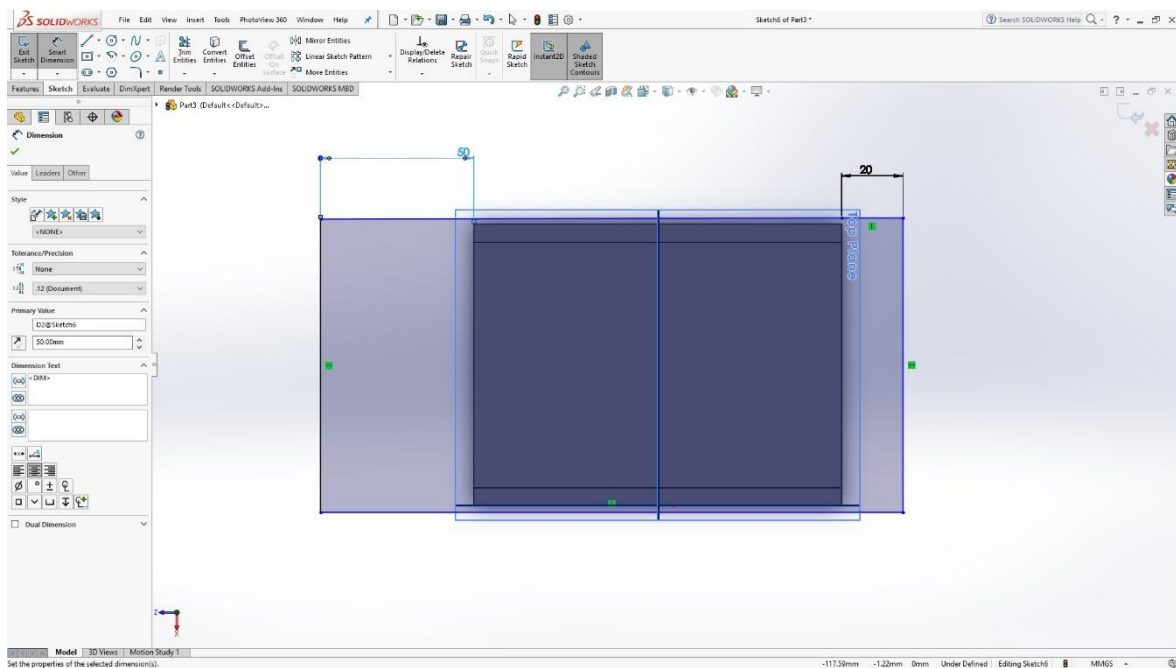


Slika 6.5: Donji i desni brid modela



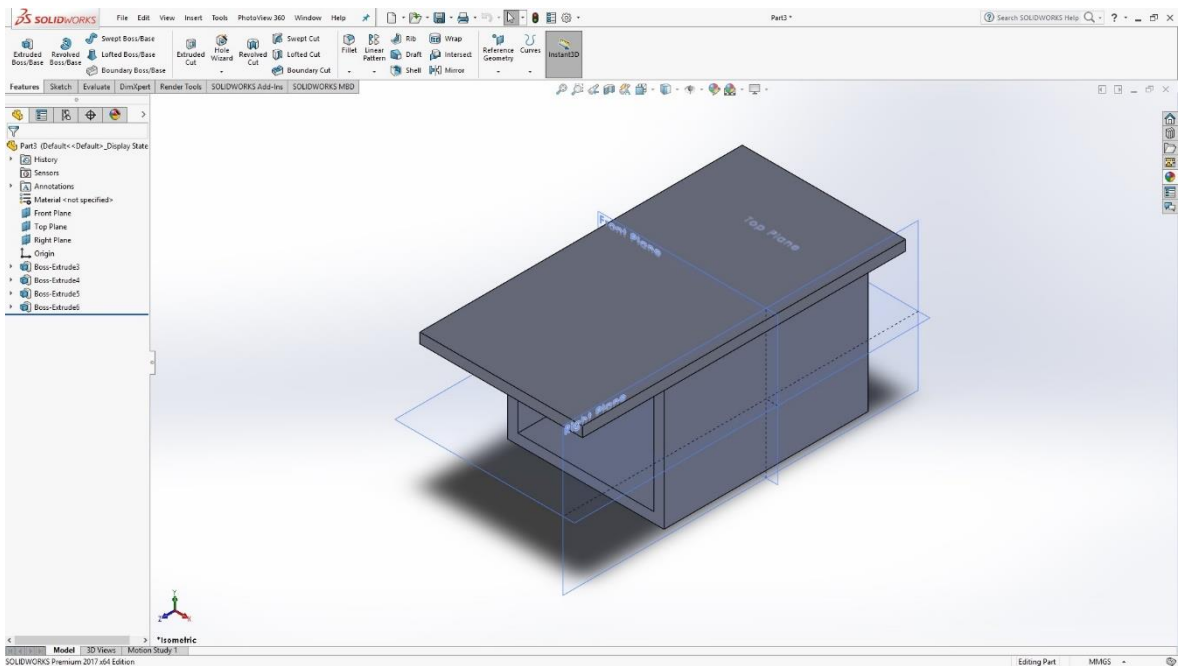
Slika 6.6: Lijevi brid dodan u model

Istim postupkom kako smo bili izradili desni brid tako izrađujemo i lijevi brid. Radimo skicu u Sketch-u te ju naredbom Extrude izvlačimo u 3D model.

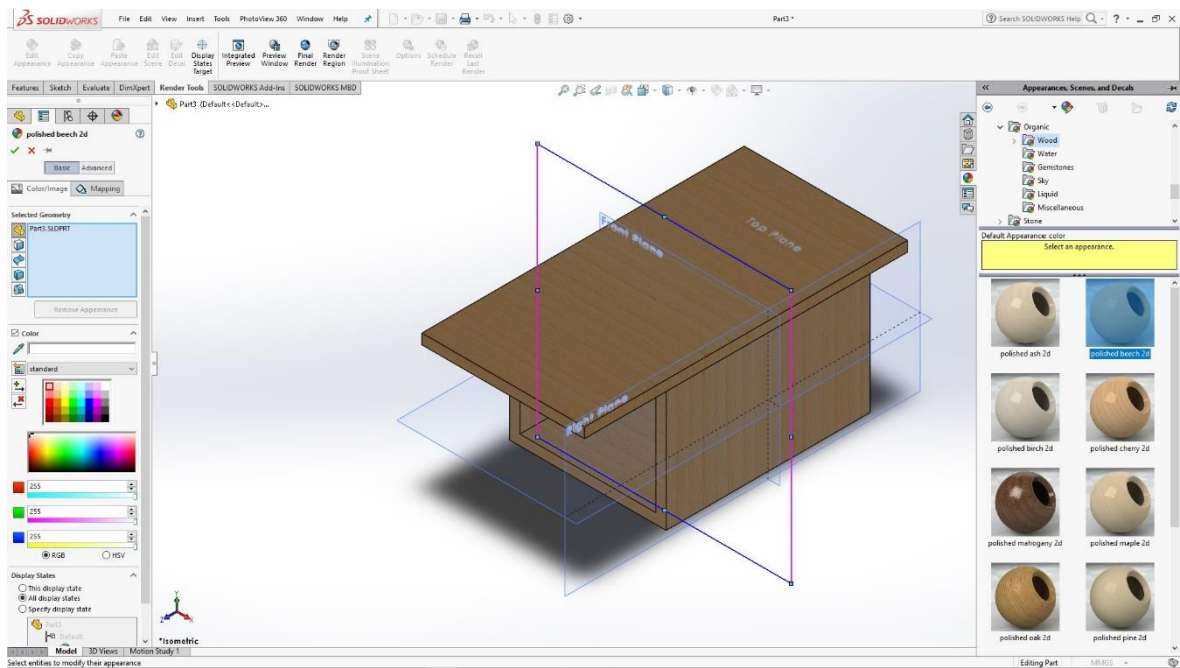


Slika 6.7: Gornji brid sklopa

Kada smo napravili lijevi brid, potrebno je napraviti gornji brid ili dio sklopa na kojem će materijal kliziti s klizne trake. Postupak je isti kao i za sve ostale bridove samo mijenjamo poziciju i veličinu te ga na kraju izvlačimo u 3D model. S time dobivamo gotov 3D model Bočne klizne trake.

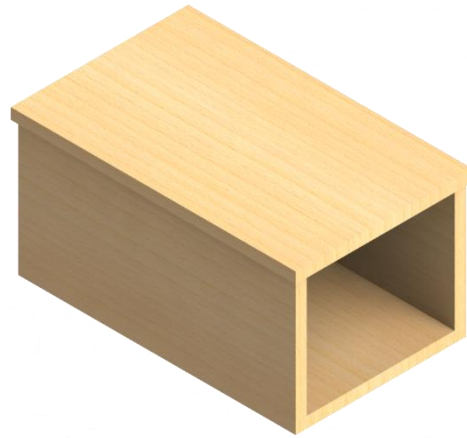


Slika 6.8: 3D model Bočne klizne trake
 Gotovom modelu potrebno je još dodati materijal za izradu render-a modela. Materijal odabran za bočnu kliznu traku je drvo.

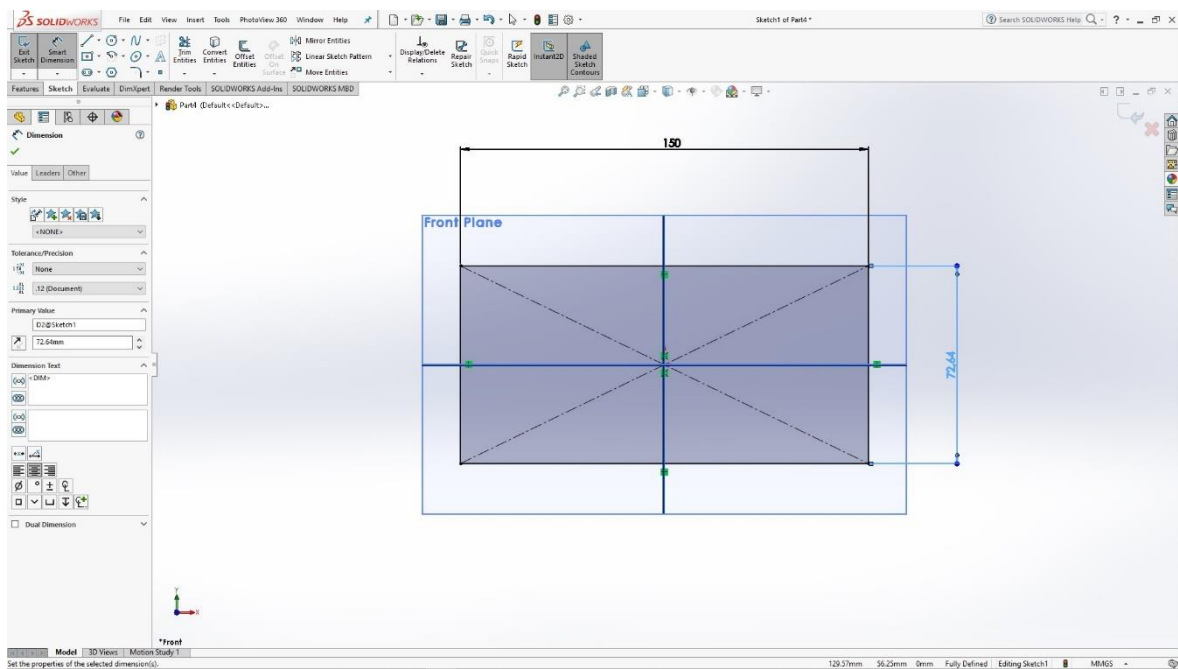


Slika 6.9: Odabir materijala za render

6.2 Izlazna klizna traka

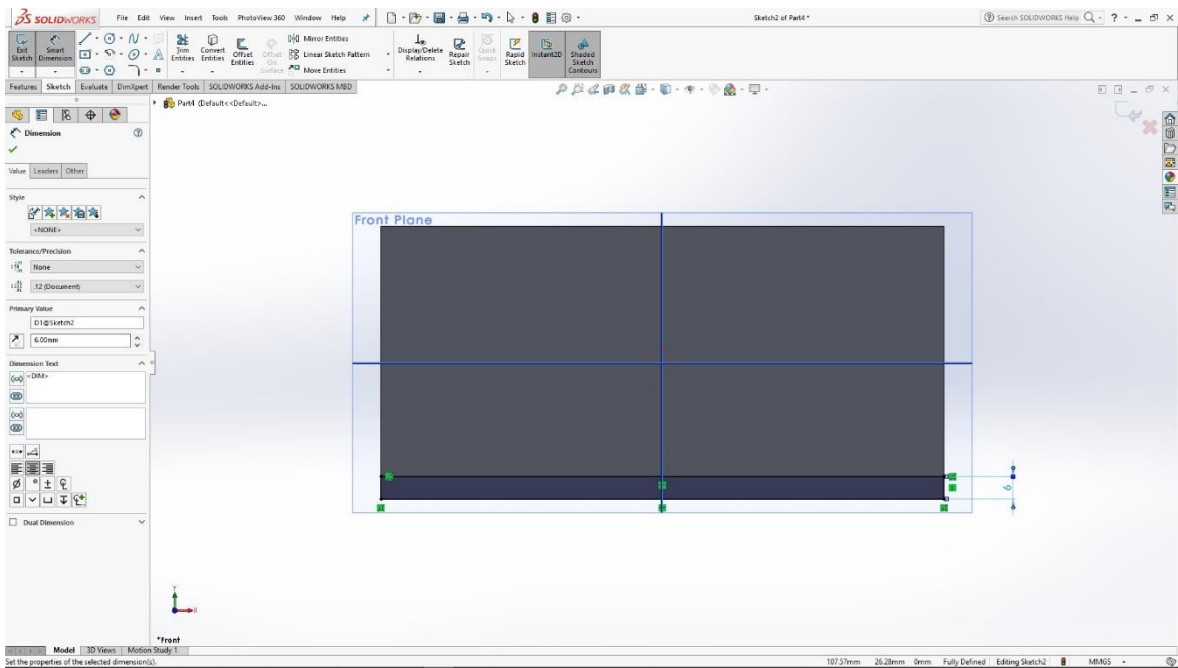


Slika 6.10: Render Izlazne klizne trake



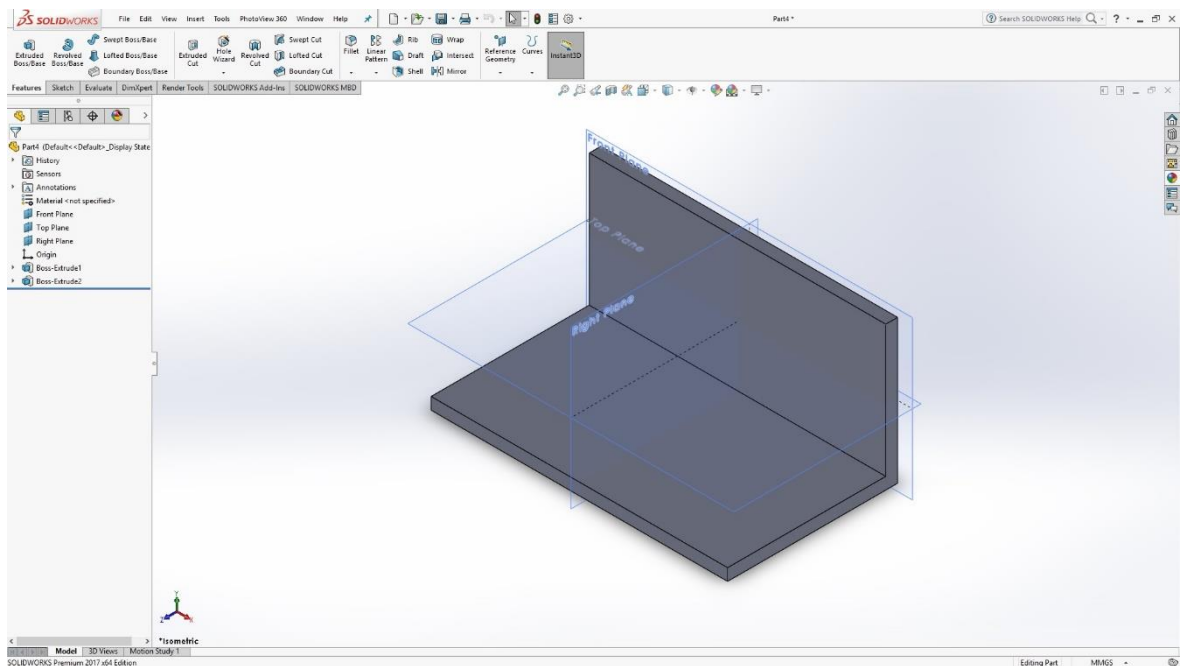
Slika 6.11: Desni brid modela

Pri izradi sklopa moramo prvo započeti s skiciranim pravokutnikom u prednjoj ravnini koji naredbom Extrude izvlačimo u 3D model.

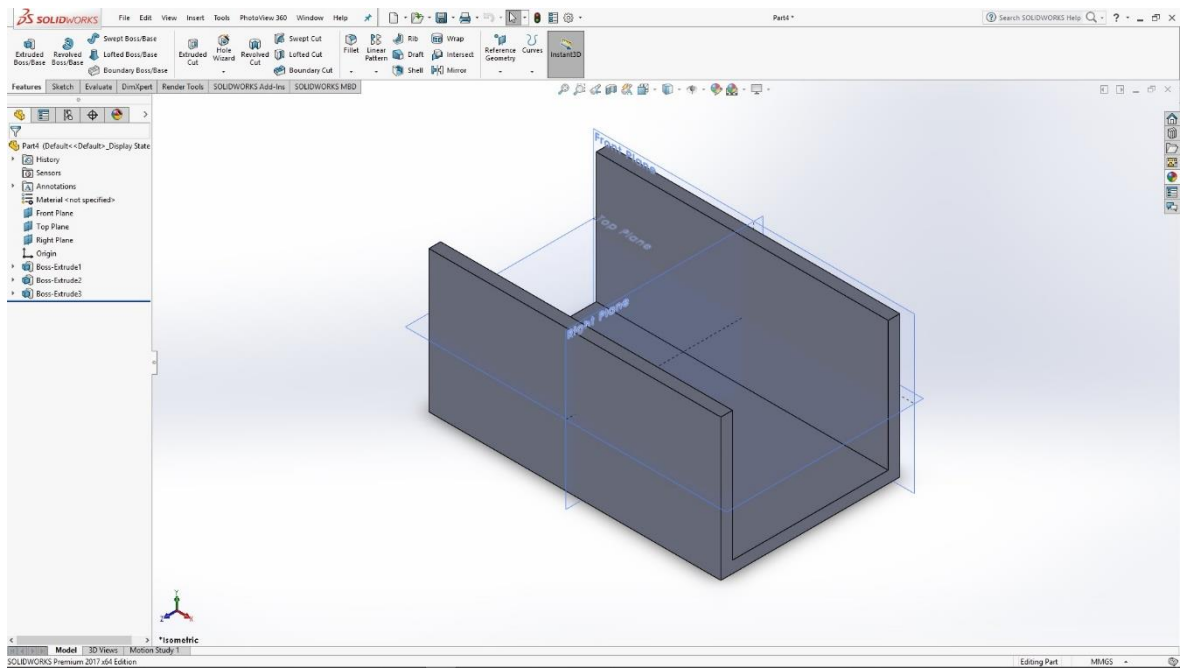


Slika 6.12: Skiciranje donjeg brida

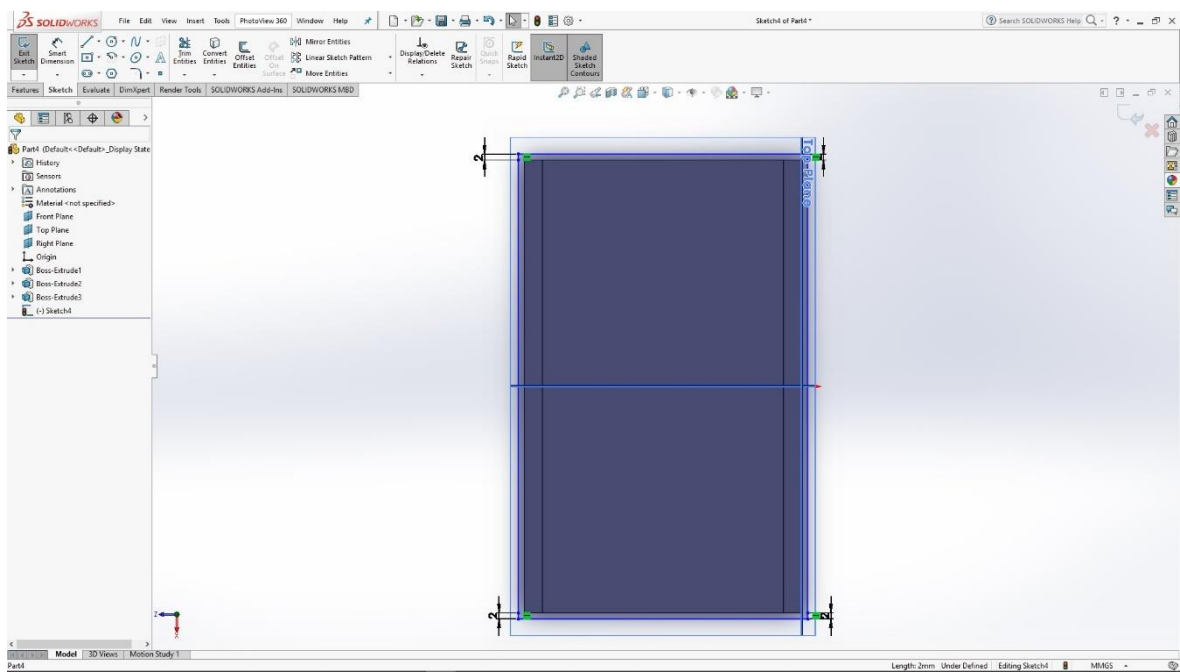
Na donji dio desnog brida skiciramo pravokutnik i izvlačimo ga u 3D model kako bismo dobili donji brid. Istom metodom izrađujemo lijevi brid i kliznu podlogu Izlazne klizne trake.



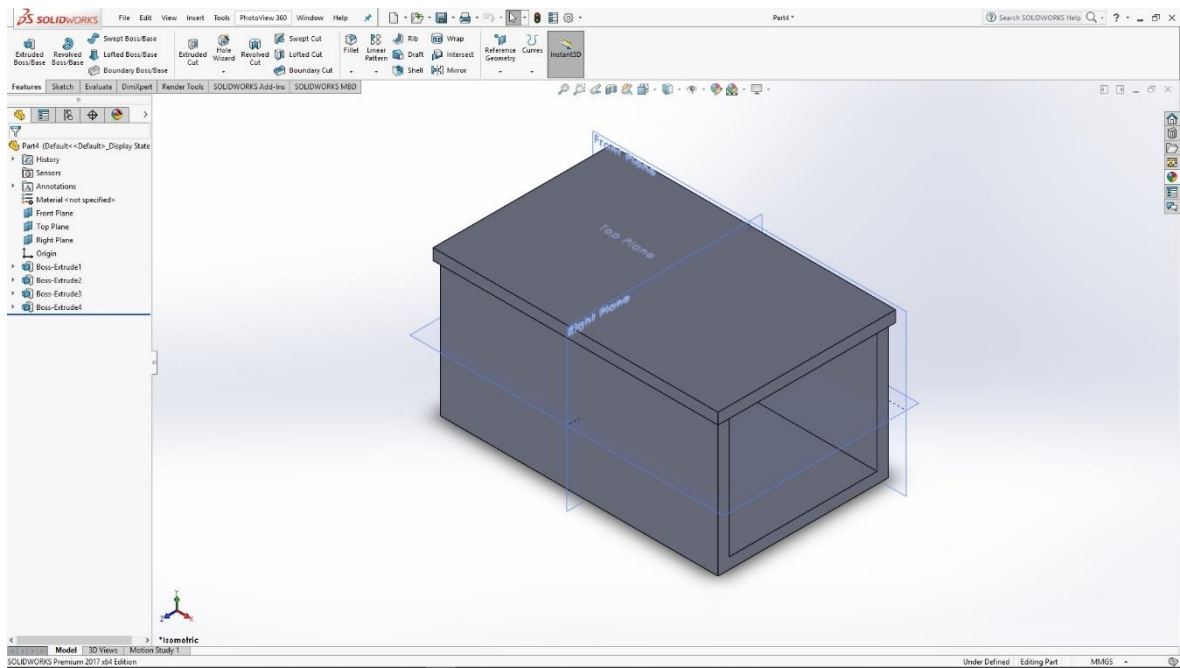
Slika 6.13: 3D model donjeg i desnog brida



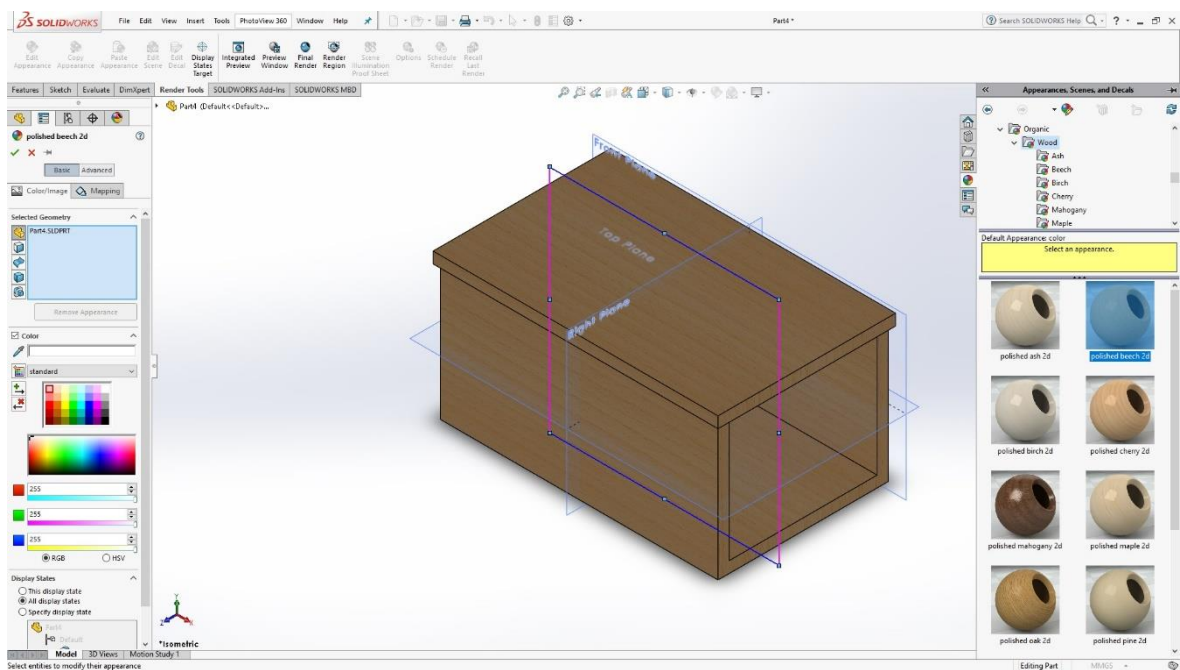
Slika 6.14: 3D model donjeg, desnog i lijevog brida



Slika 6.15: Skiciranje kliznog brida



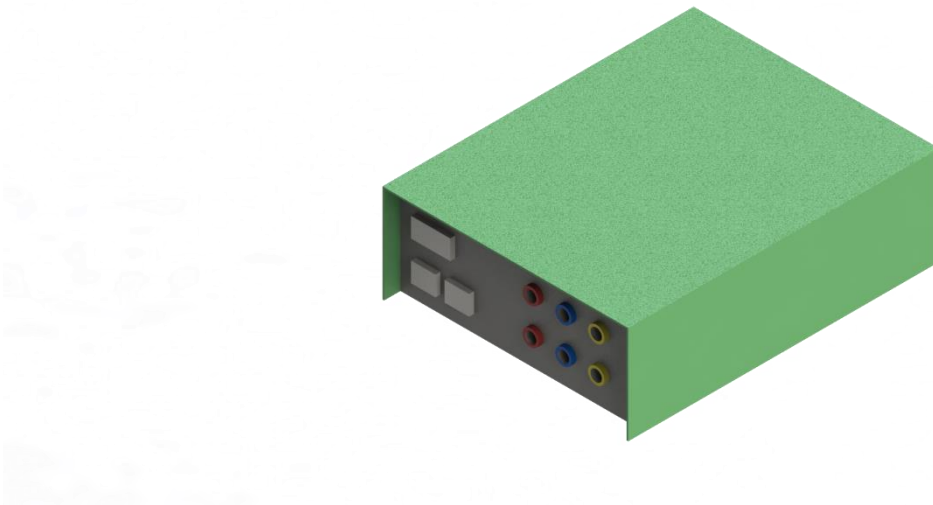
Slika 6.16: 3D model Izlazne klizne trake



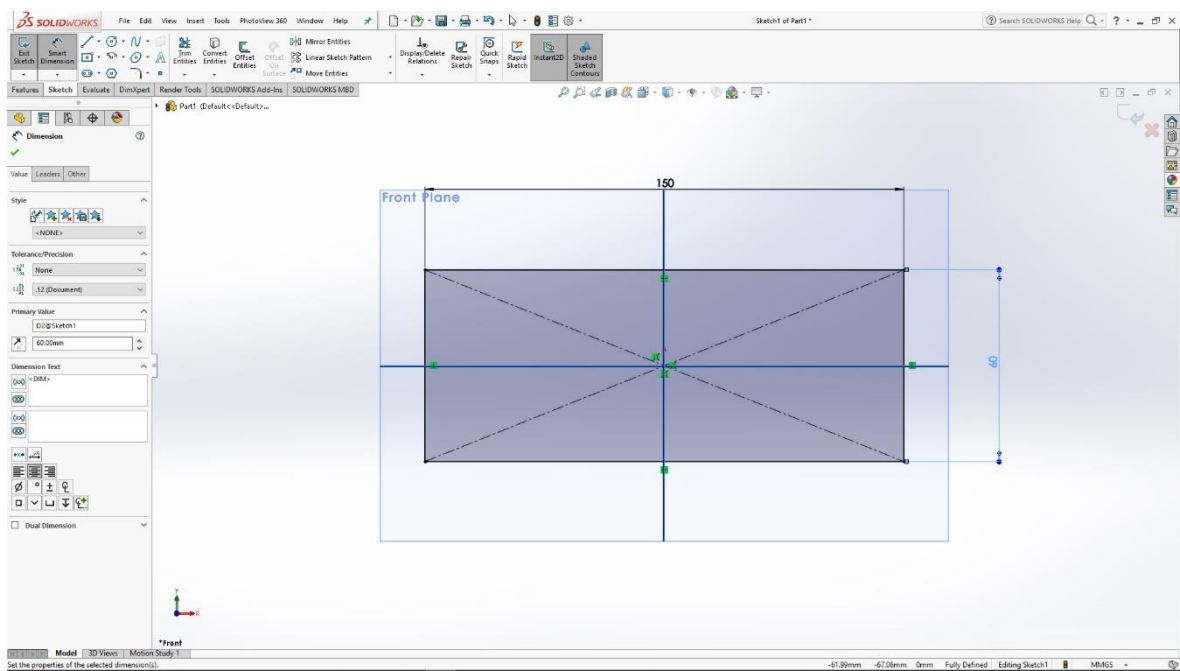
Slika 6.17: Odabir materijala za 3D model

Na gotov 3D model Izlazne klizne trake potrebno je odabrati materijal. Odabrani materijal je drvo. Po odabranom materijalu, idemo u PhotoView360 te napravimo render modela.

6.3 Generator napona

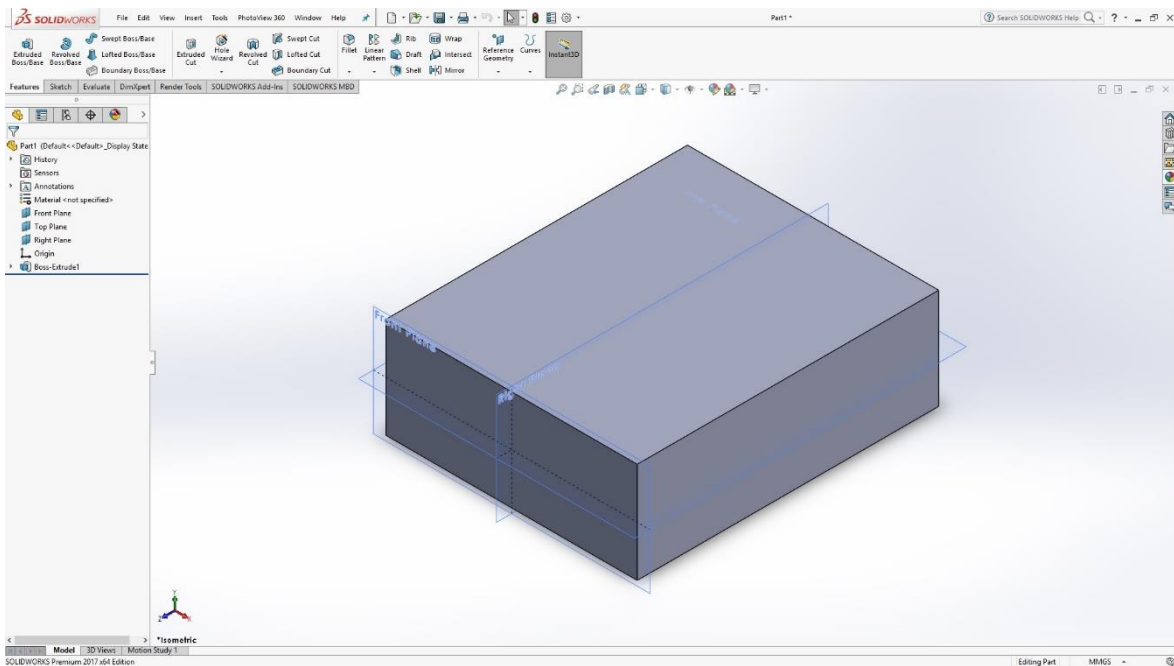


Slika 6.18: Render generatora napona



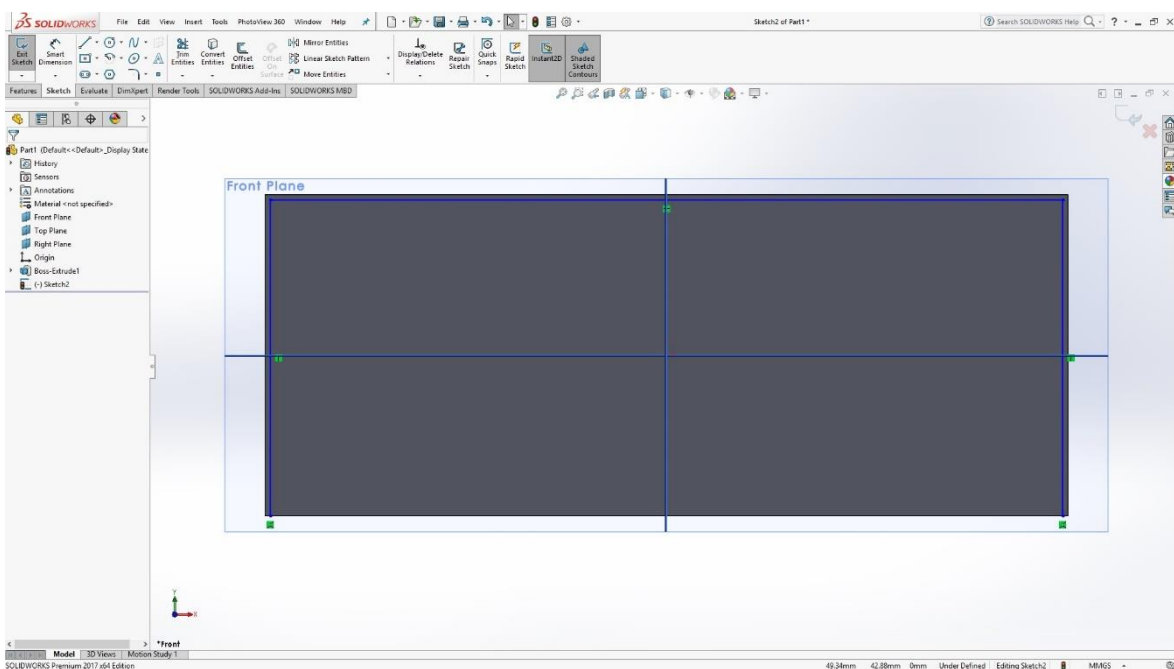
Slika 6.19: Skiciranje pravokutnika u prednjoj ravni

U prednjoj ravni skiciramo pravokutnik koji pomoću naredbe Extrude izvlačimo kako bismo dobili 3D model pravokutnika.

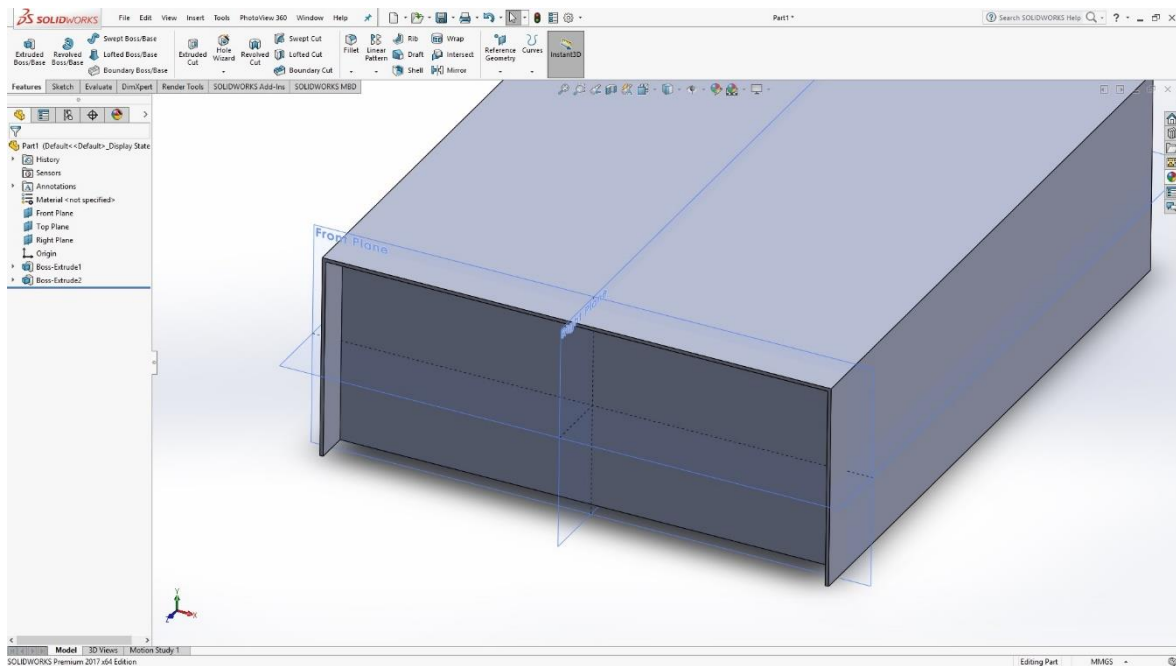


Slika 6.20: 3D model pravokutnika

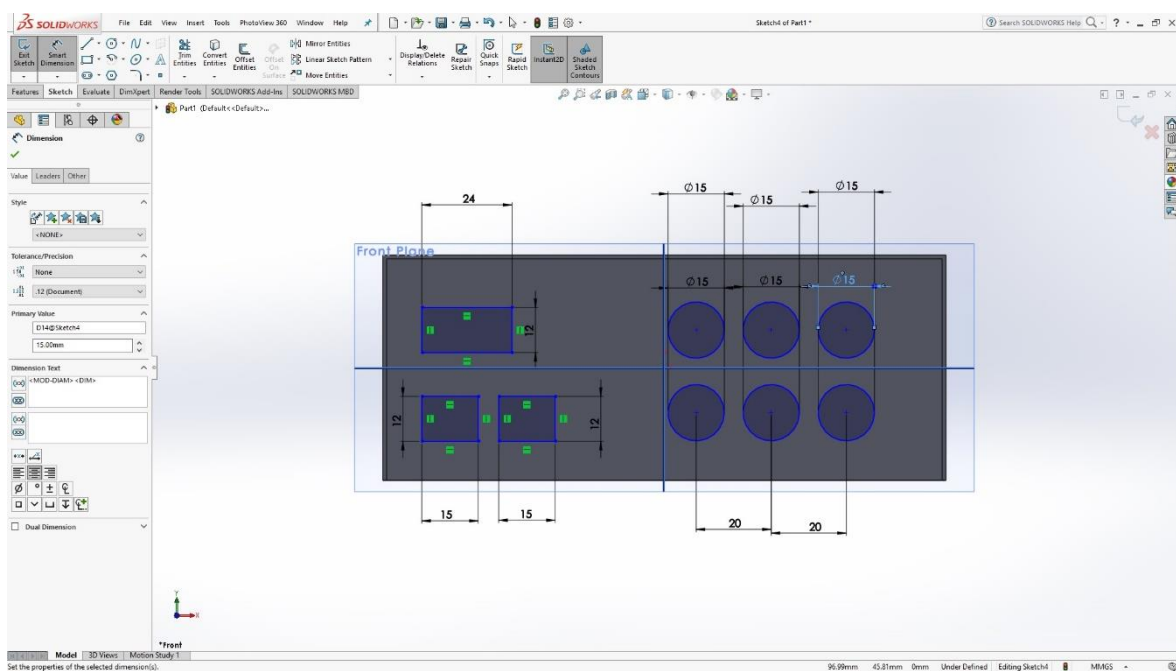
Na prednji dio pravokutnika skiciramo naopako okrenut „U“ oblik te mu naredbom Extrude thin dajemo podebljanje i izvlačimo na odabranu veličinu kako bismo dobili 3D oblik



Slika 6.21: Skiciranje „U“ oblika

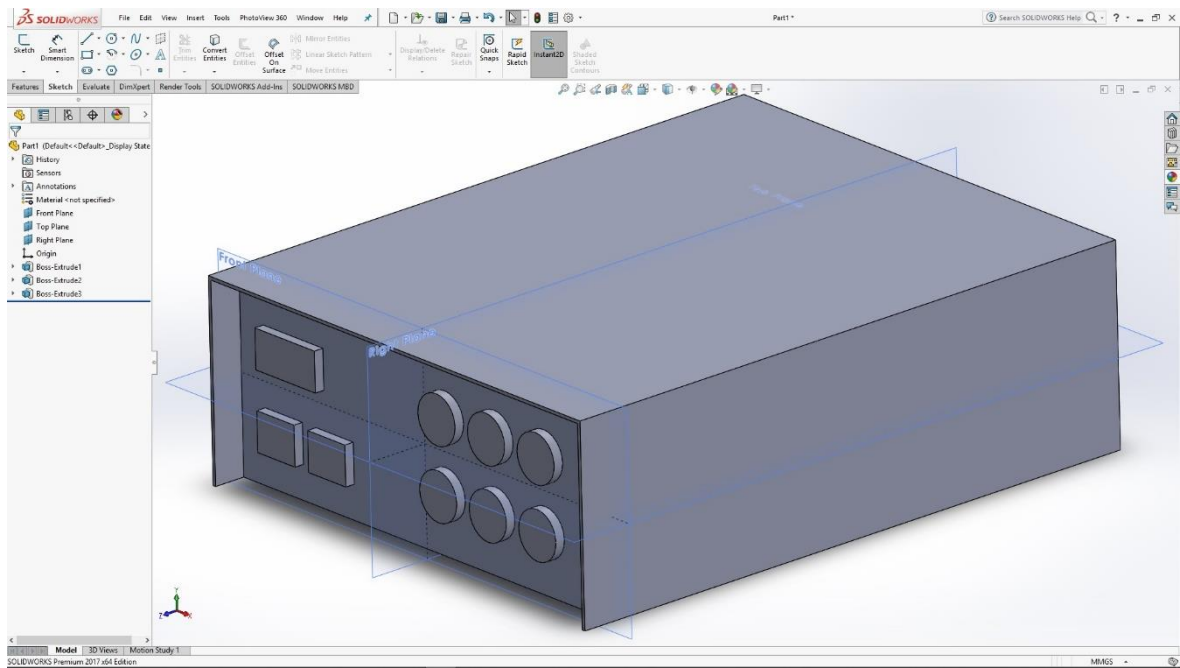


Slika 6.22: 3D model kućišta generatora napona

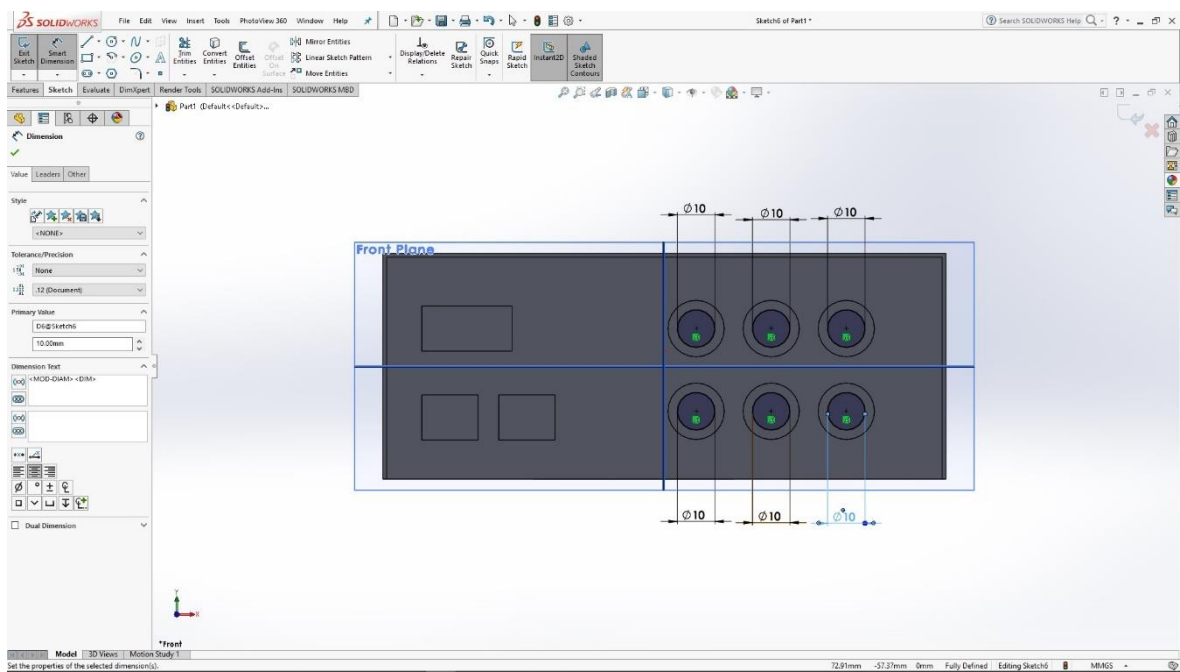


Slika 6.23: Skica za utore kablova i dugmadi

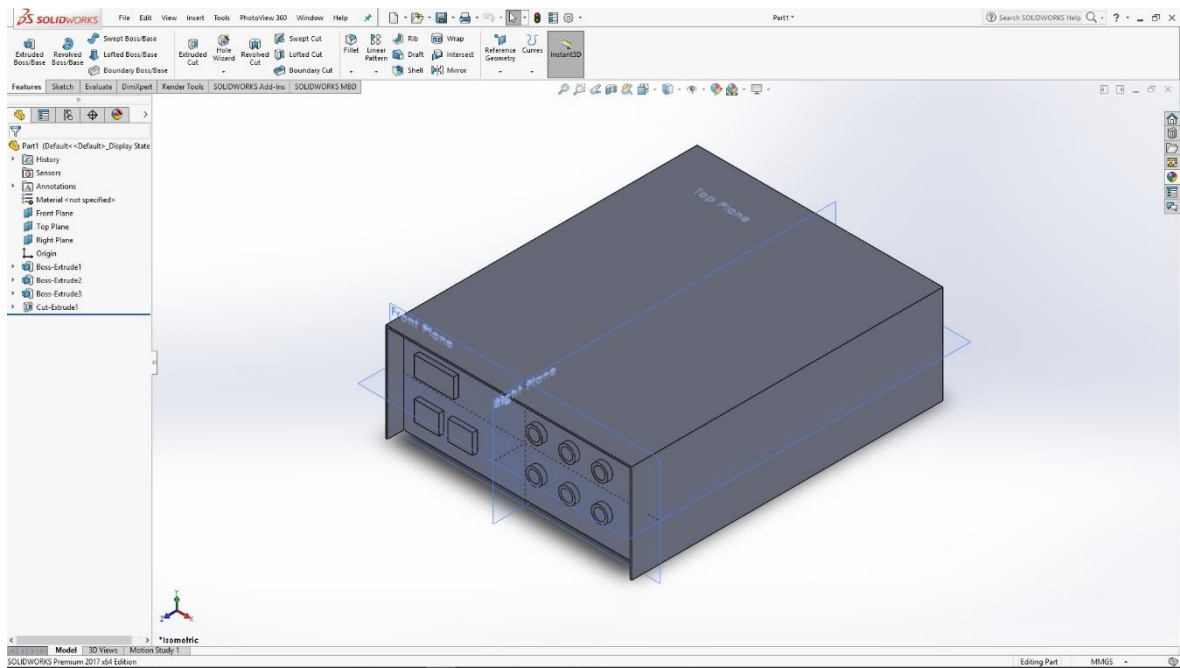
Na prednjem dijelu kućišta skiciramo pravokutnike i krugove kako bismo ih naredbom Extrude mogli izvući 3D model. Na 3D modelu krugova, to jest valjka, skiciramo manje krugove na kojima naredbom Cut izrađujemo utore unutar valjka za kablove.



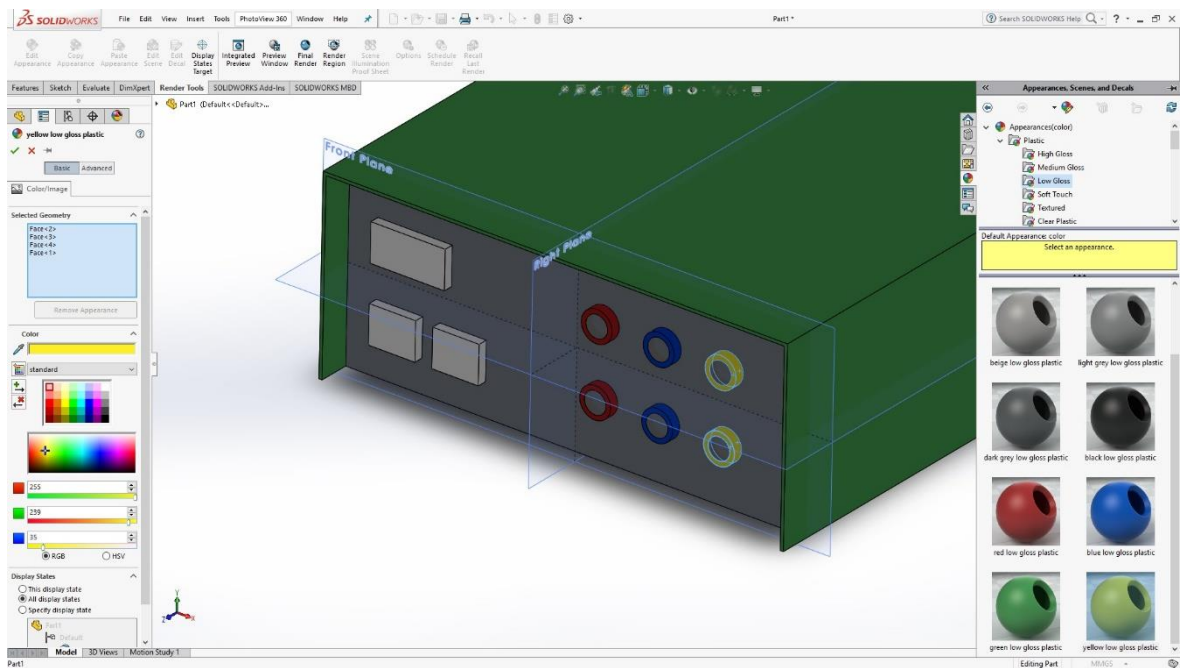
Slika 6.24: 3D model dugmadi



Slika 6.25: Skica za utore kablova



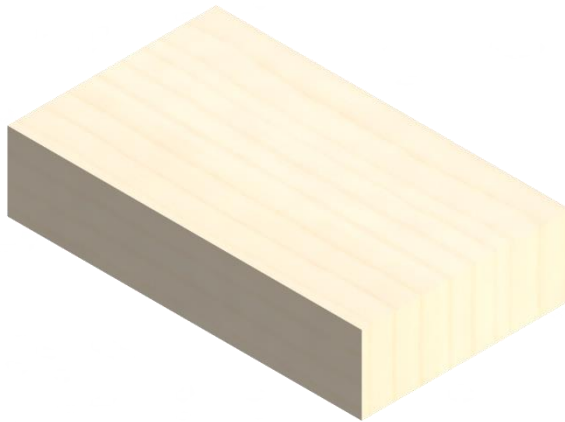
Slika 6.26: 3D model generatora napona



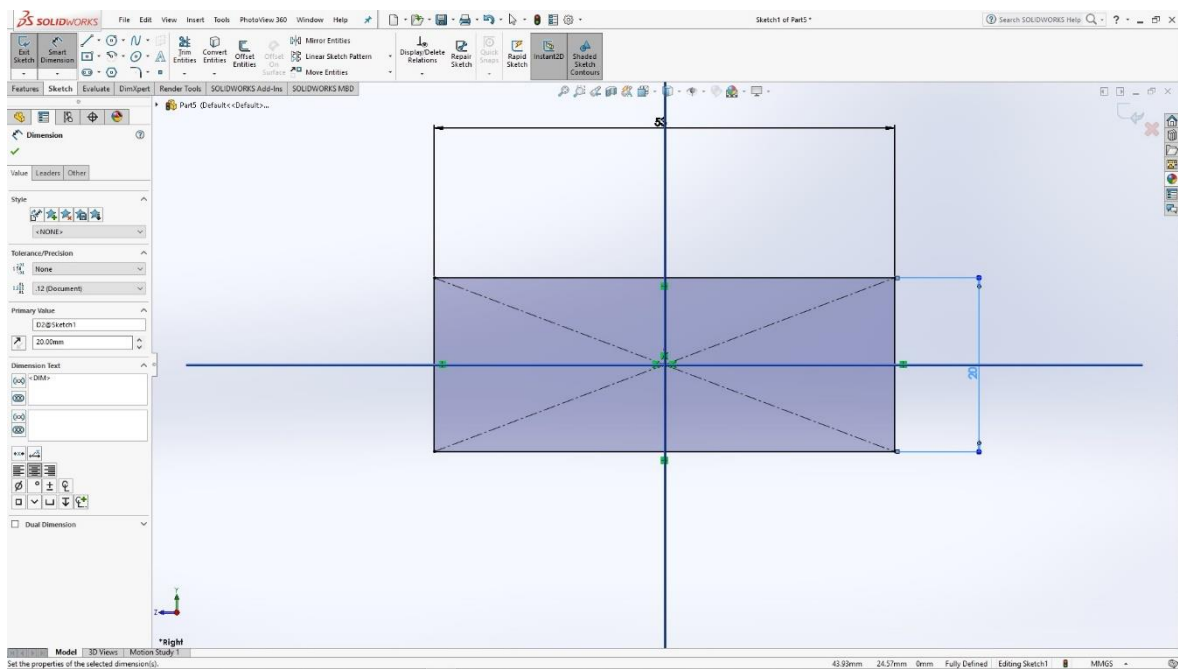
Slika 6.27: Odabir materijala za render

Završnom modelu treba na kraju još odabrati materijal koji će biti korišten za renderiranje slike modela.

6.4 Radni materijal

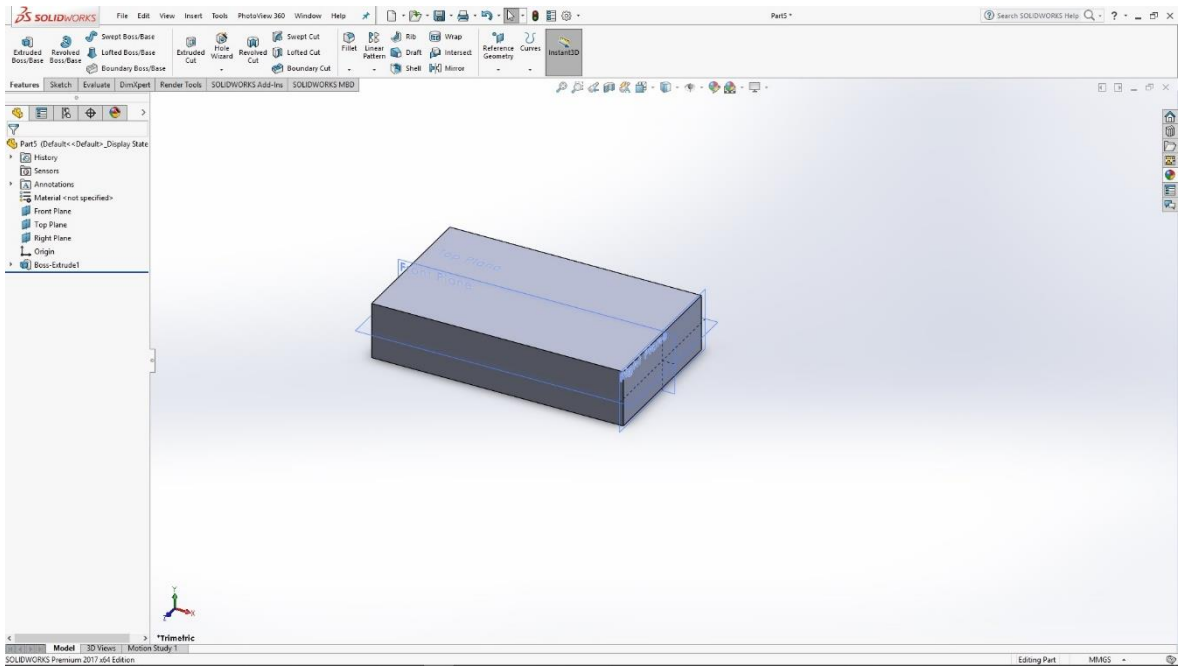


Slika 6.28: Render radnog materijala

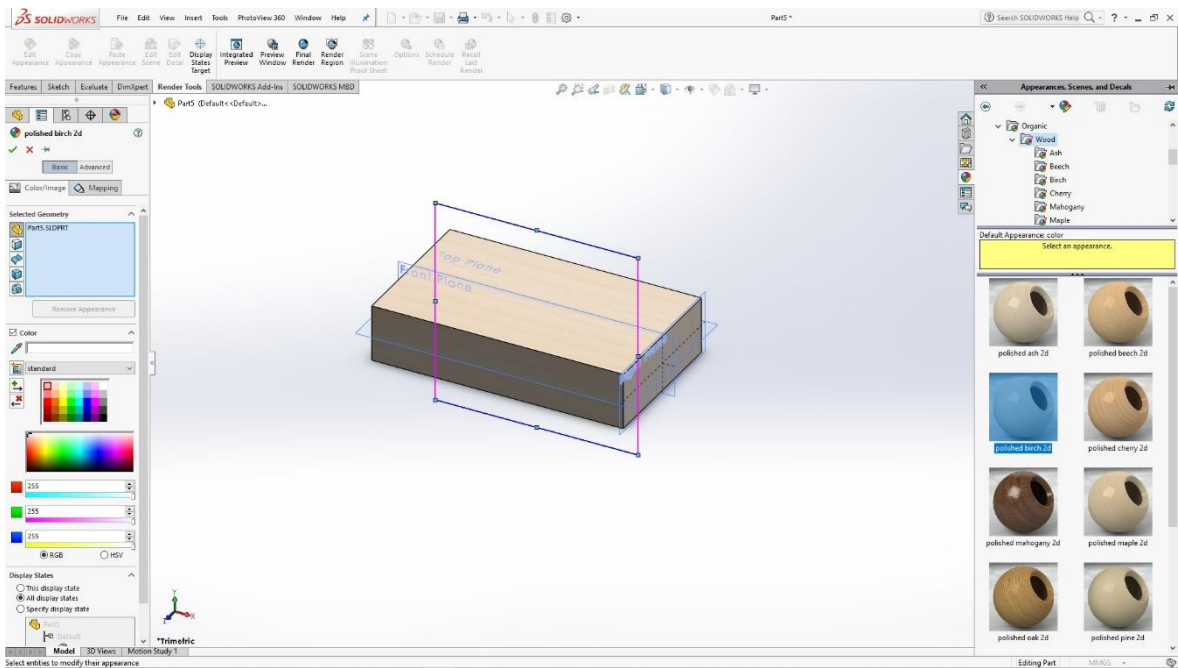


Slika 6.29: Skica pravokutnika u desnoj ravnini

Izradbom 3D modela radnog materijala započinjemo u desnoj ravnini skiciranjem pravokutnika. Naredbom Extrude izvlačimo 3D model iz skice na zadanu veličinu, te dobivamo 3D model radnog materijala. Na taj 3D model još je potrebno odabrati njegov materijal za renderiranje slike. Odabrani materijal je drvo.

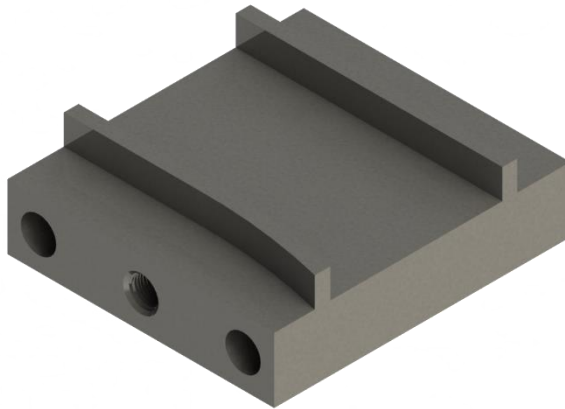


Slika 6.30: 3D model radnog materijala

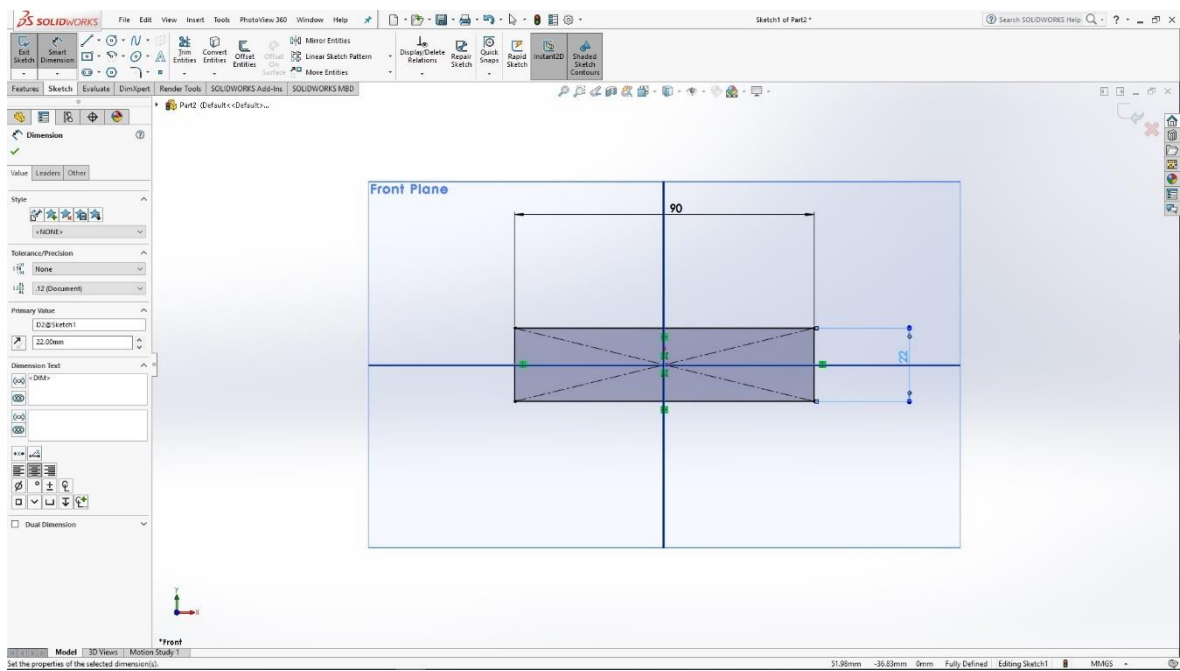


Slika 6.31: Odabir materijala za render

6.5 Nosač radnog materijala

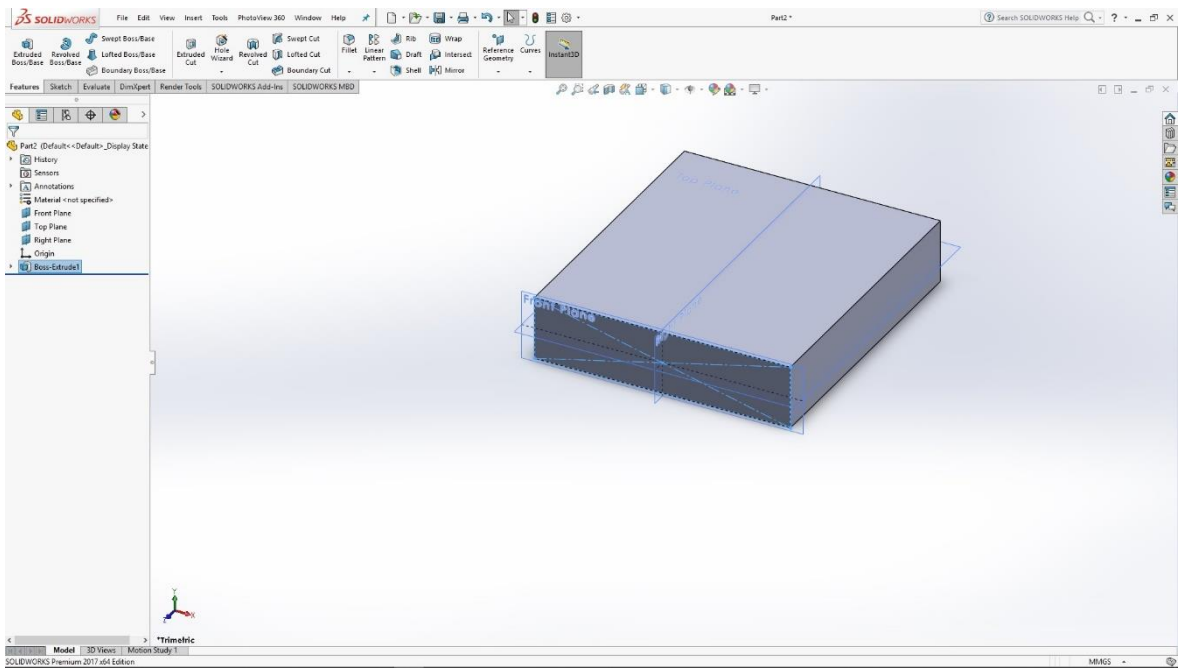


Slika 6.32: Render nosača radnog materijala



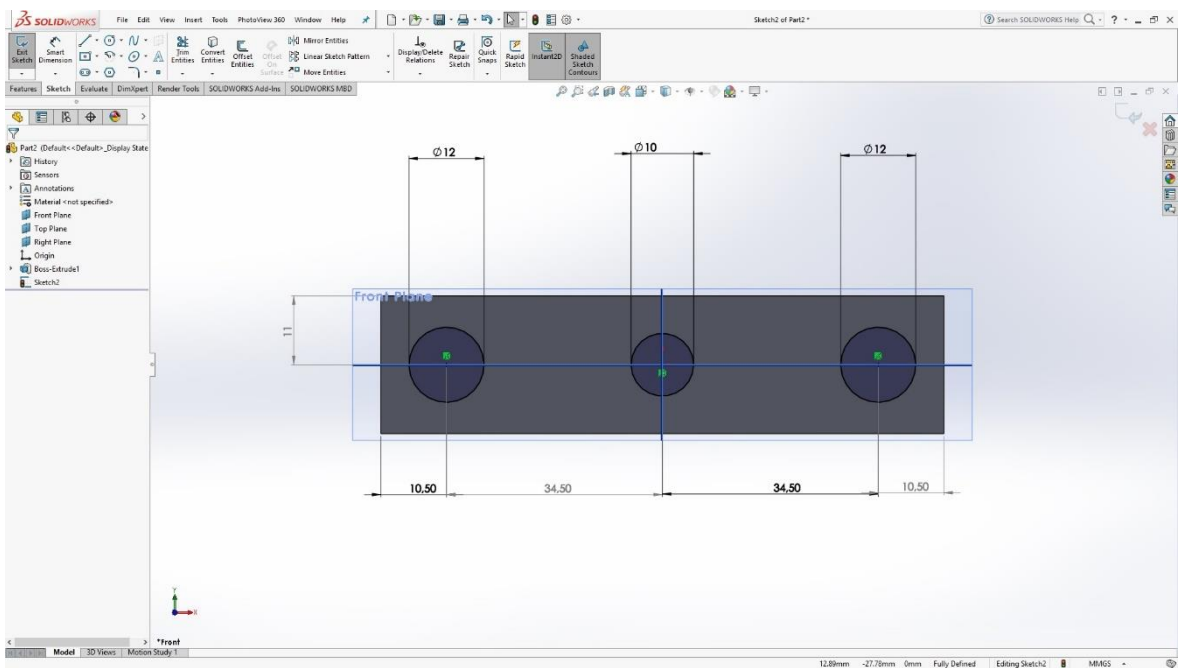
Slika 6.33: Skiciranje pravokutnika u prednjoj ravnini

Izrada 3D modela nosača radnog materijala započinje u prednjoj ravnini skicom pravokutnika. Skicu naredbom Extrude izvlačimo u 3D model pravokutnika.

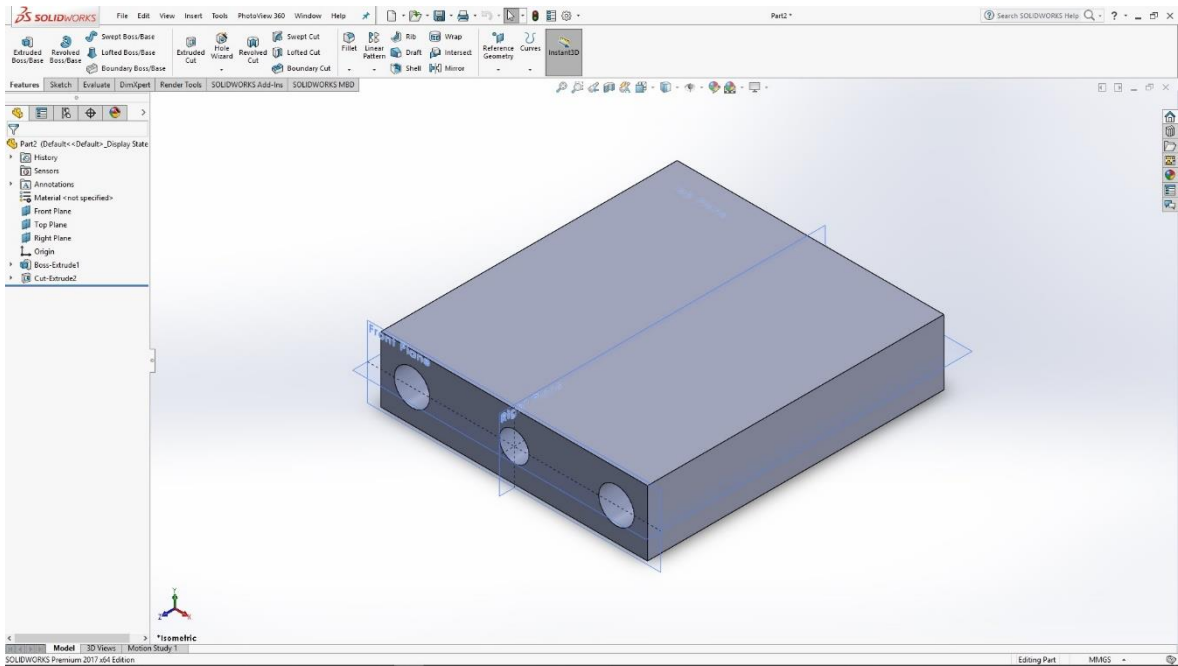


Slika 6.34: 3D model pravokutnika

U prednjoj ravni pravokutnika skiciramo krugove koje naredbom Cut oblikujemo utore u pravokutniku.

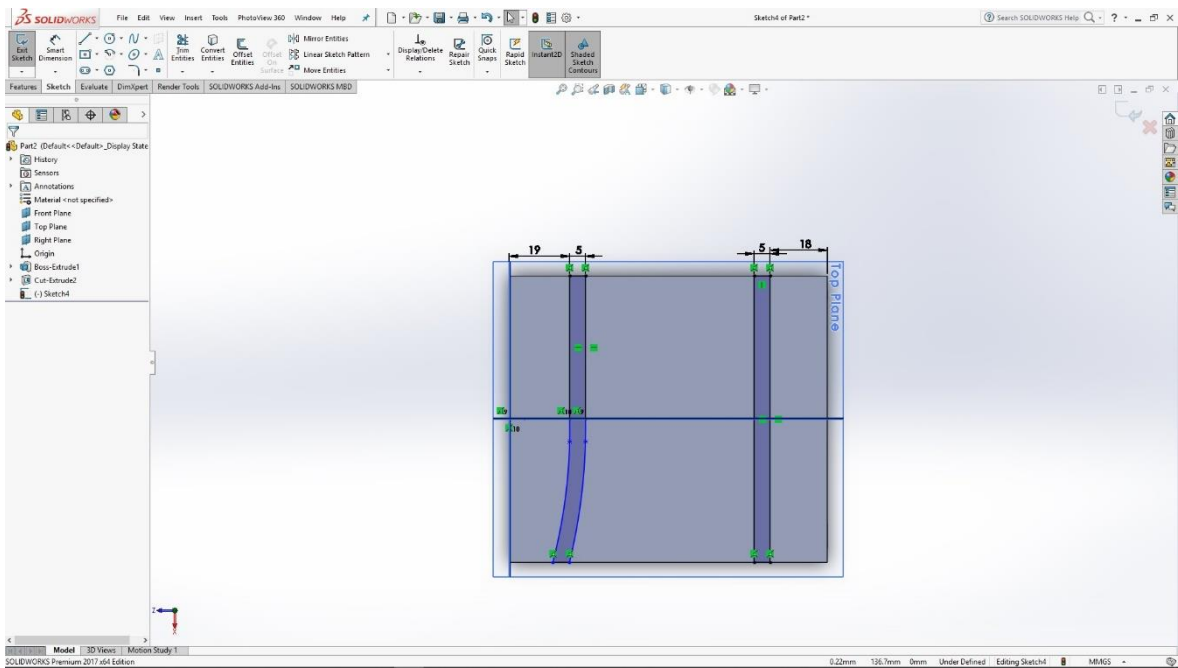


Slika 6.35: Skica krugova u prednjoj ravni

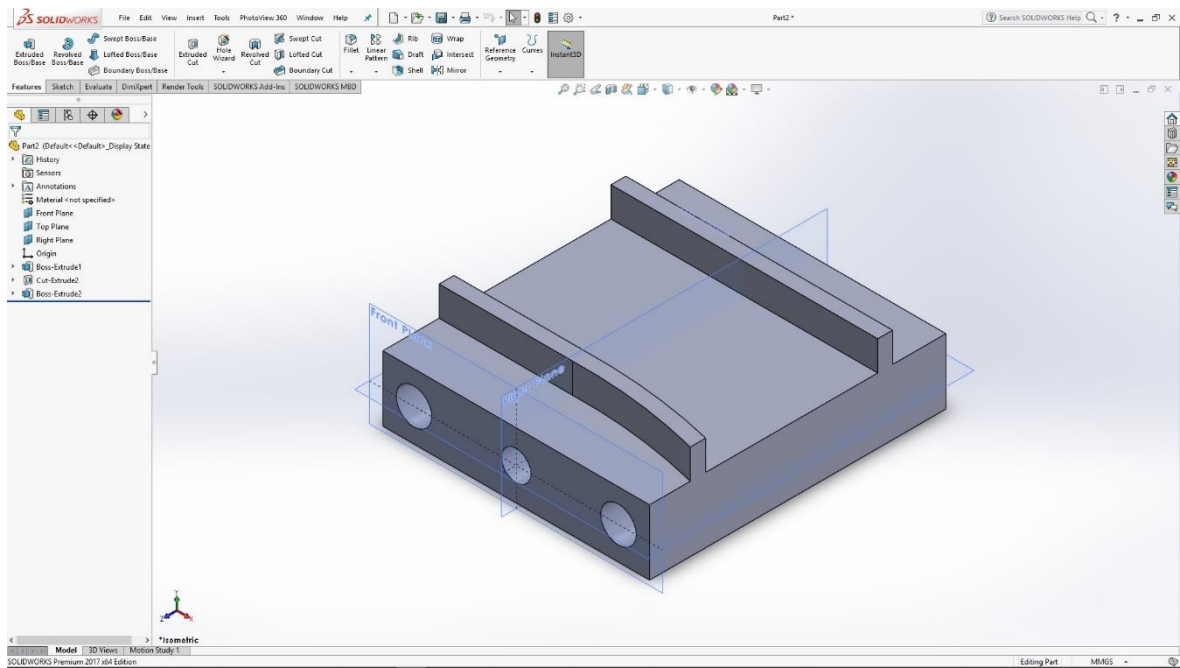


Slika 6.36: 3D model pravokutnika s 3 utora

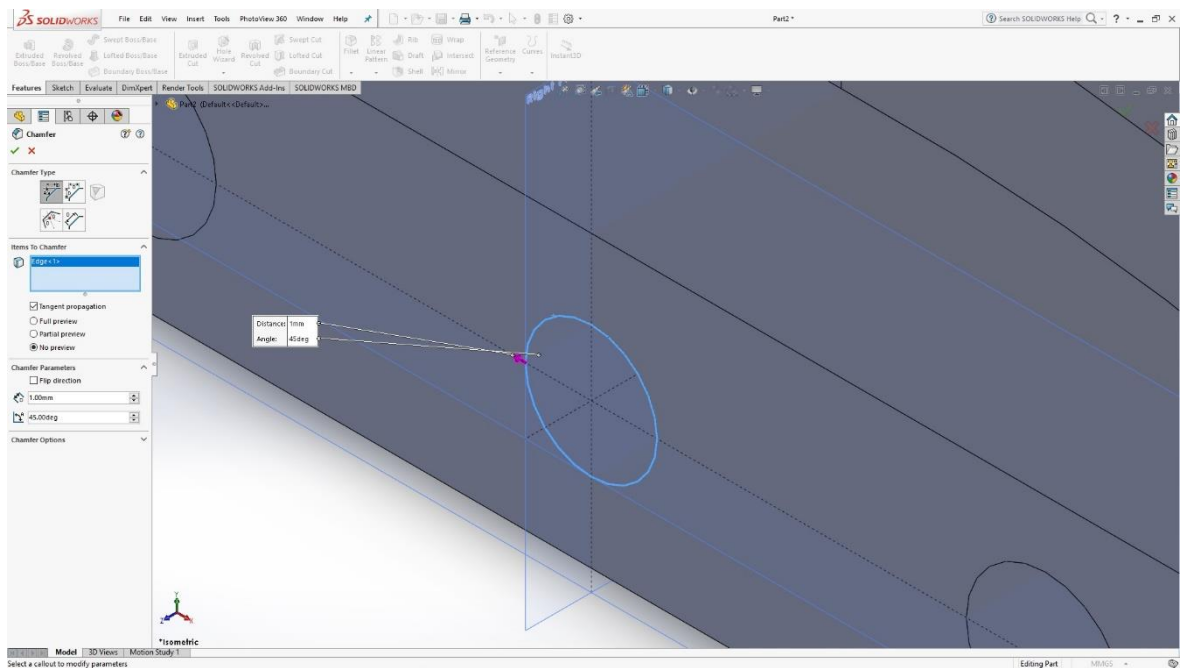
Na gornjoj plohi pravokutnika skiciramo vodilice i držače radnog materijala koje naredbom Extrude izvlačimo u 3D model.



Slika 6.37: Skica vodilica radnog materijala

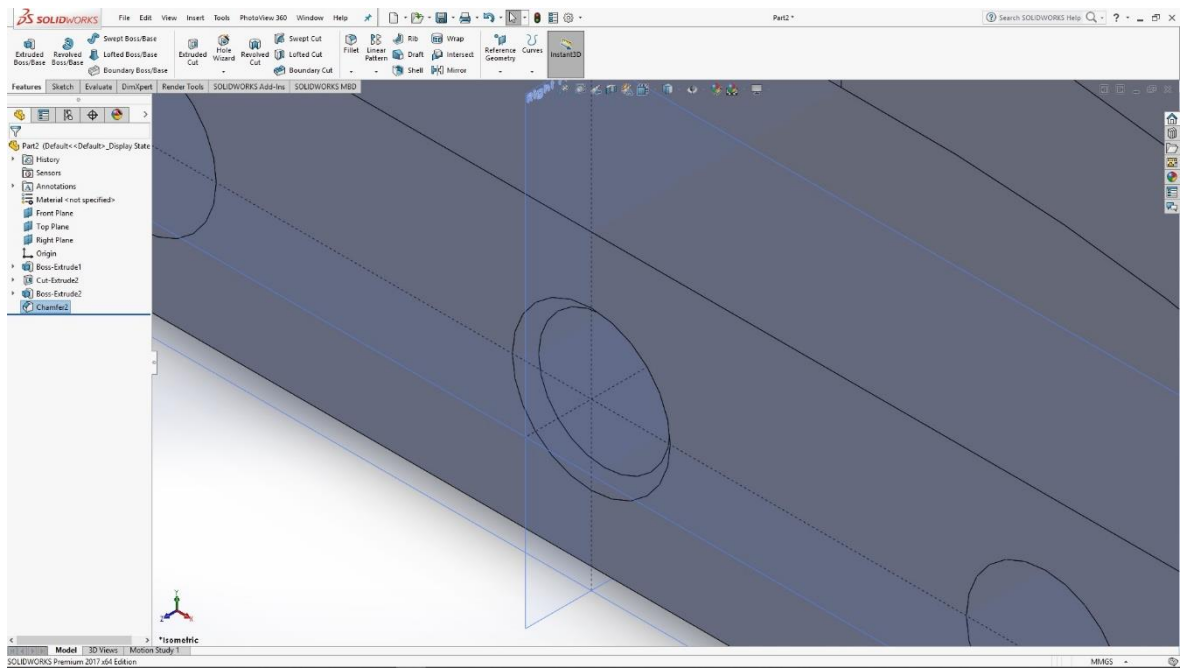


Slika 6.38: 3D model nosača radnog materijala

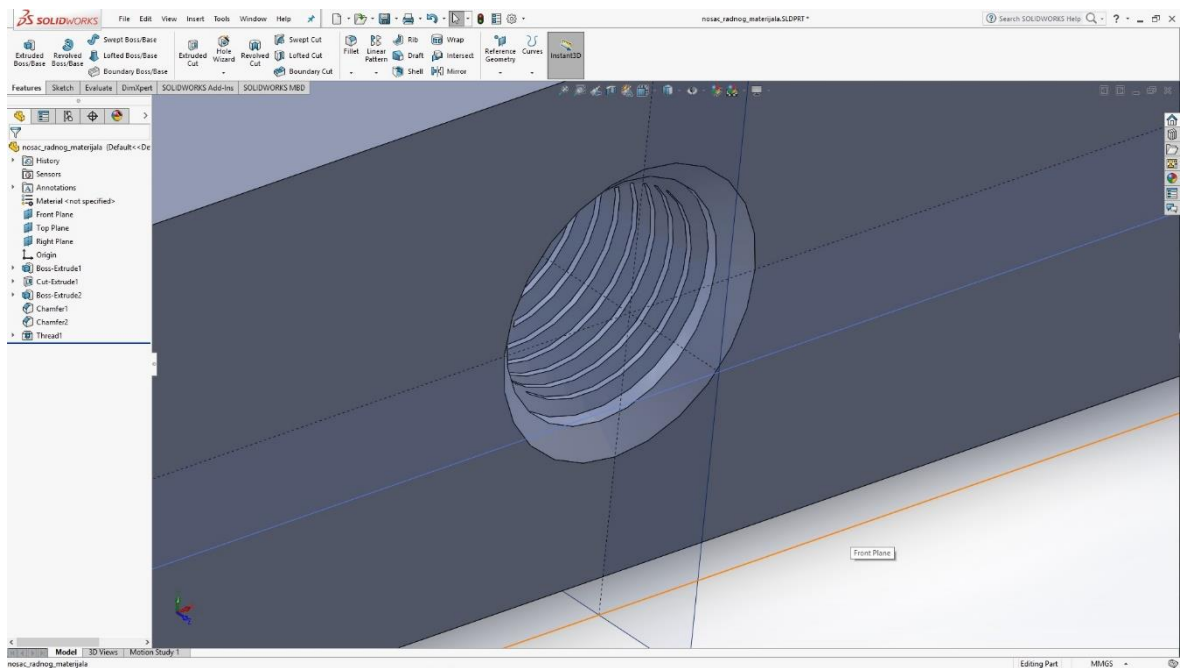


Slika 6.39: Skica kruga iznad srednjeg utora

Na srednjem utoru skiciramo krug koji naredbom Cut dobijemo mali provrt, te naredbom Thread oblikujemo unutarnji navoj srednjeg utora.

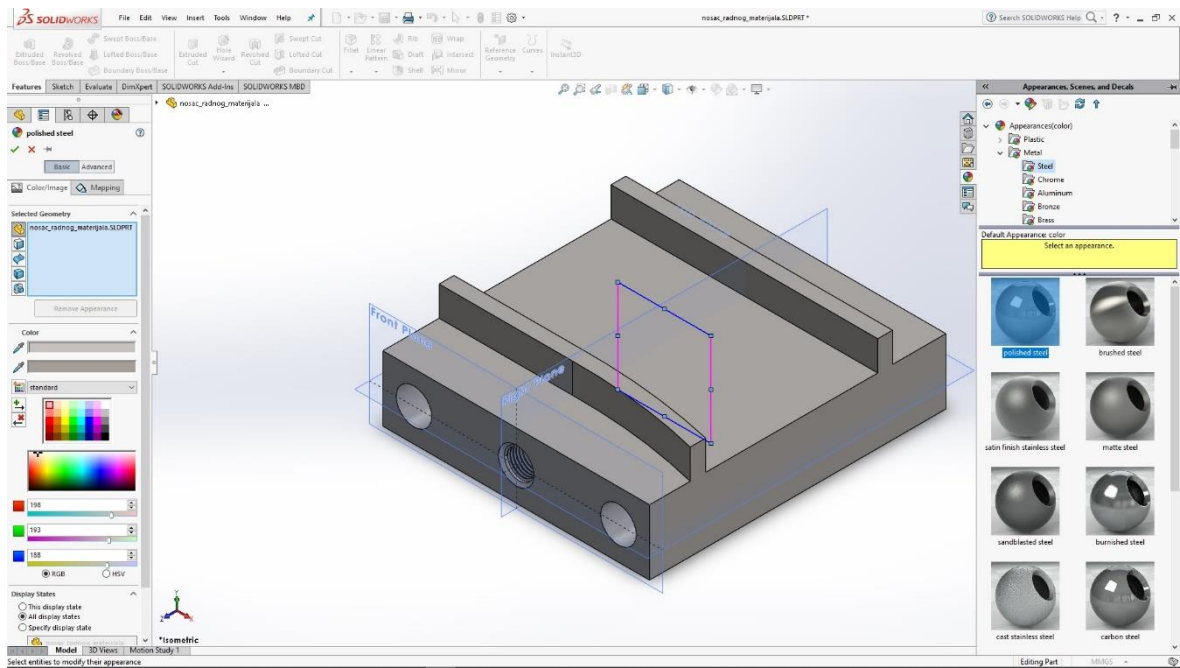


Slika 6.40: Provrt srednjeg utora



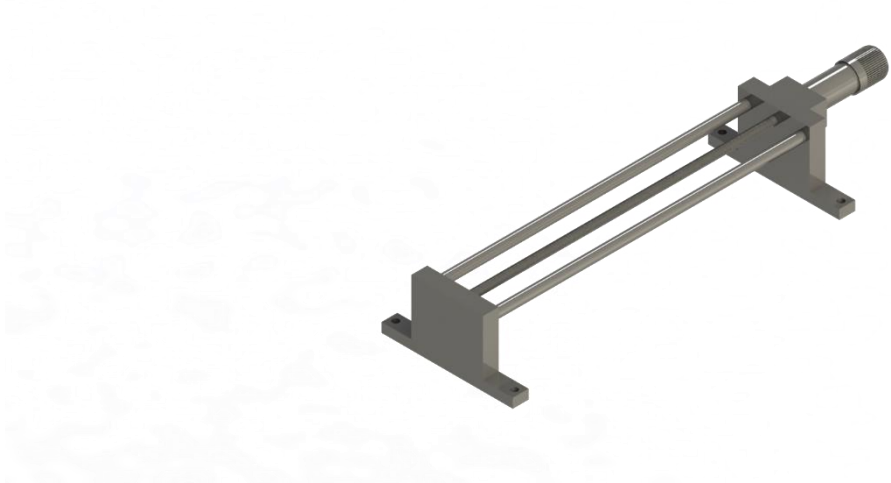
Slika 6.41: Unutarnji navoj u srednjem utoru

Na modelu je još potrebno odabrati materijal za renderiranje. Materijal odabran za nosač radnog materijala je čelik.

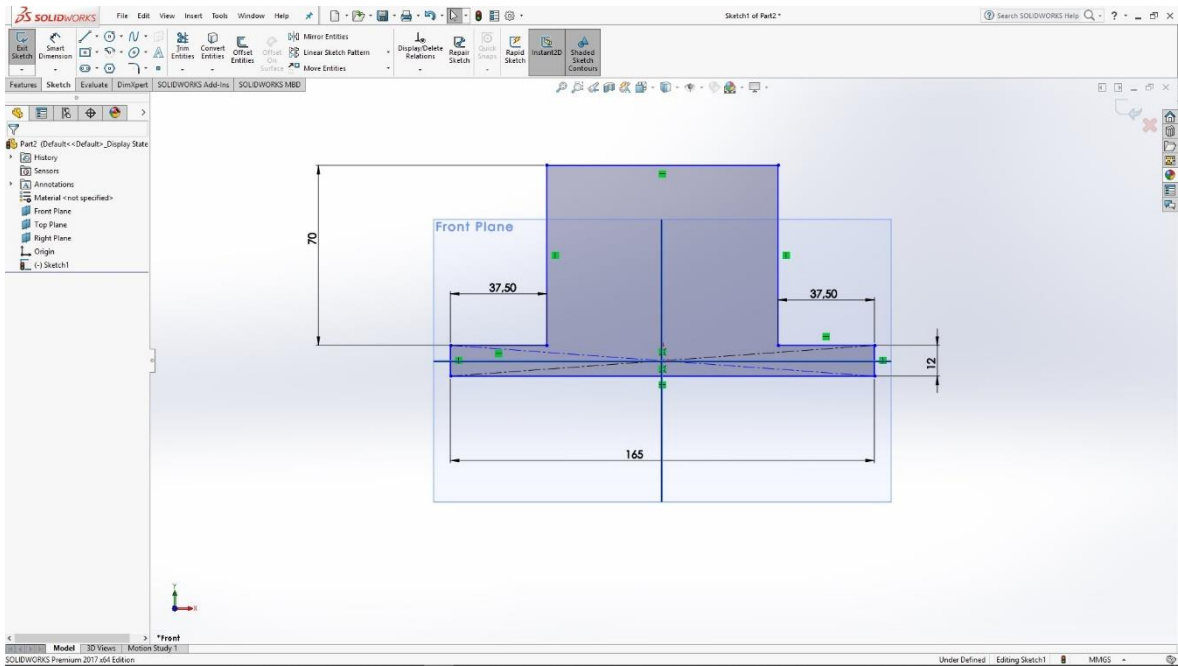


Slika 6.42: Odabir materijala za render

6.6 Pokretna traka

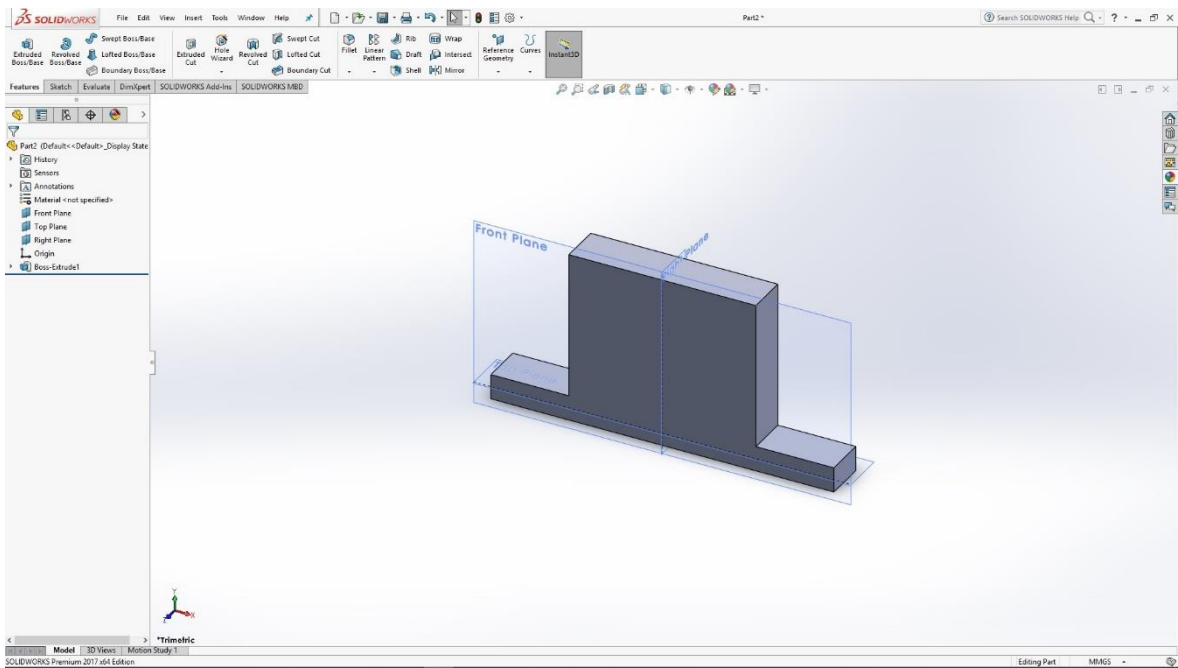


Slika 6.43: Render pokretne trake

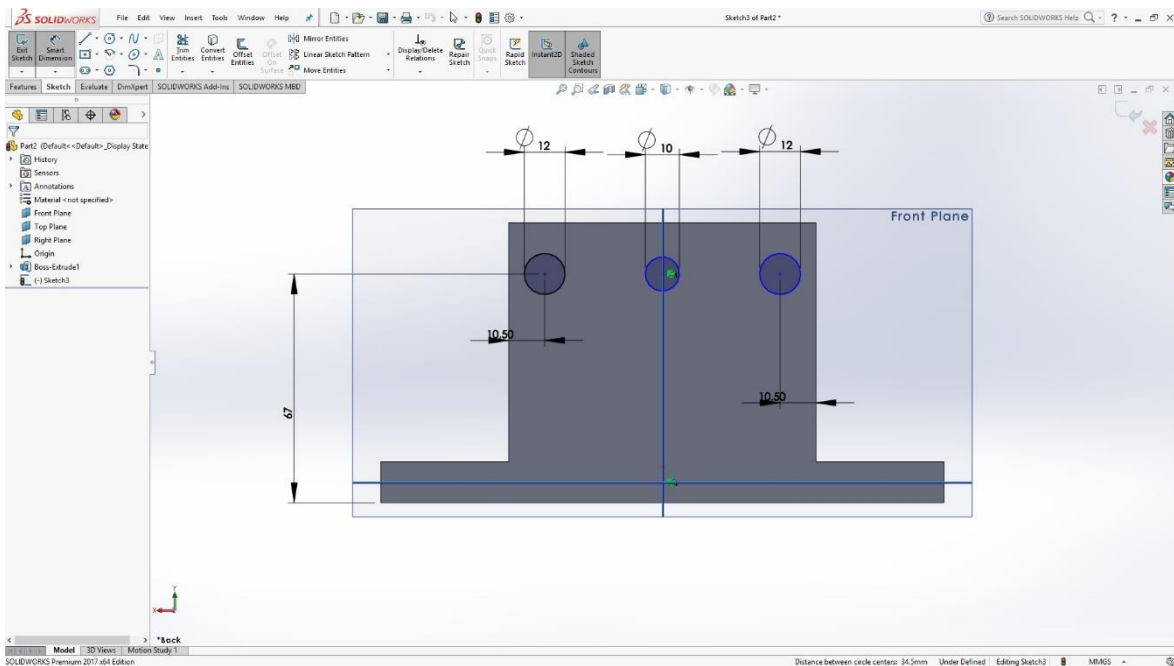


Slika 6.44: Skica u prednjoj ravnini

Izrada modela pokretne trake počinje u prednjoj ravnini skicom stalka koju naredbom Extrude izvlačimo u 3D model.

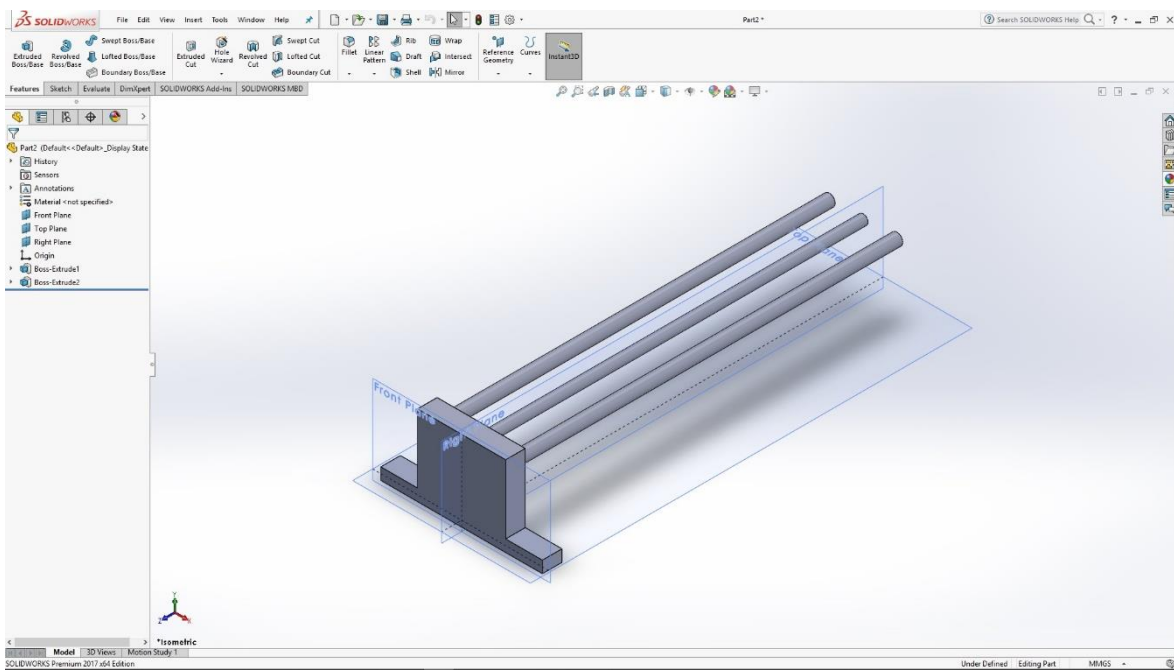


Slika 6.45: 3D model stalka

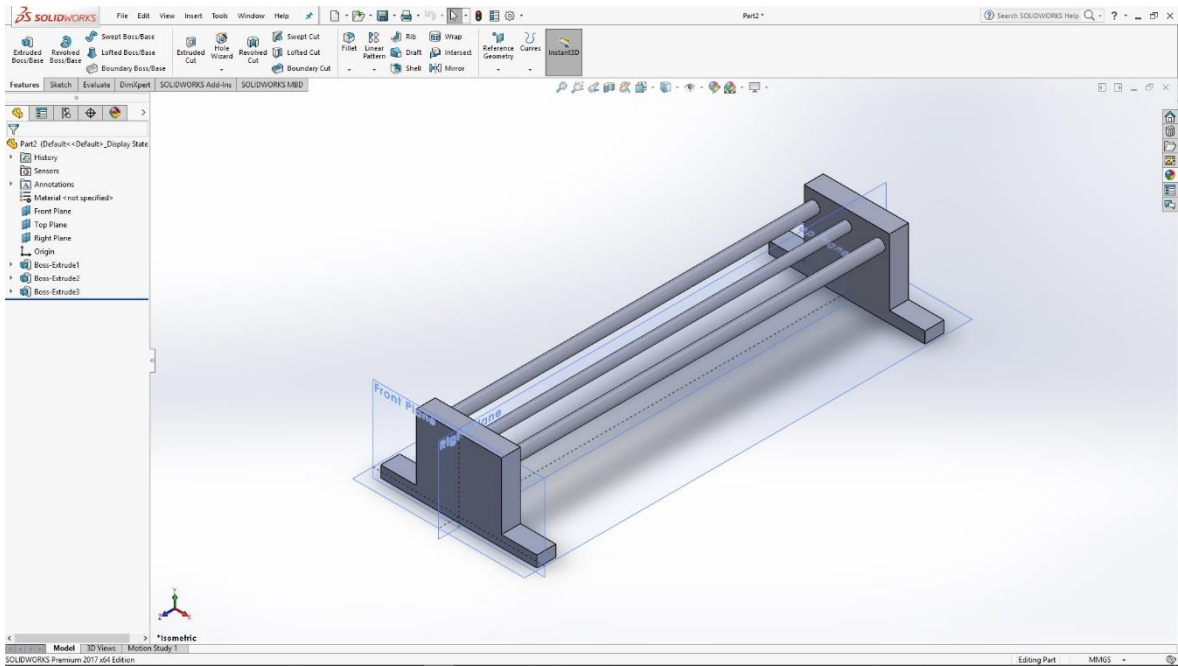


Slika 6.46: Skica kružnica u prednjoj ravni

Na stalku u prednjoj ravni skiciramo kružnice koje izvlačimo u 3D model vodilica naredbom Extrude.

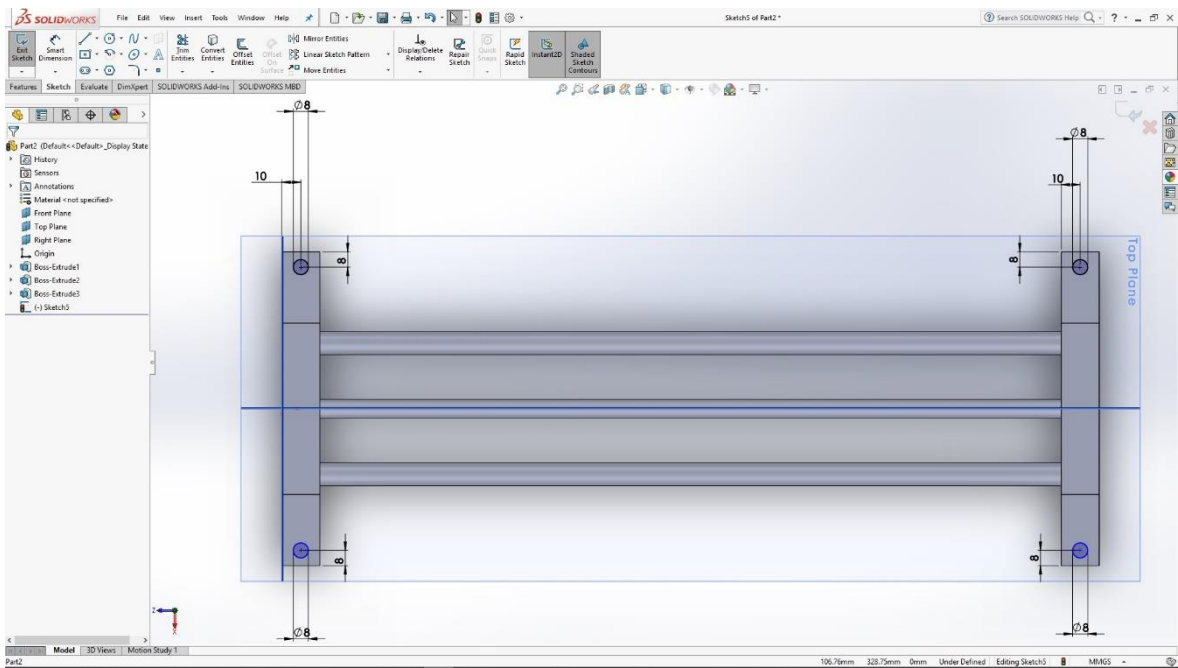


Slika 6.47: 3D model vodilica

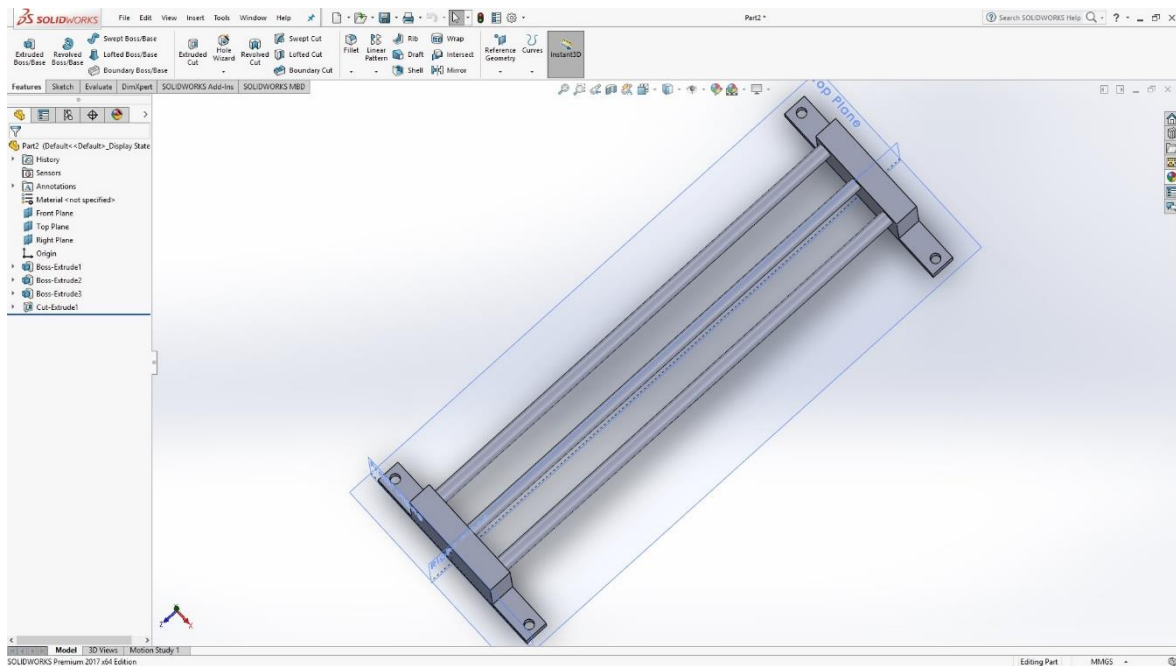


Slika 6.48: Model oba stalka i vodilica

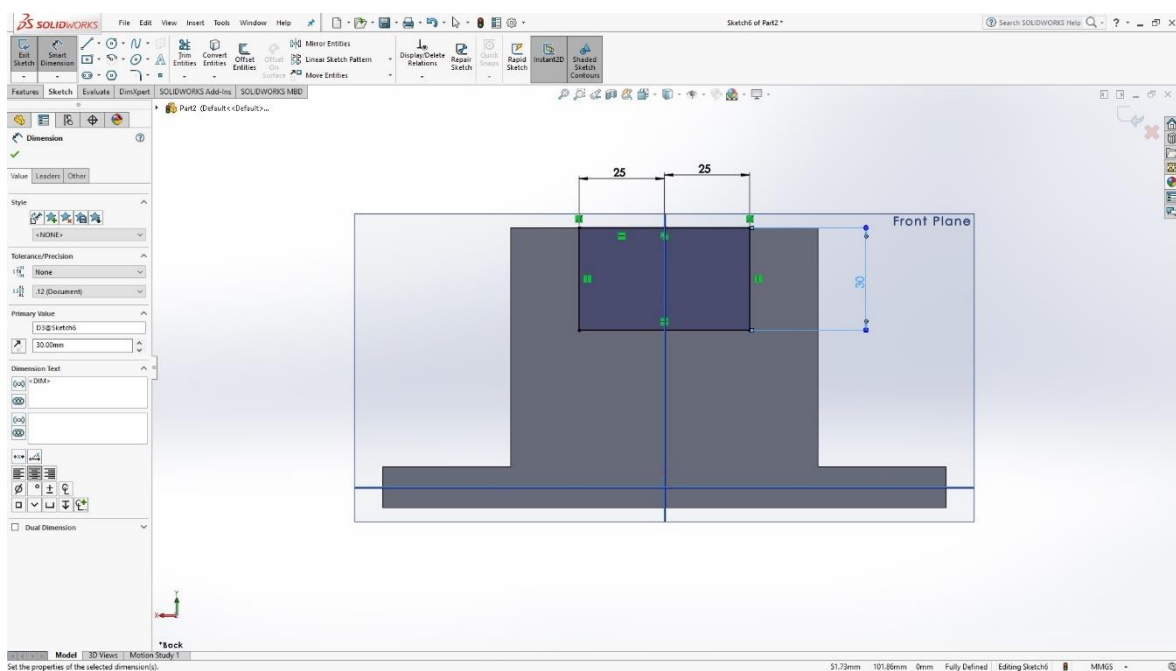
Na kraju vodilica napravimo 3D model stalka te na krajnjim stranicama stalka skiciramo kružnice koje naredbom Cut pretvaramo u utore u stranicama stalka.



Slika 6.49: Skica kružnica na stranicama stalka

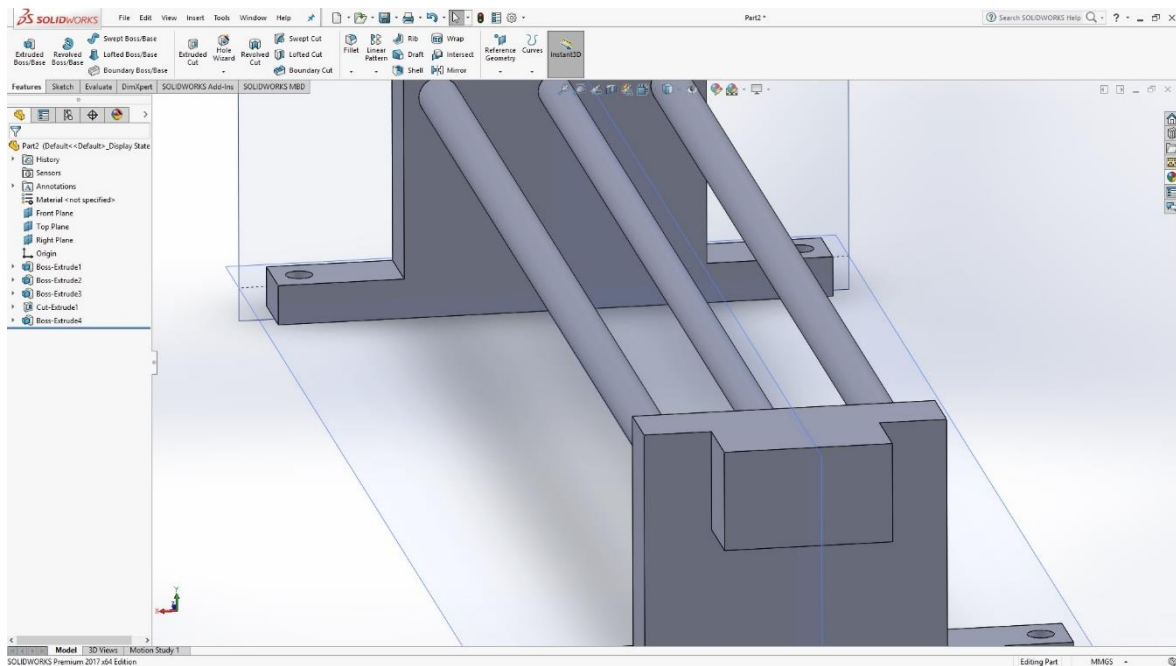


Slika 6.50: 3D model stalaka s utorima

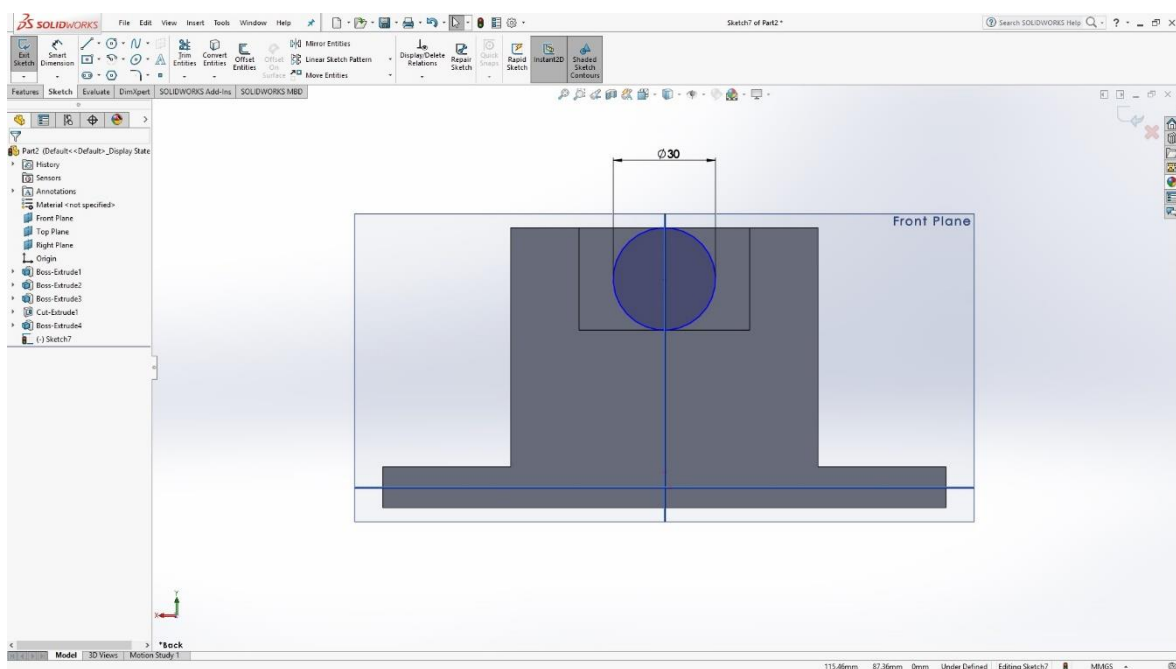


Slika 6.51: Skica pravokutnika u prednjoj ravni

Na krajnjem dijelu stalka izrađujemo motor koji će biti korišten za pomicanje držača radnog materijala. U prednjoj ravni krajnjeg dijela stalka skiciramo pravokutnik koji naredbom Extrude izvlačimo u 3D model.

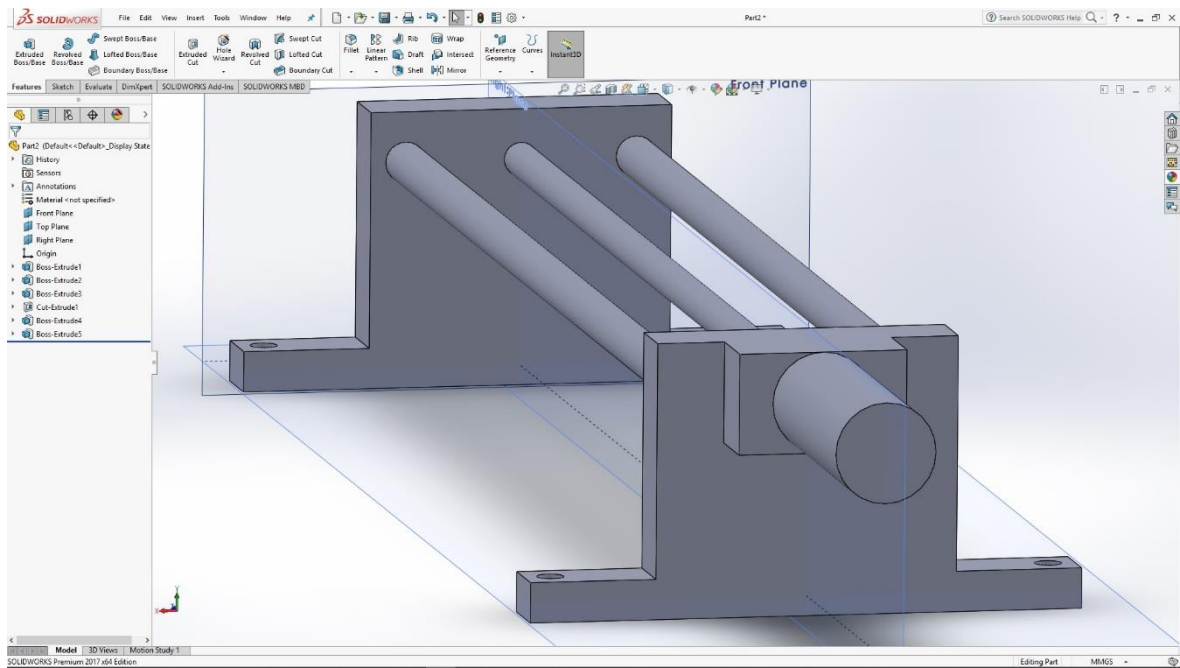


Slika 6.52: 3D model pravokutnika

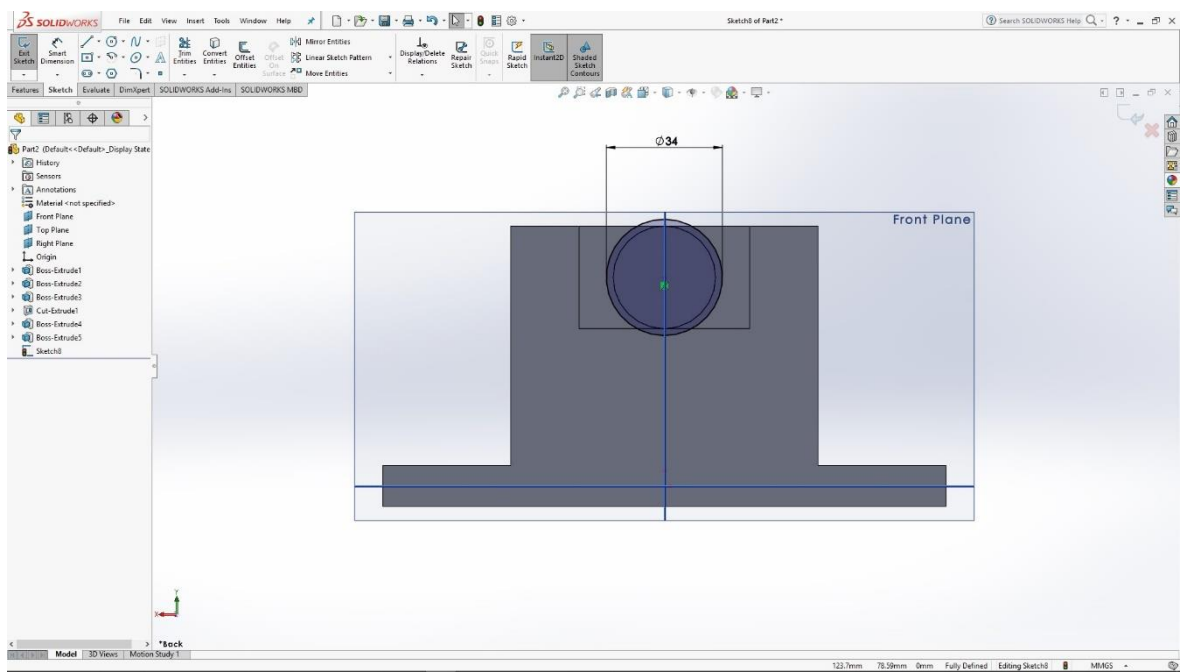


Slika 6.53: Skica kružnice u prednjoj ravni

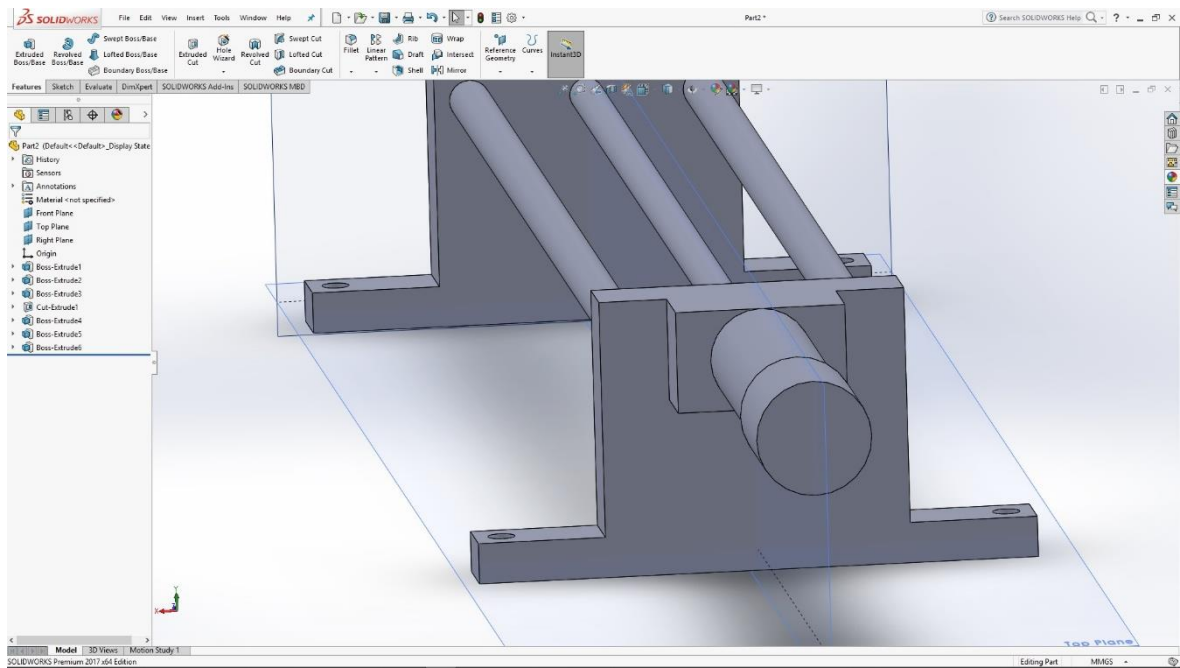
Na prednjoj strani modela pravokutnika skiciramo kružnicu. Naredbom Extrude izvlačimo kružnicu u valjak te na tom istom valjku skiciramo još jednu malo veću kružnicu koju istom naredbom izvlačimo u kraći valjak.



Slika 6.54: 3D model valjka

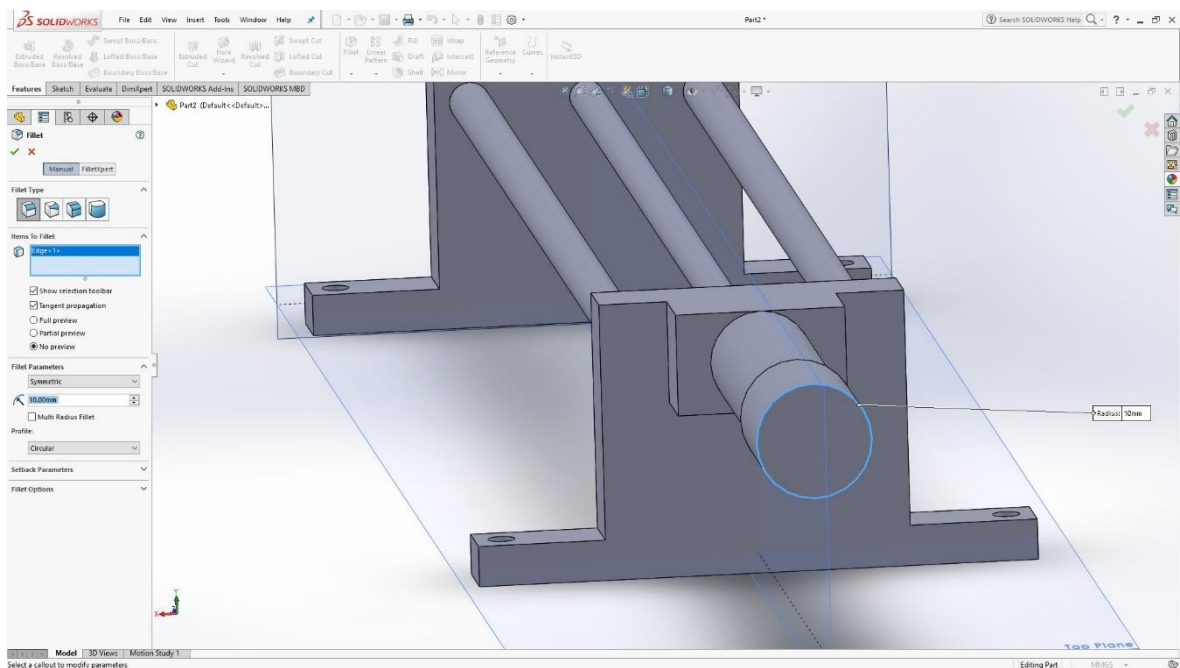


Slika 6.55: Skica kružnice u prednjoj ravni

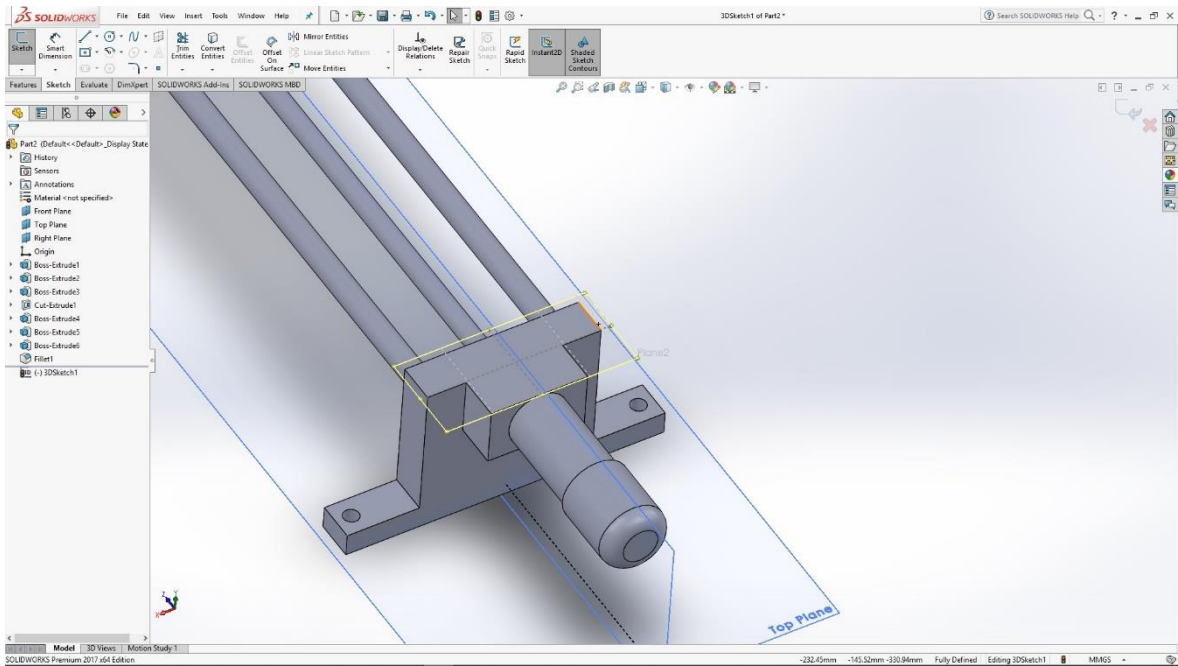


Slika 6.56: 3D model valjka

Naredbom Fillet izradujemo zaobljenje na krajnjem valjku.

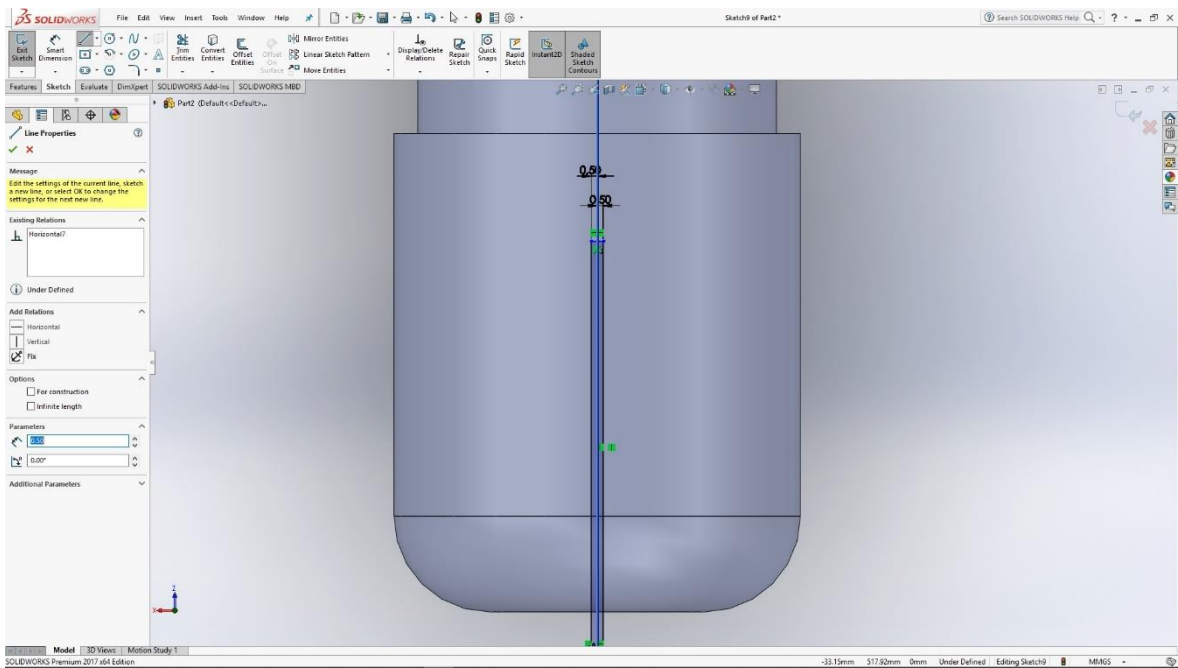


Slika 6.57: Izrada zaobljenja ruba

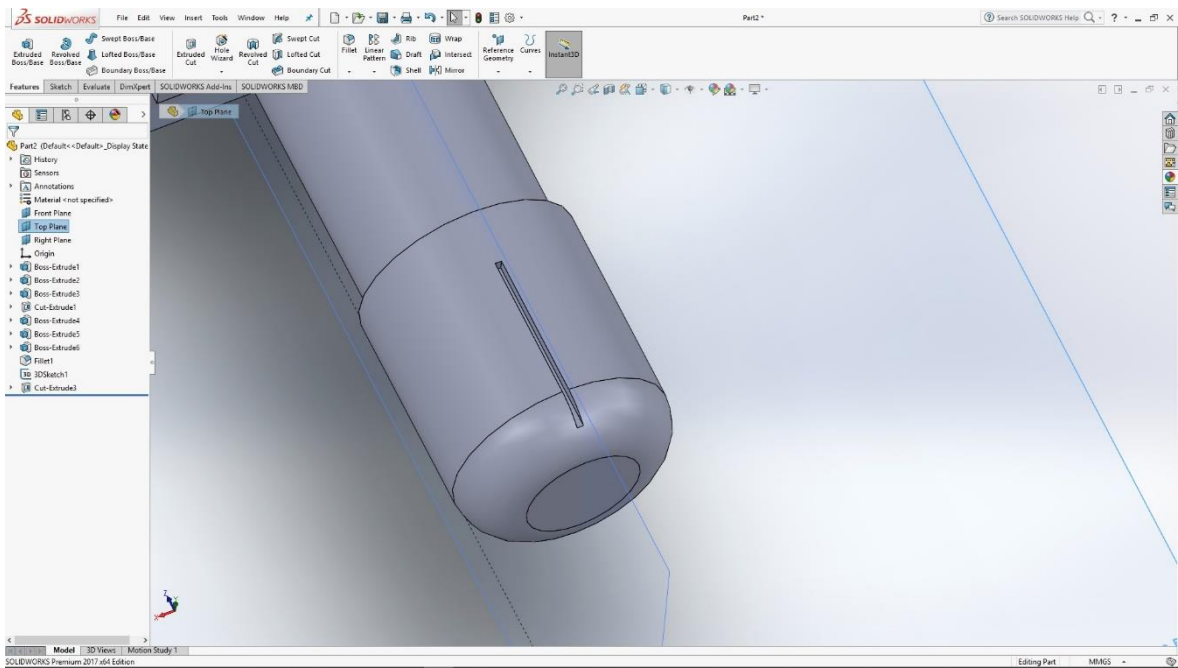


Slika 6.58: Zaobljeni rub valjka

U gornjoj ravnini krajnjeg valjka skiciramo pravokutnik s kojim naredbom Cut izrađujemo mali utor u valjku.

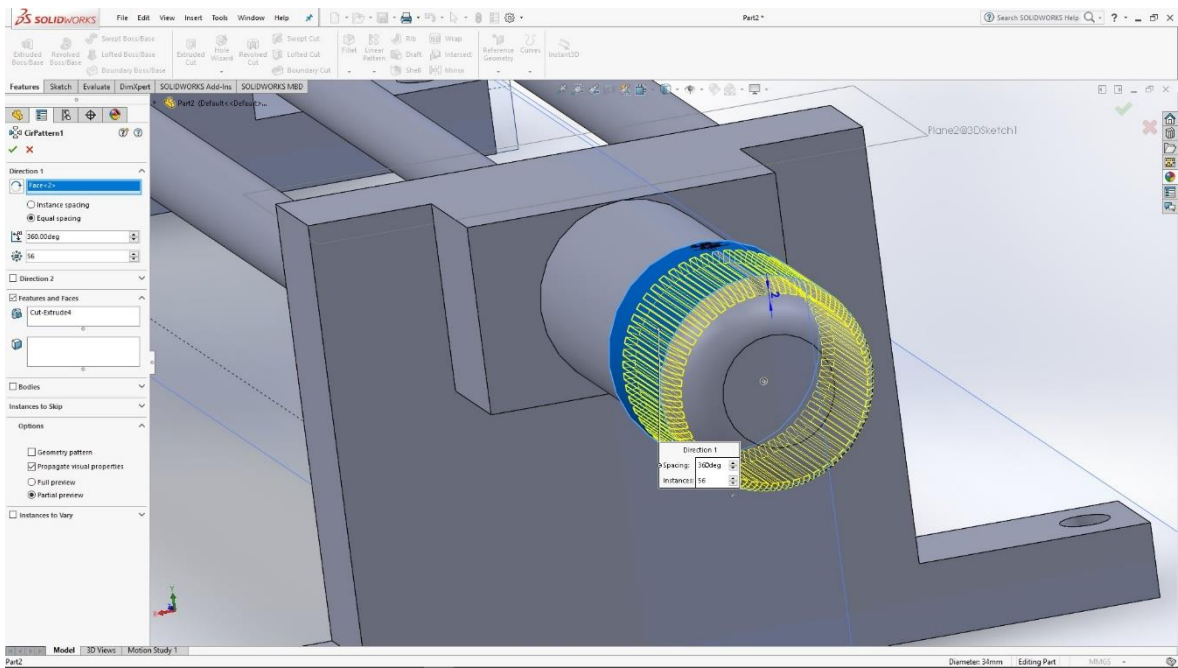


Slika 6.59: Skica pravokutnika u gornjoj ravnini

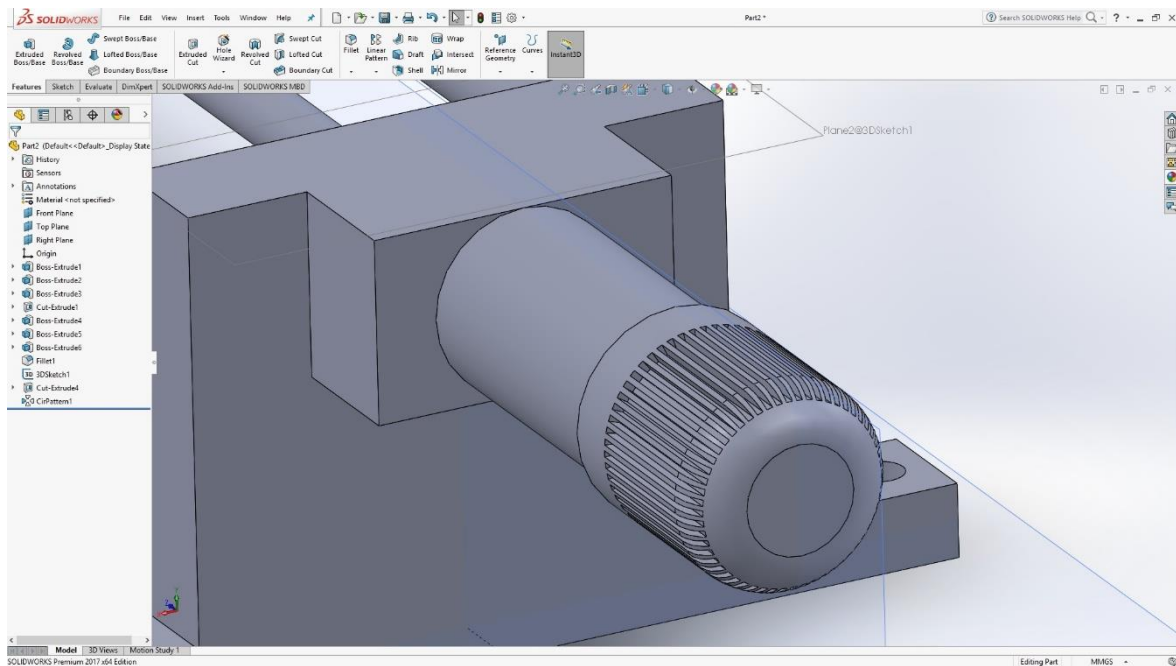


Slika 6.60: Utor u valjku

Cilj nam je napraviti utore u valjku po cijeloj njegovoj površini. Kako bismo si olakšali izradu, koristimo naredbu Cut-pattern.

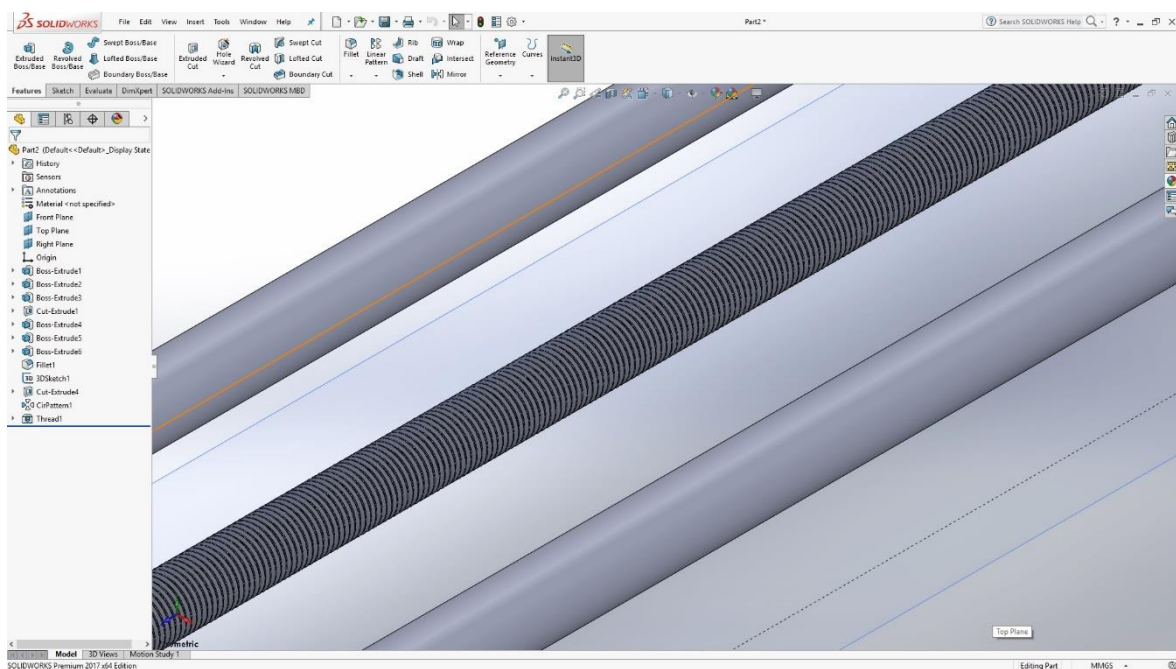


Slika 6.61: Izrada utora na cijeloj površini valjka



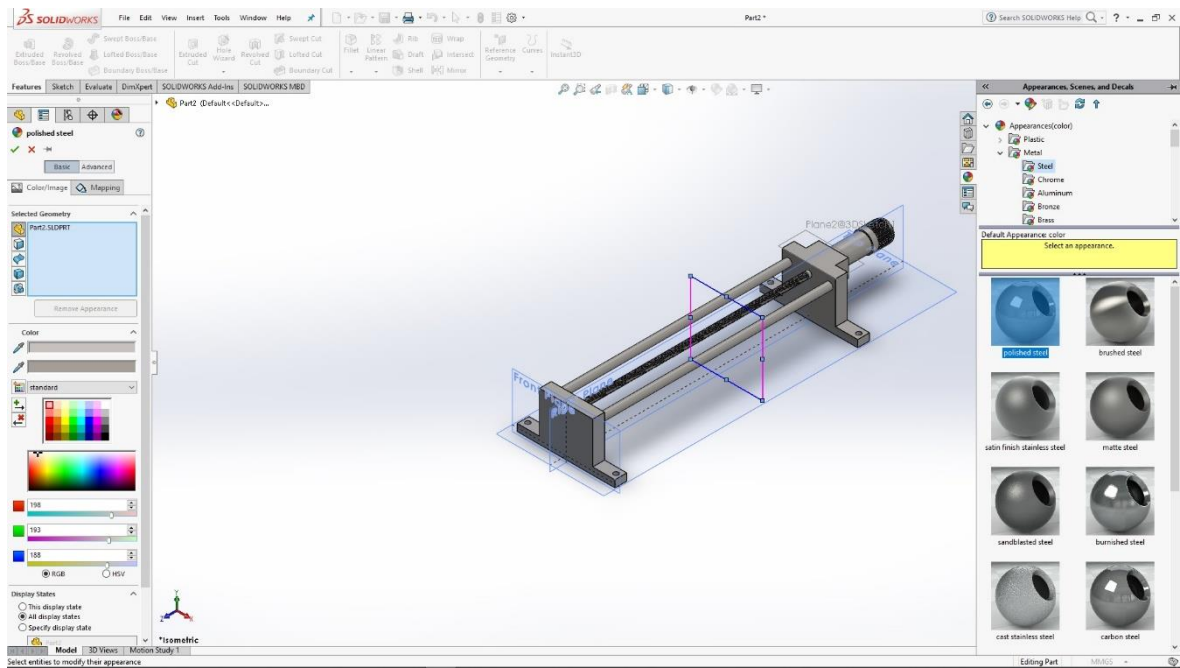
Slika 6.62: Utori u valjku

S obzirom da se treba pomicati nosač radnog materijala potrebno je još napraviti vanjski navoj na srednjoj vodilici. Za izradu navoja koristimo naredbu Thread te u opciji naredbe odabiremo metrički navoj.



Slika 6.63: Navoj na srednjoj vodilici

S gotovim 3D modelom pokretne trake potrebno je još odabrati materijal kako bismo mogli renderirati sliku modela.

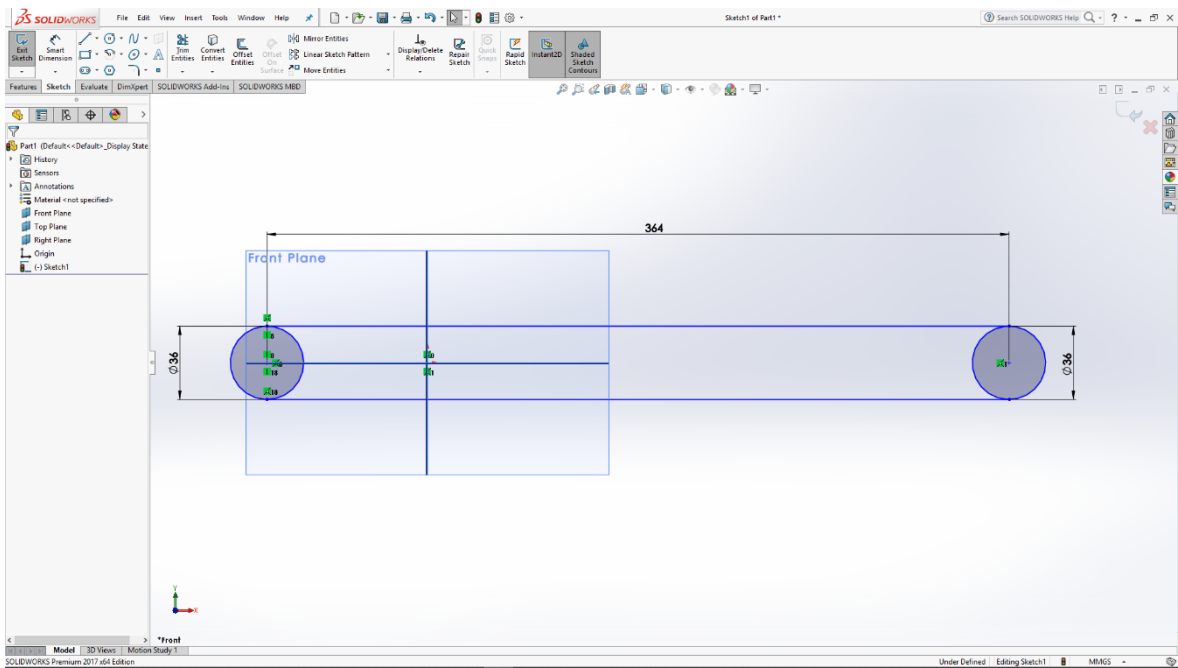


Slika 6.64: Odabir materijala za render

6.7 Pokretna traka s remenom

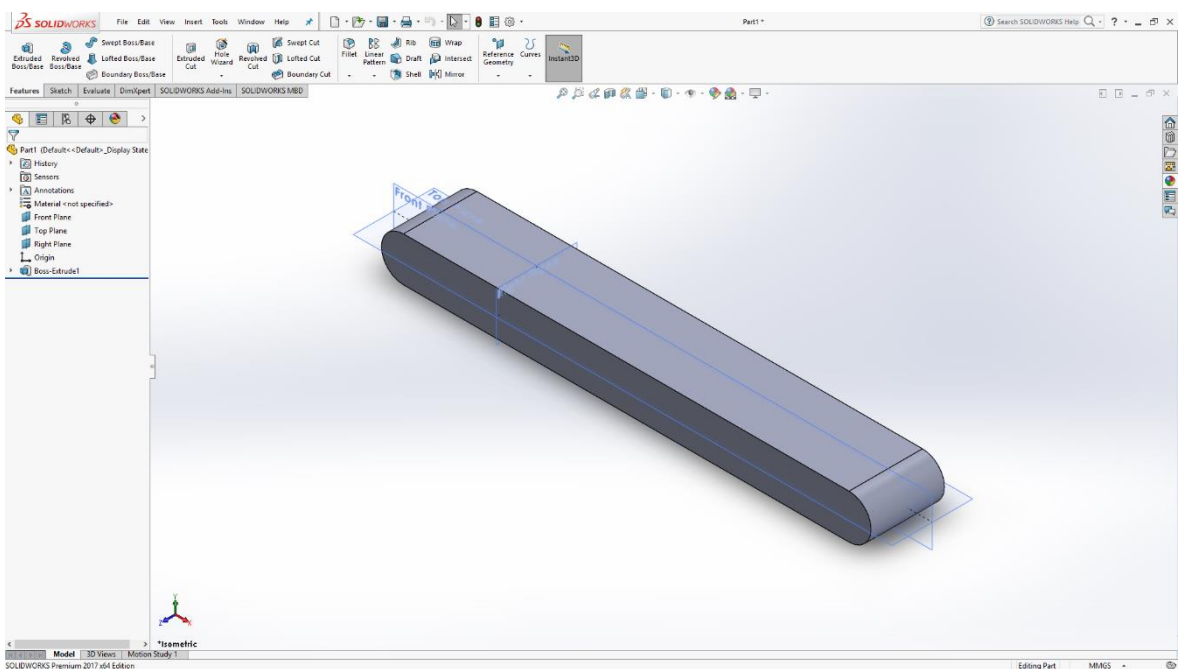


Slika 6.65: Render pokretne trake s remenom

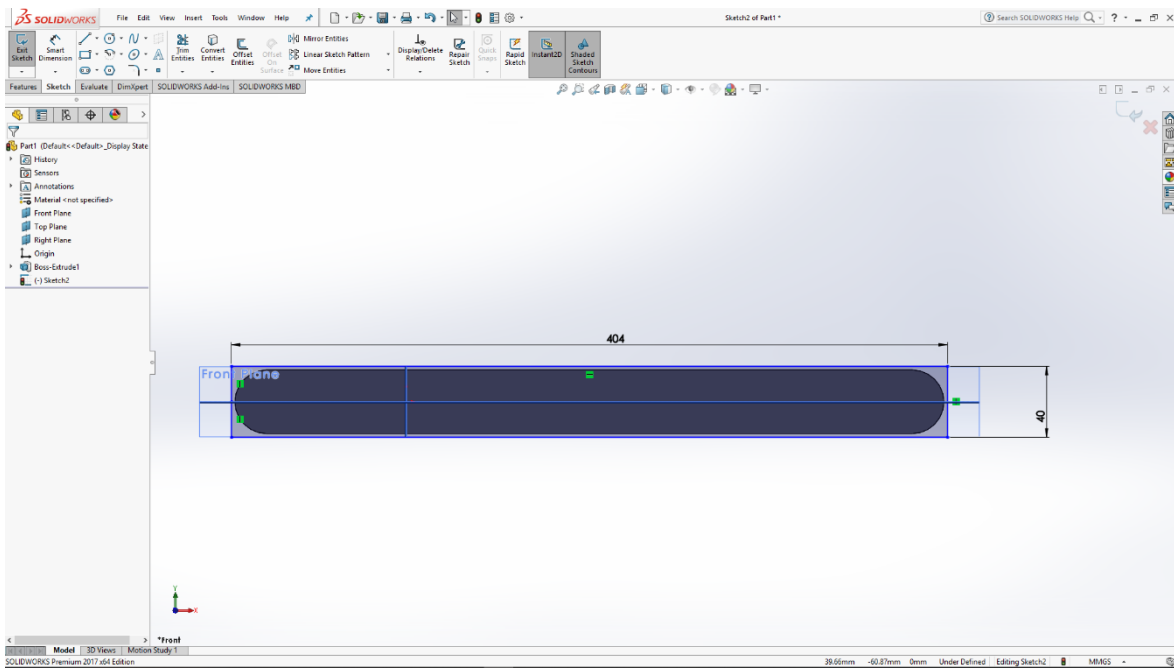


Slika 6.66: Skica zaobljenja

Izrada 3D modela počinje u prednjoj ravnini skicom dviju kružnica koje su spojene s dvije dužine kako bismo dobili zaobljeni oblik. Taj oblik naredbom Extrude izvlačimo u 3D model.

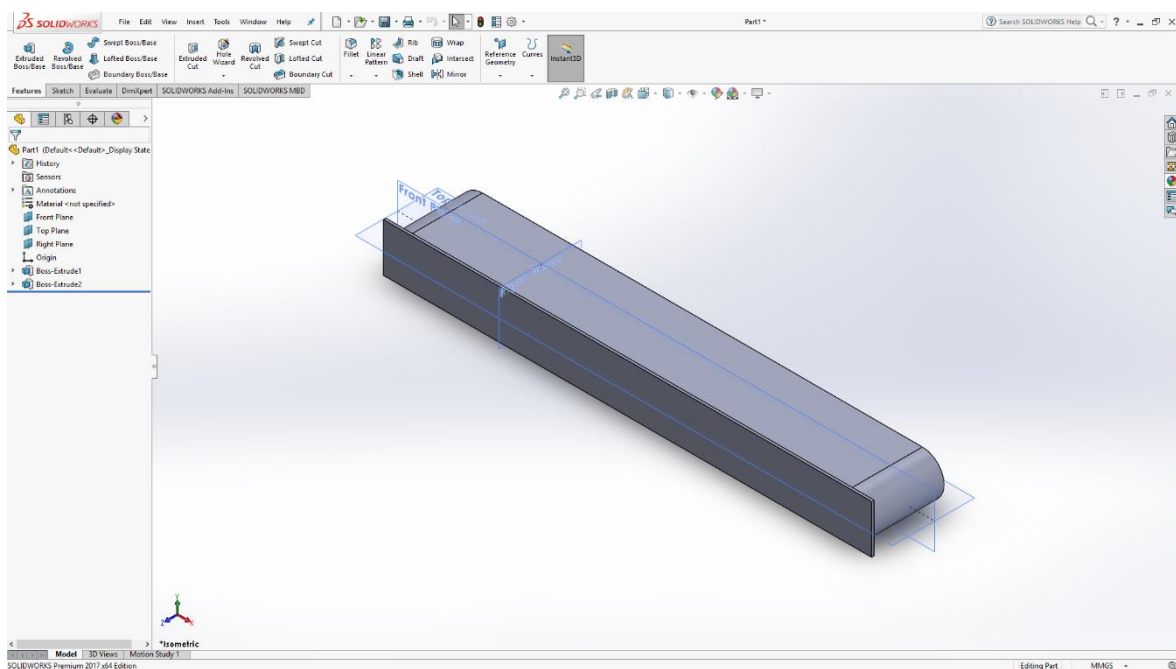


Slika 6.67: Pokretni dio pokretne trake s remenom

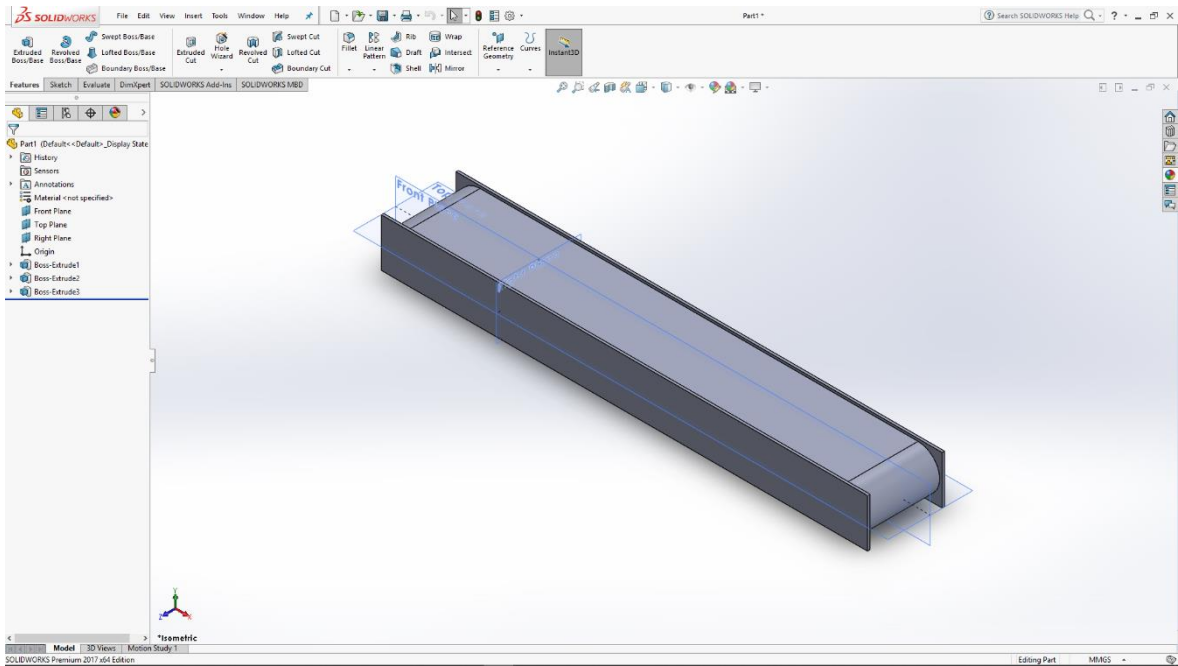


Slika 6.68: Skica pravokutnika u prednjoj ravnini

U prednjoj ravnini 3D modela skiciramo pravokutnika koji naredbom Extrude izvlačimo u 3D model pravokutnika. Istim postupkom izrađujemo još jedan pravokutnik na drugoj strani modela.

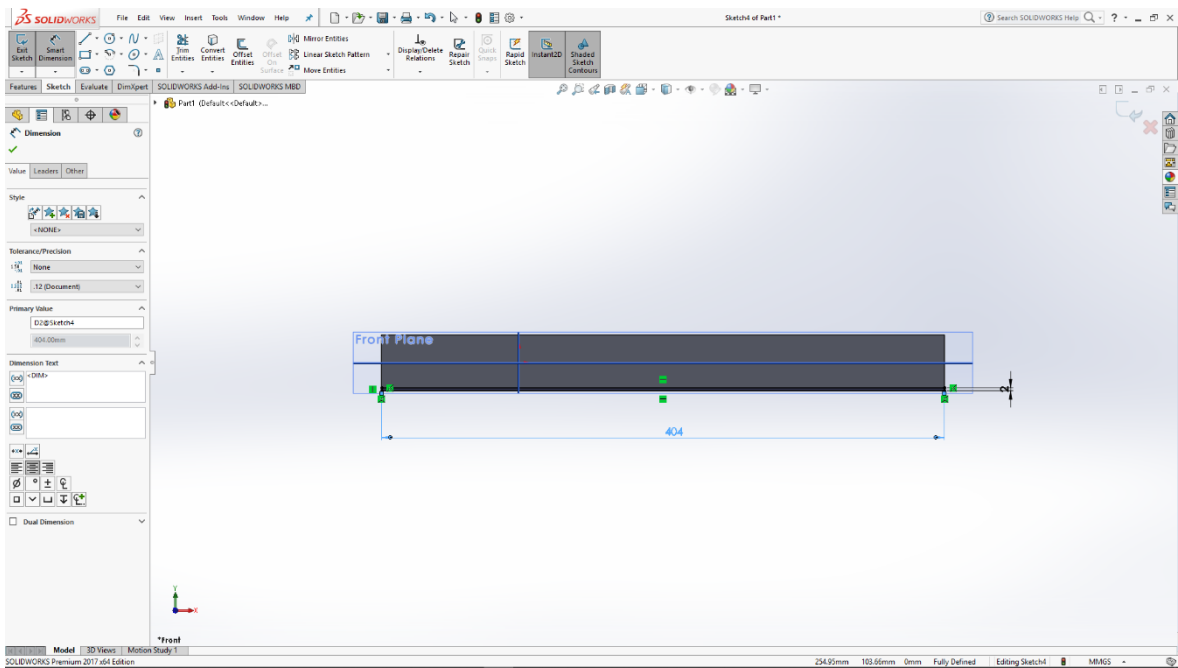


Slika 6.69: 3D model pravokutnika

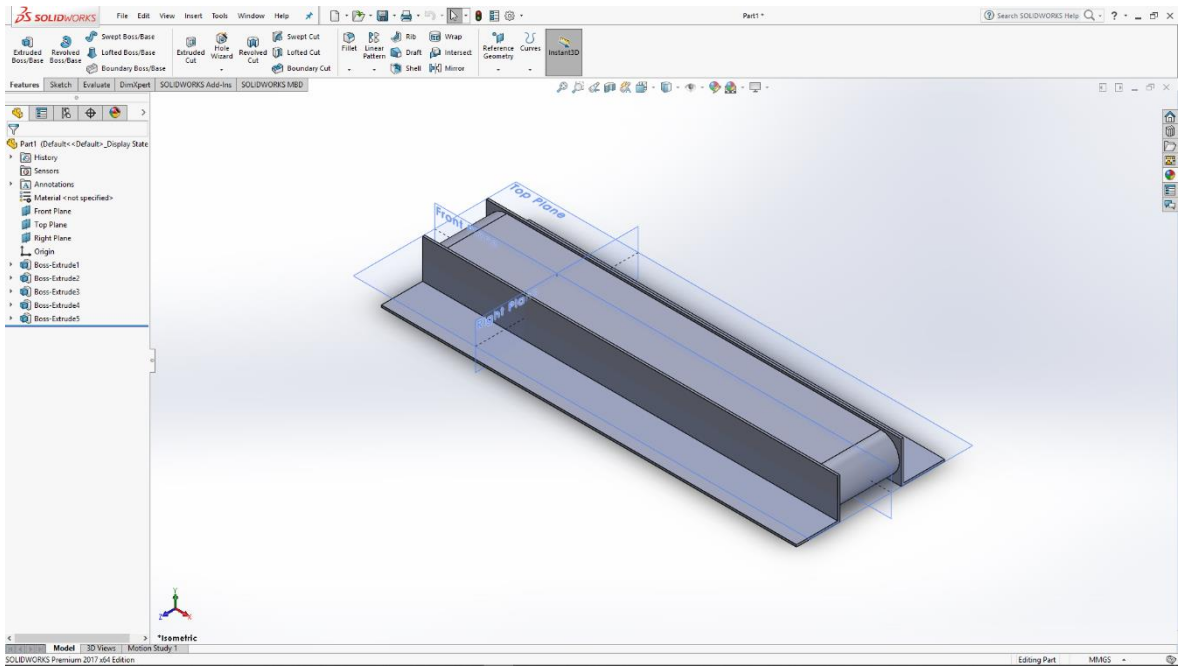


Slika 6.70: 3D model pravokutnika na objim stranama

Na donjim stranama oba pravokutnika skiciramo pravokutnik u Sketch-u koji naredbom Extrude izvlačimo u 3D model.

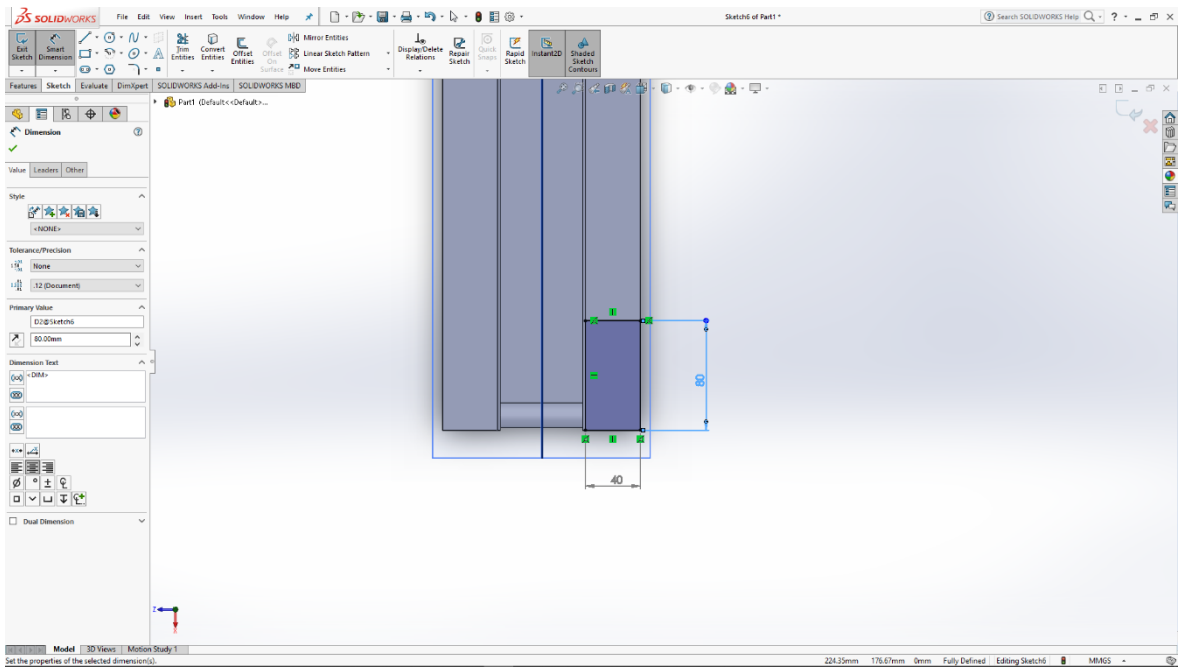


Slika 6.71: Skica pravokutnika na dnu 3D modela

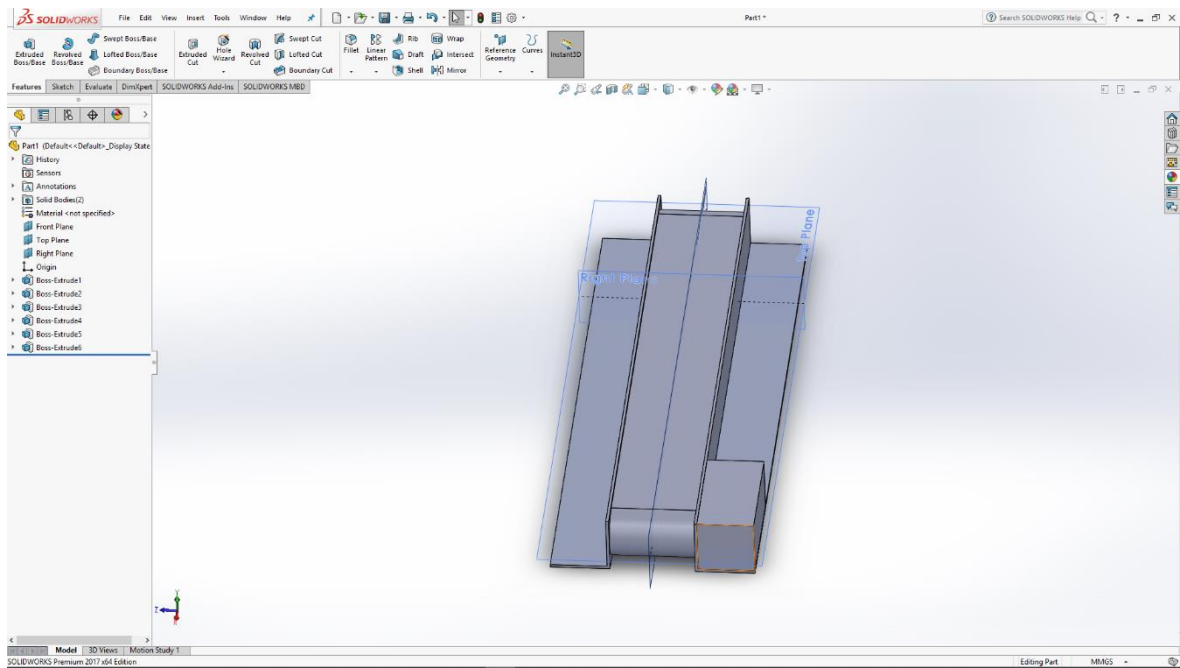


Slika 6.72: 3D model pokretne trake

U donjem desnom uglu 3D modela izrađujemo motor pokretne trake s remenom skicom pravokutnika. S naredbom Extrude izvlačimo skicu u 3D model.

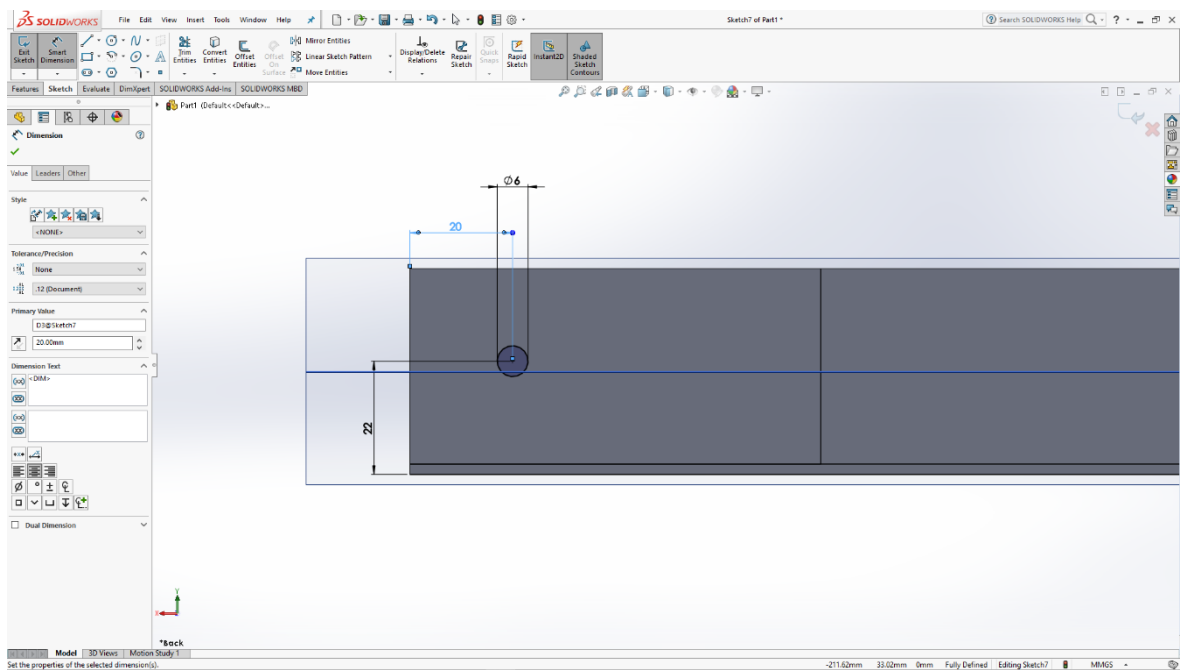


Slika 6.73: skica pravokutnika za motor

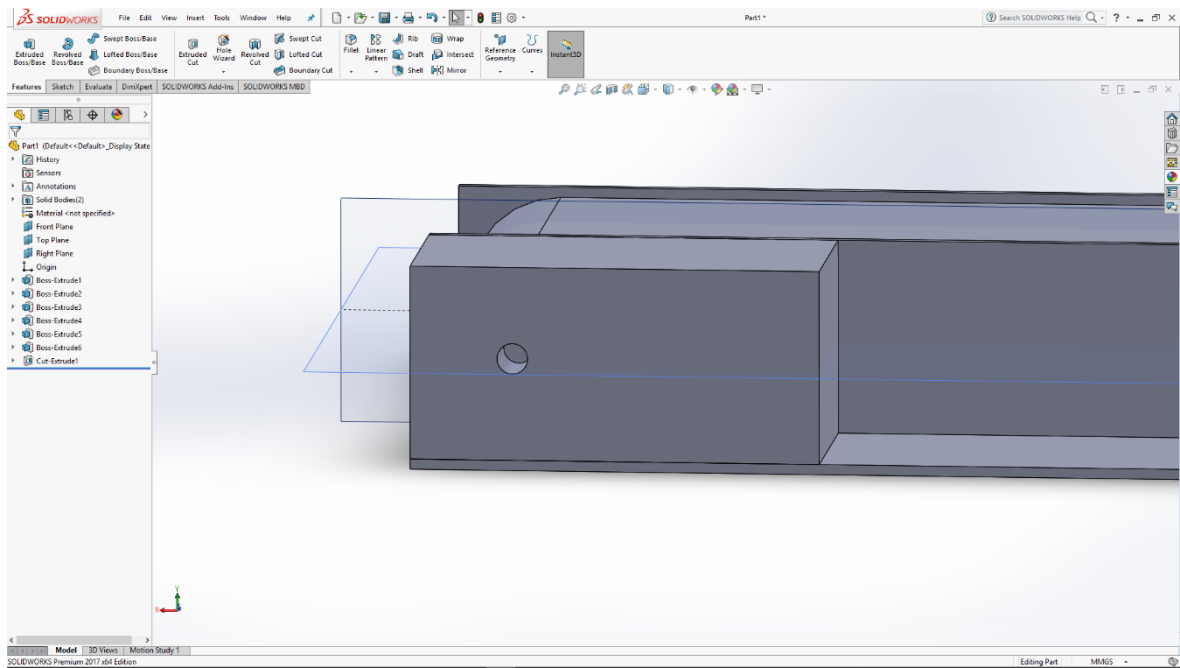


Slika 6.74: 3D model pravokutnika

Na modeliranom pravokutniku radimo utor u koji bude nasjeo motor pokretne trake.

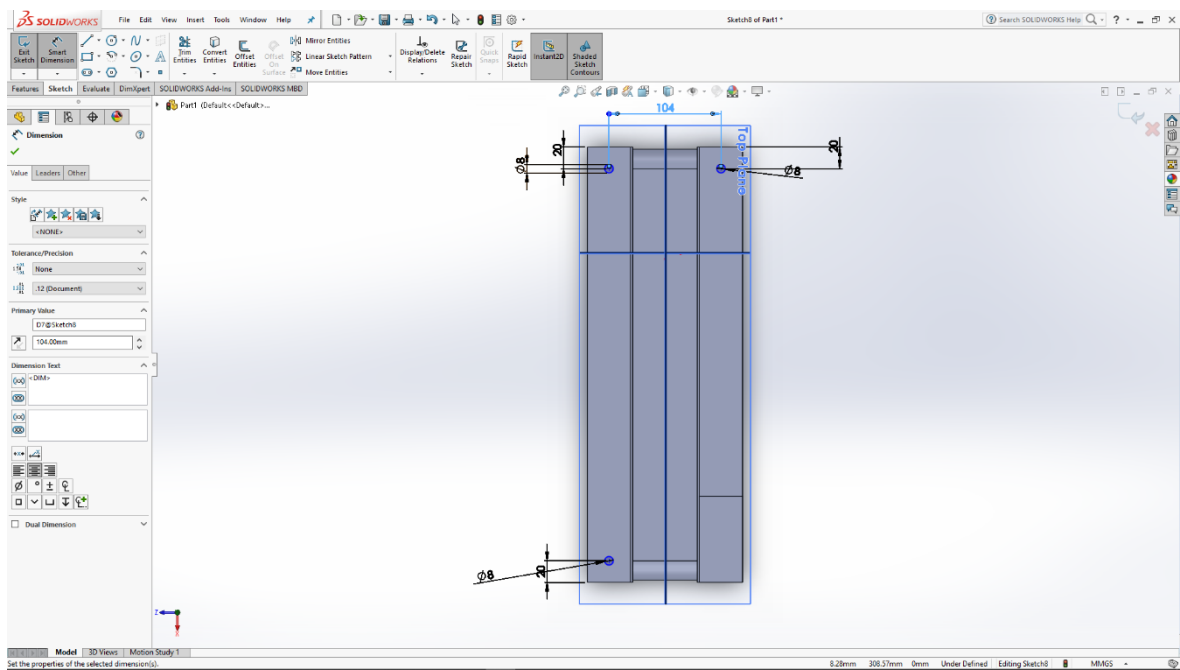


Slika 6.75: Skica kružnice na 3D modelu pravokutnika

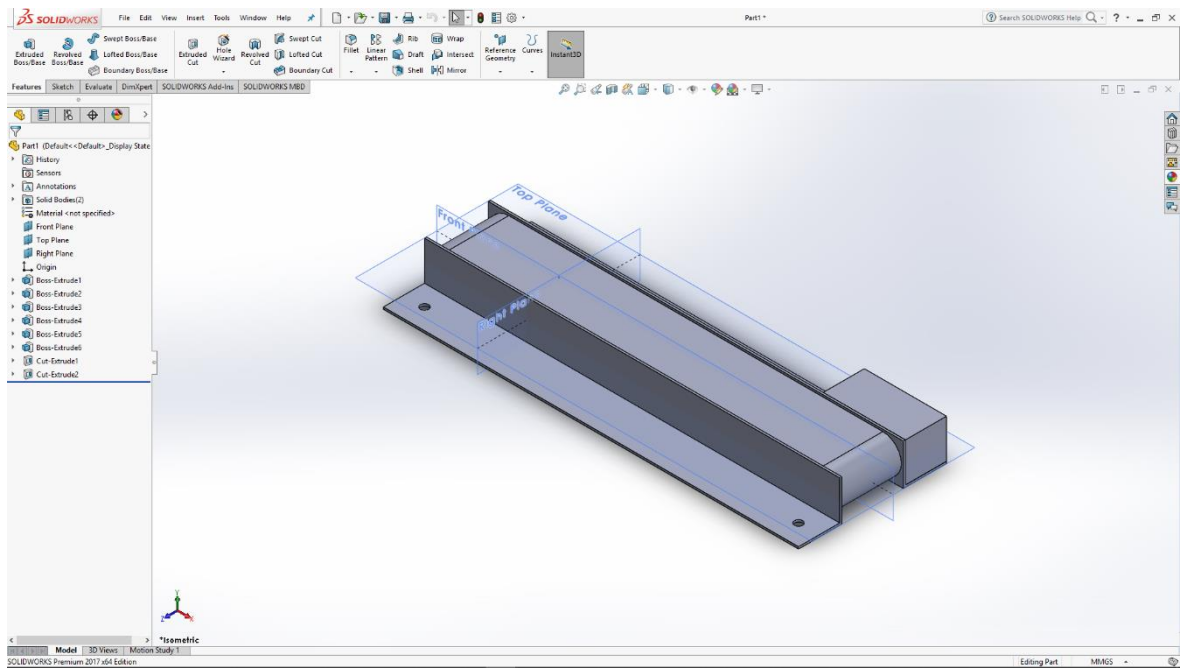


Slika 6.76: Izrađeni utor

Na bazi modela skiciramo kružnice koje naredbom Cut izrađujemo provrte $\varnothing 8$ u modelu i s time dobijemo gotov model pokretne trake s remenom.

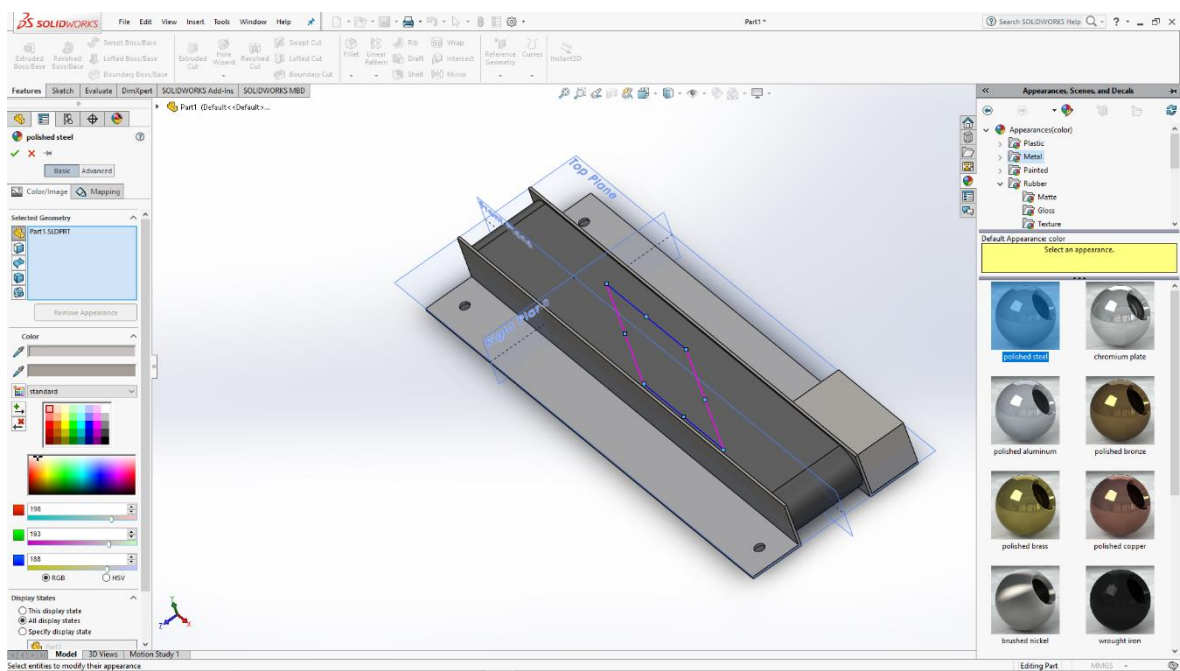


Slika 6.77: Skica kružnica



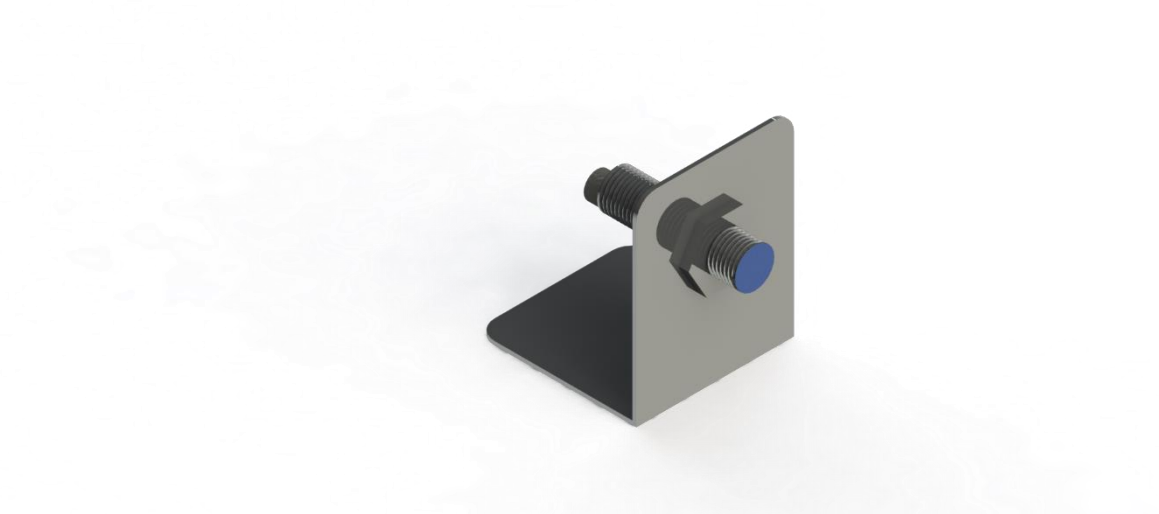
Slika 6.78: 3D model pokretne trake s remenom

S gotovim modelom potrebno je još odabrati materijal za postupak renderiranja modela.



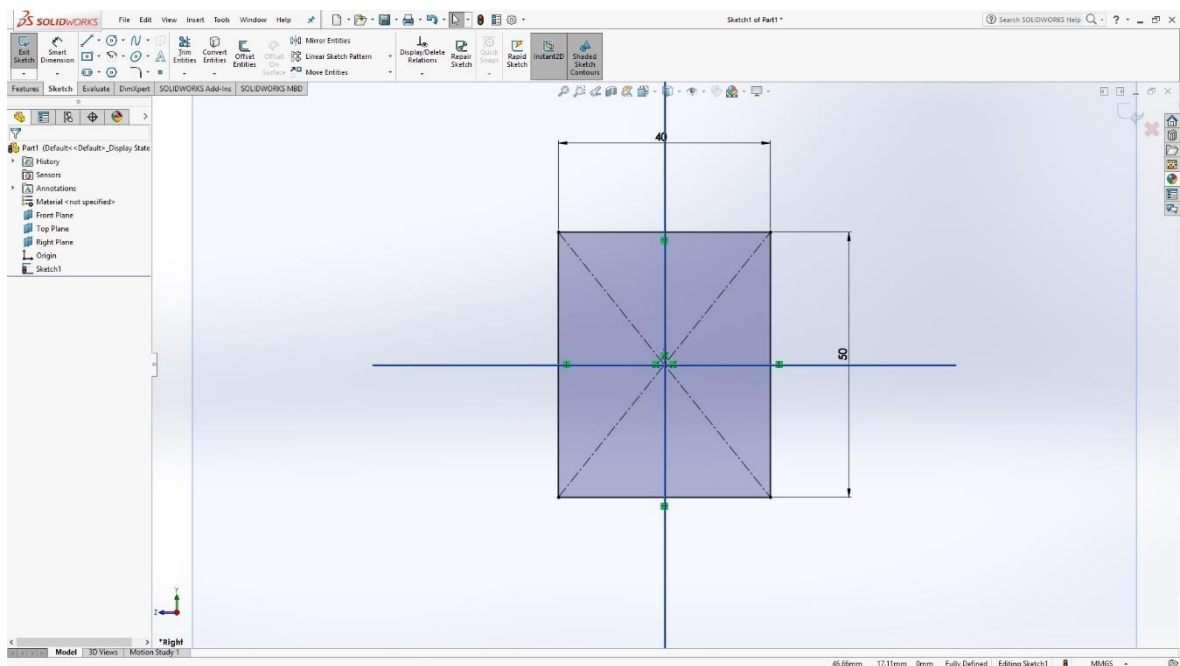
Slika 6.79: Odabir materijala za render

6.8 Nosač senzora 1.

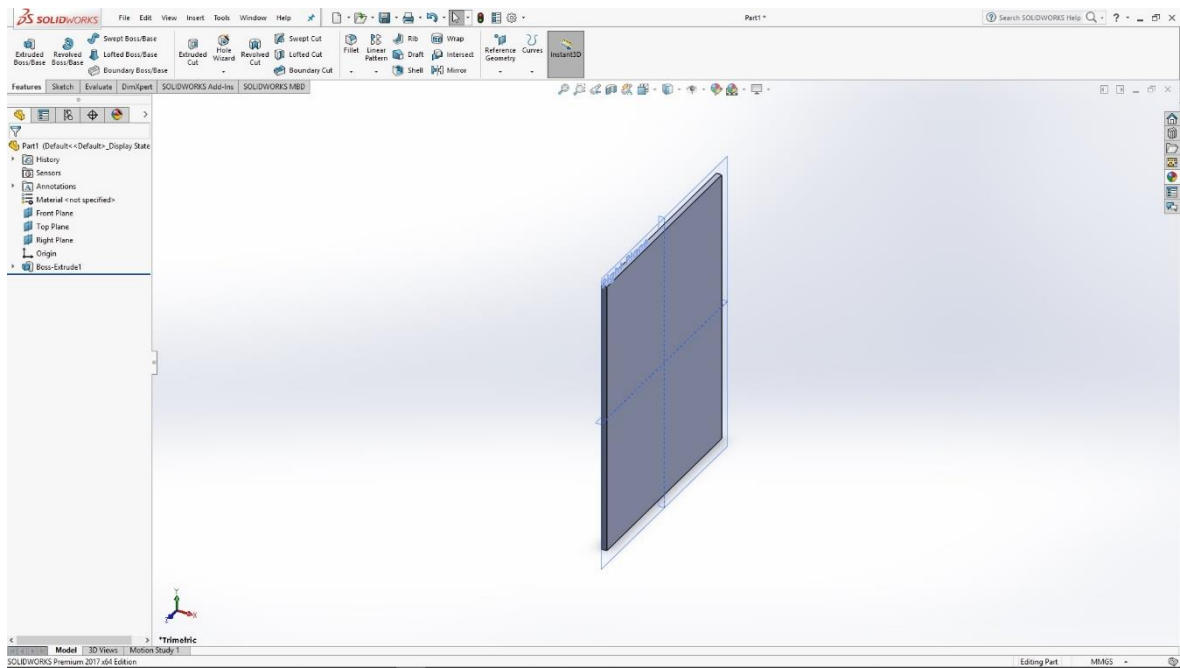


Slika 6.80: Render nosača senzora

Izrada modela nosača senzora započinje u desnoj ravnini. Skiciramo pravokutni oblik koji naredbom Extrude izvlačimo u 3D model.

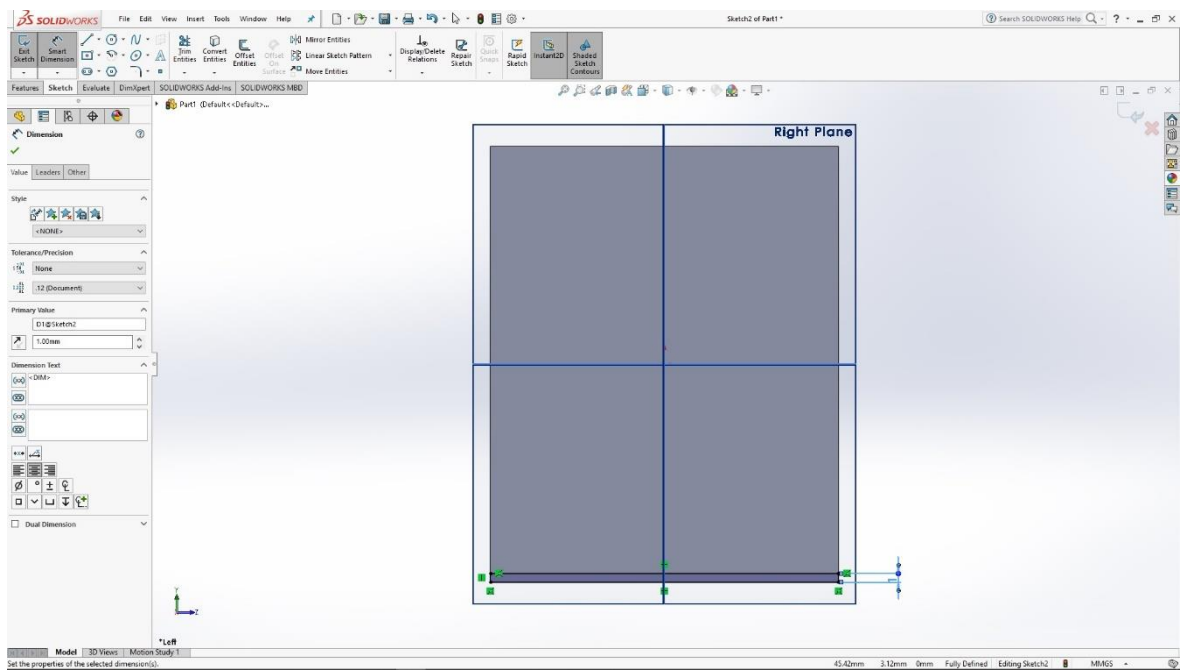


Slika 6.81: Skica pravokutnika

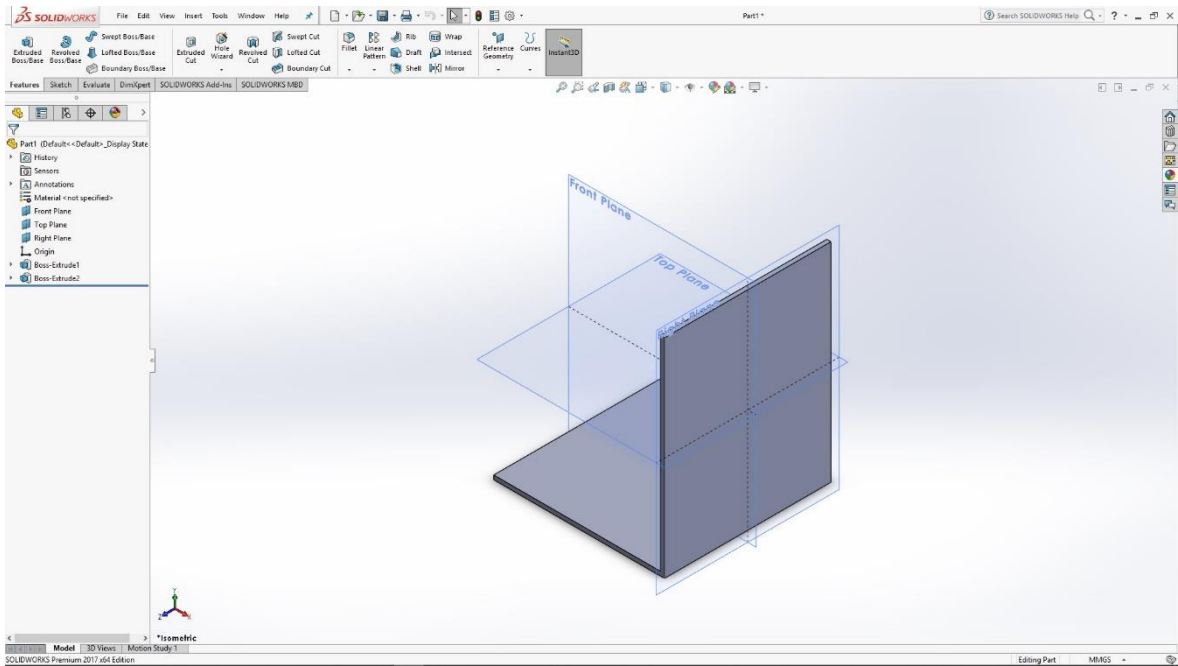


Slika 6.82: 3D model pravokutnika

Na dnu pravokutnog modela skiciramo još jedan pravokutni model koji također naredbom Extrude izvlačimo u 3D model.

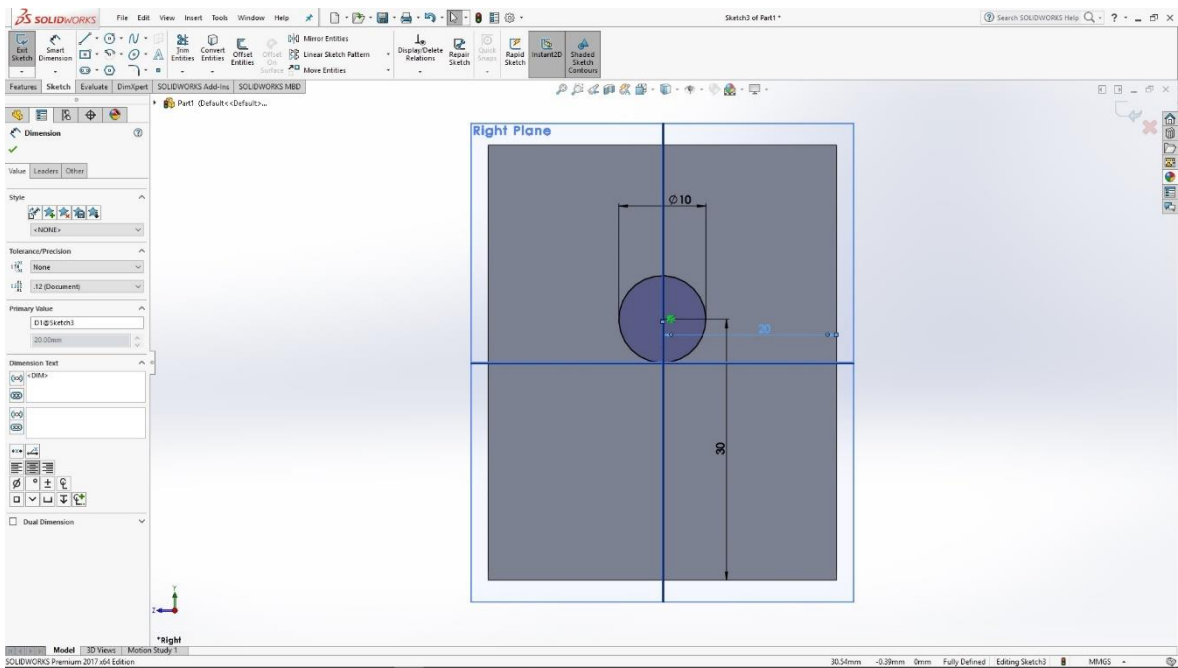


Slika 6.83: Skica pravokutnika na dnu modela

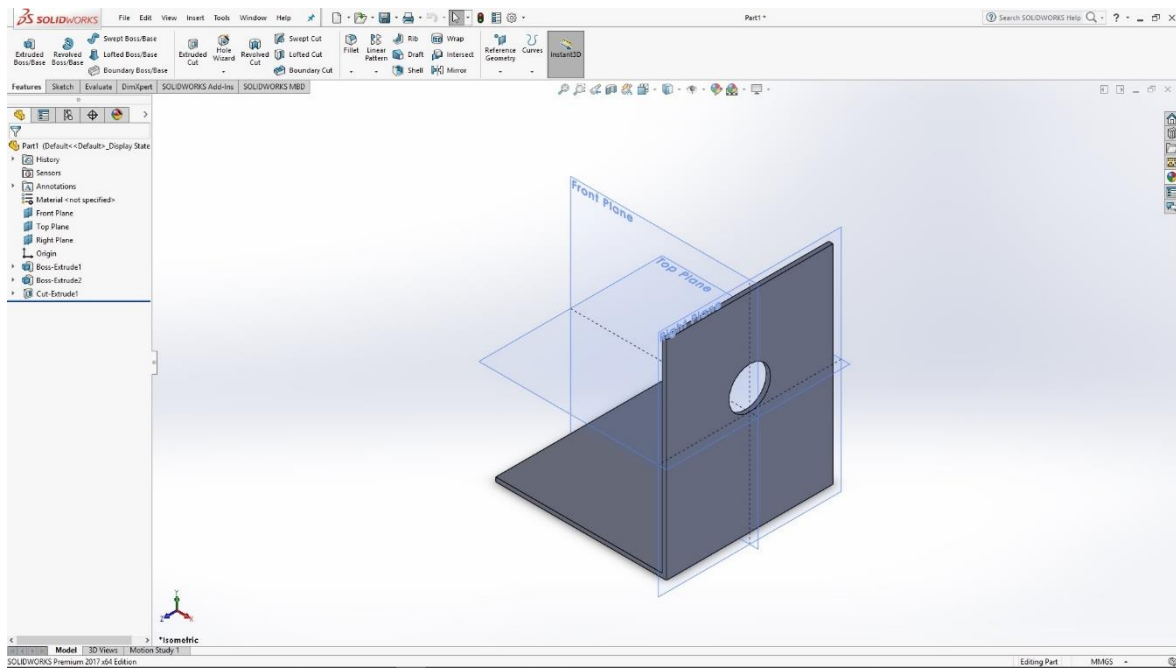


Slika 6.84: 3D model donjeg pravokutnika

Na uspravnom modelu 3D pravokutnika skiciramo kružnicu kako bismo pomoću naredbe Cut dobili provrt $\varnothing 10$ za senzor.

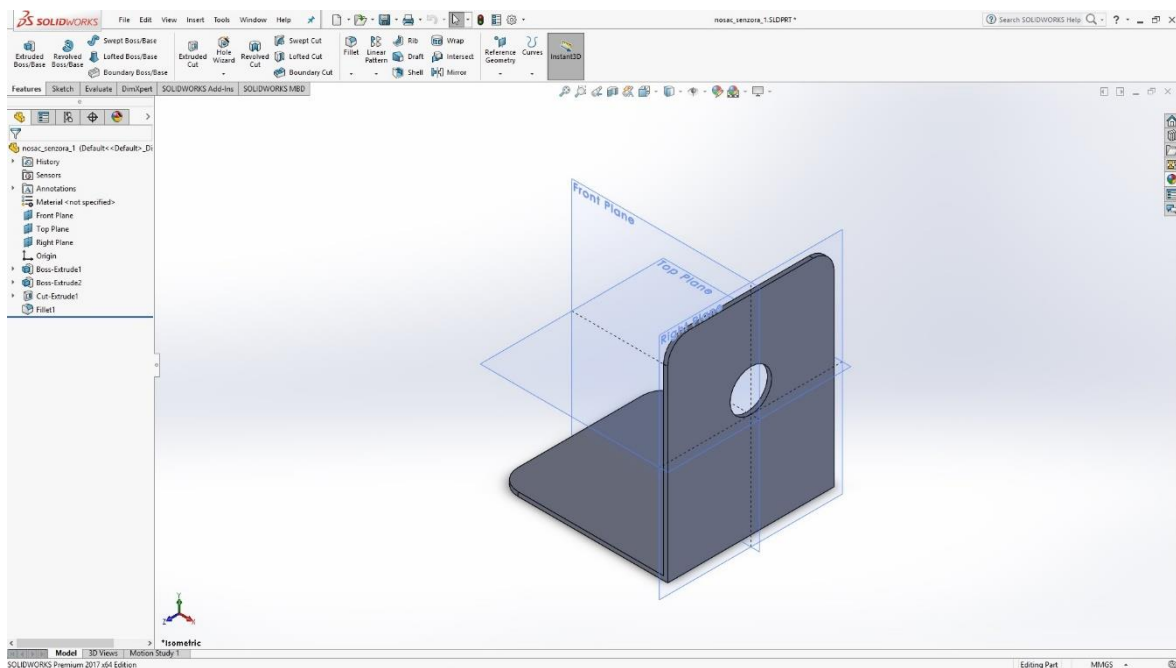


Slika 6.85: Skica kružnice

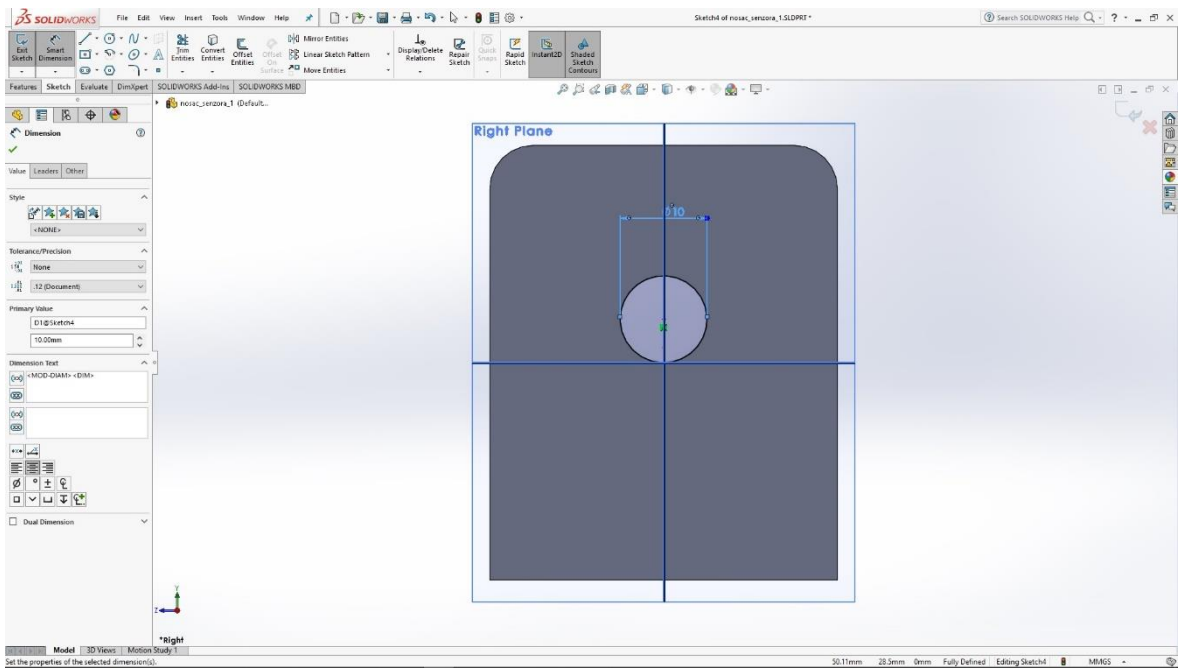


Slika 6.86: Utor za senzor

Naredbom Filet izrađujemo zaobljenja na rubovima držača.

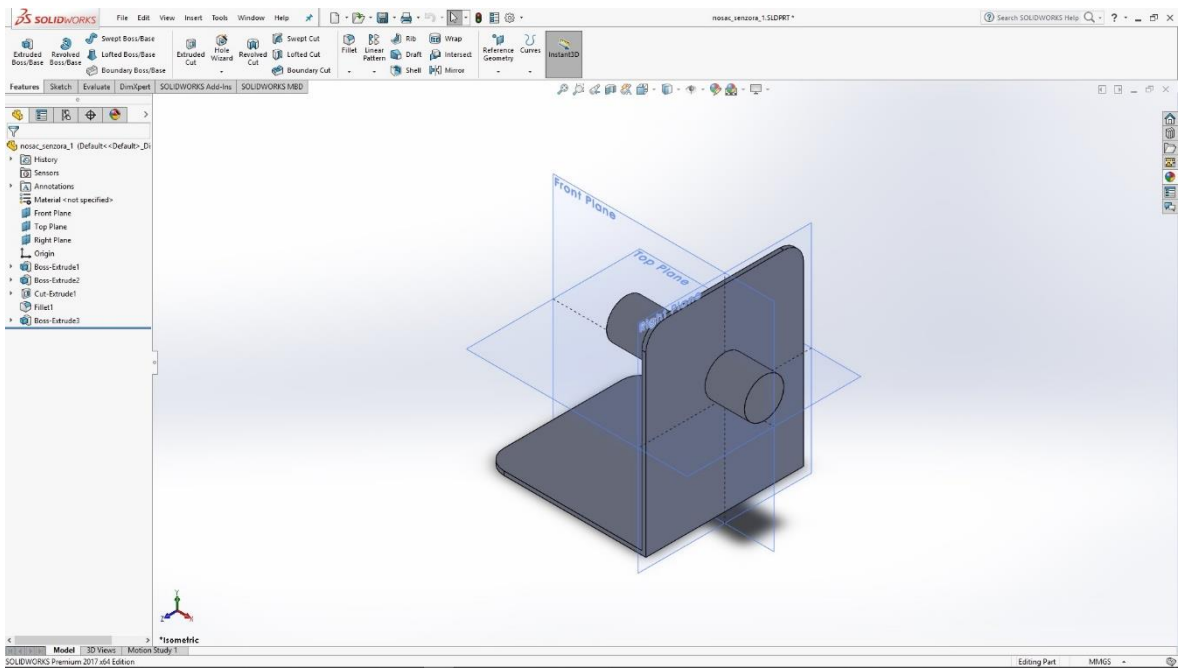


Slika 6.87: Zaobljenja na rubovima držača

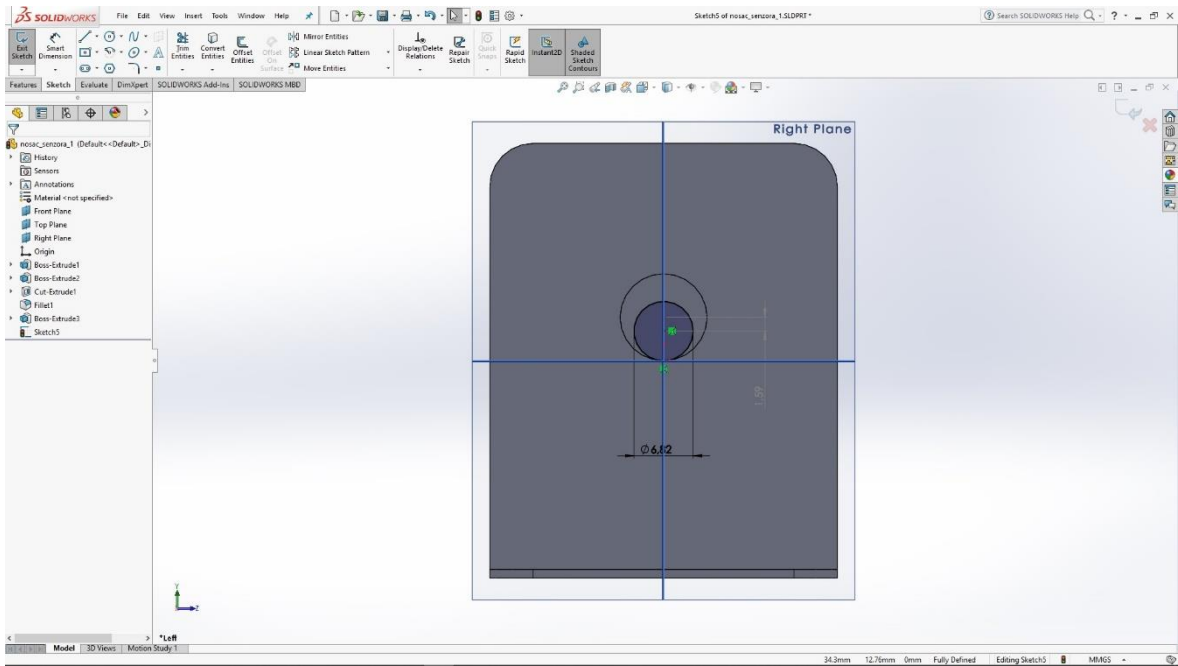


Slika 6.88: Skica kružnice

Na prijašnjem napravljenom provrtu skiciramo kružnicu koju naredbom Extrude izvlačimo u obje strane.

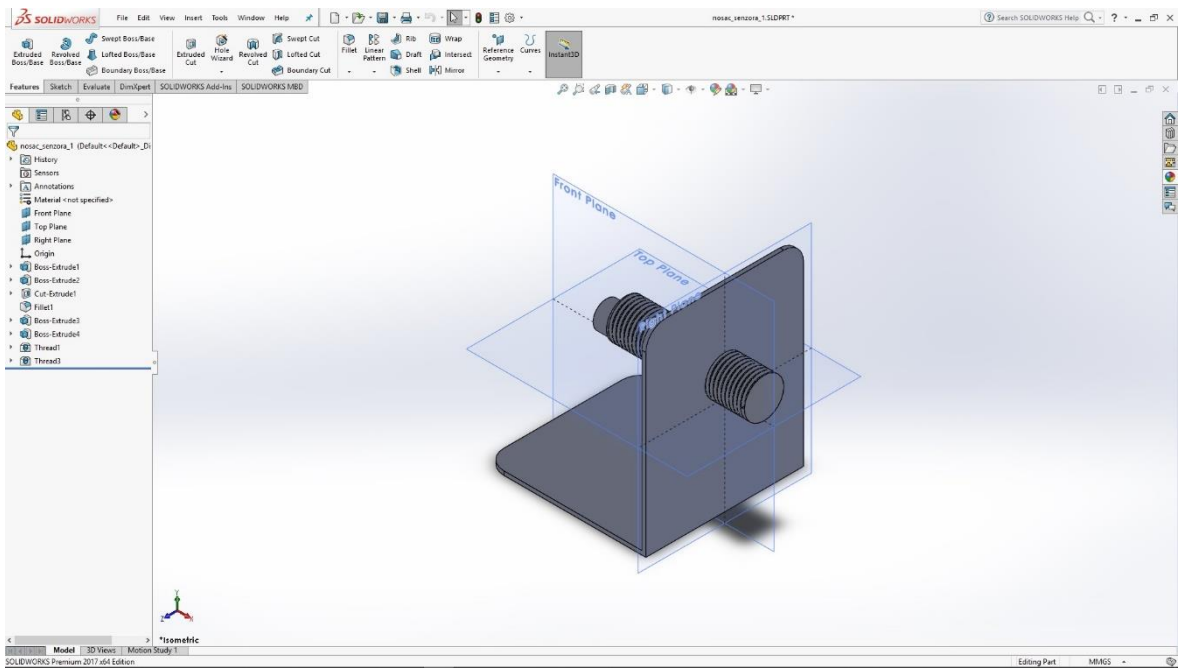


Slika 6.89: Tijelo senzora

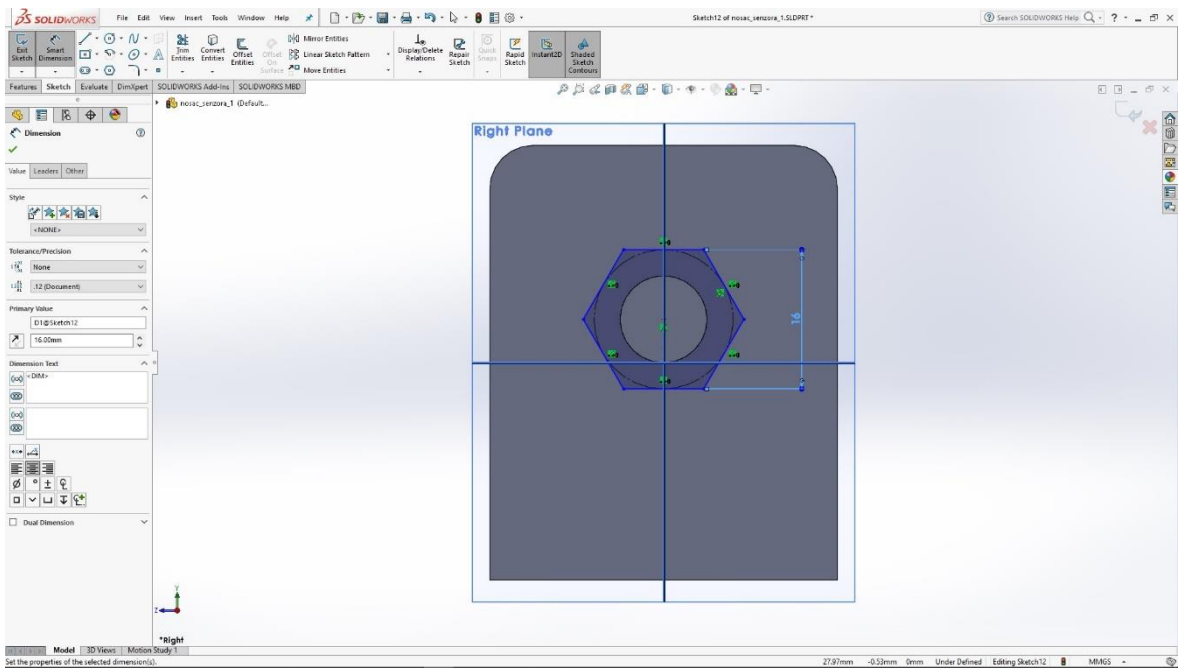


Slika 6.90: Skica kružnice

Na stražnjem dijelu senzora skiciramo manju kružnicu koju naredbom Extrude izvlačimo u 3D model. Naredbom Thread izrađujemo vanjski navoj na senzoru.

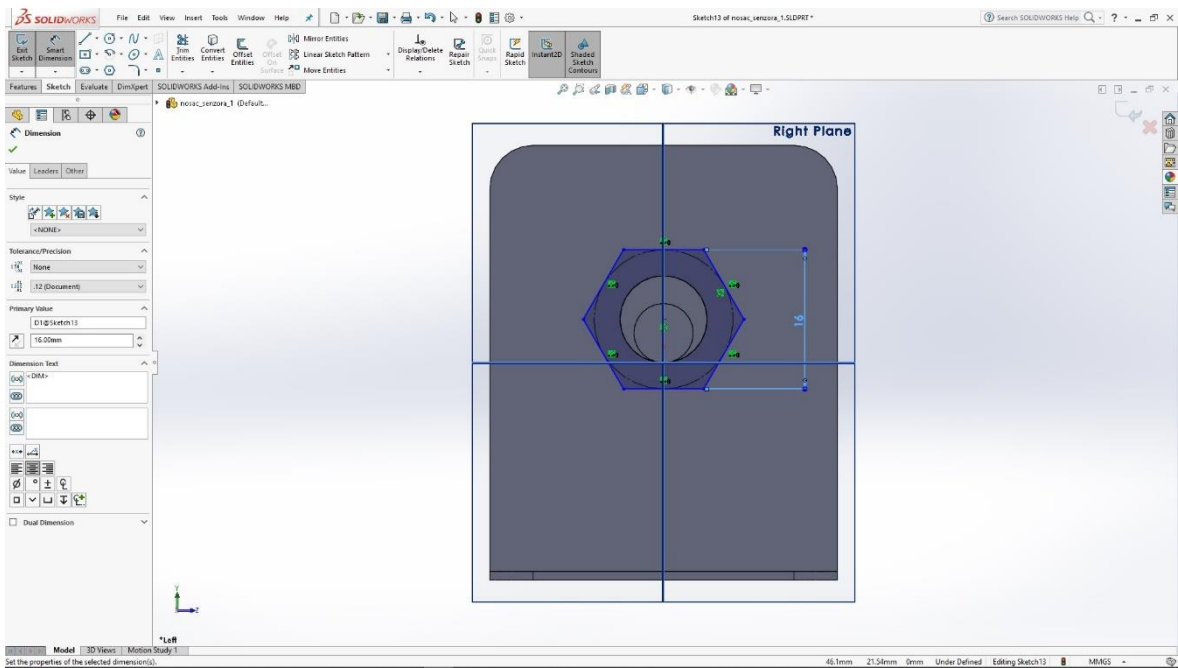


Slika 6.91: Navoj na senzoru

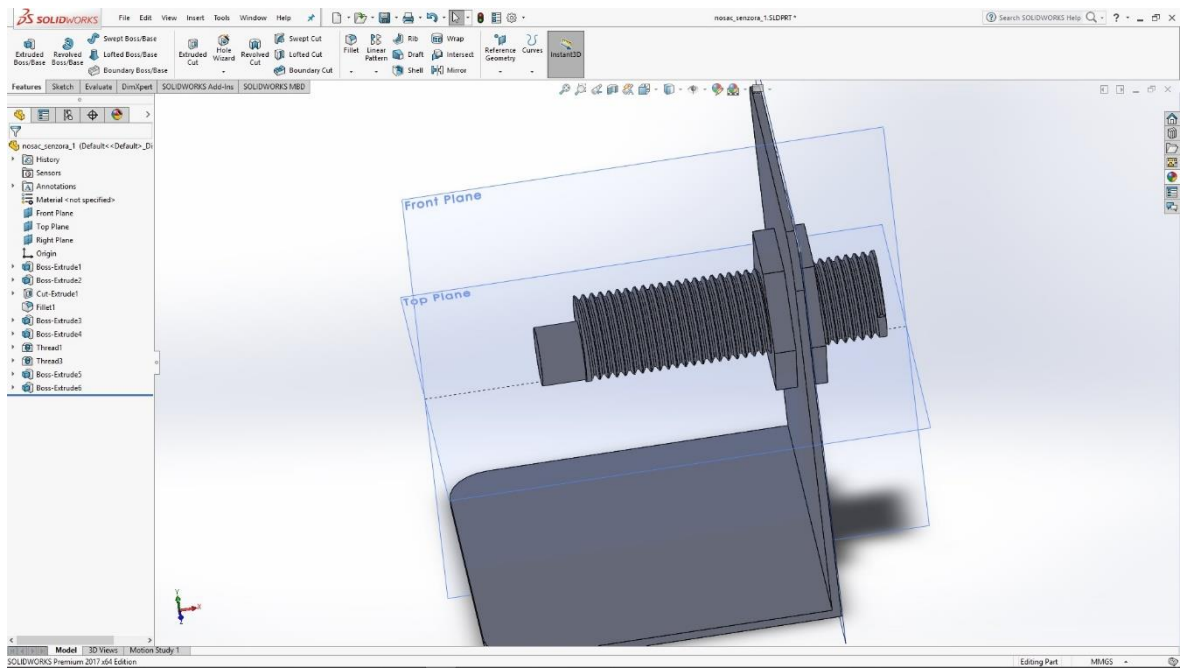


Slika 6.92: Skica prednje matice

Na prednjoj strani držača senzora skiciramo šesterokut koji naredbom Extrude izvlačimo u 3D model matice. Istim postupkom izrađujemo maticu M16 i na zadnjoj strani držača.

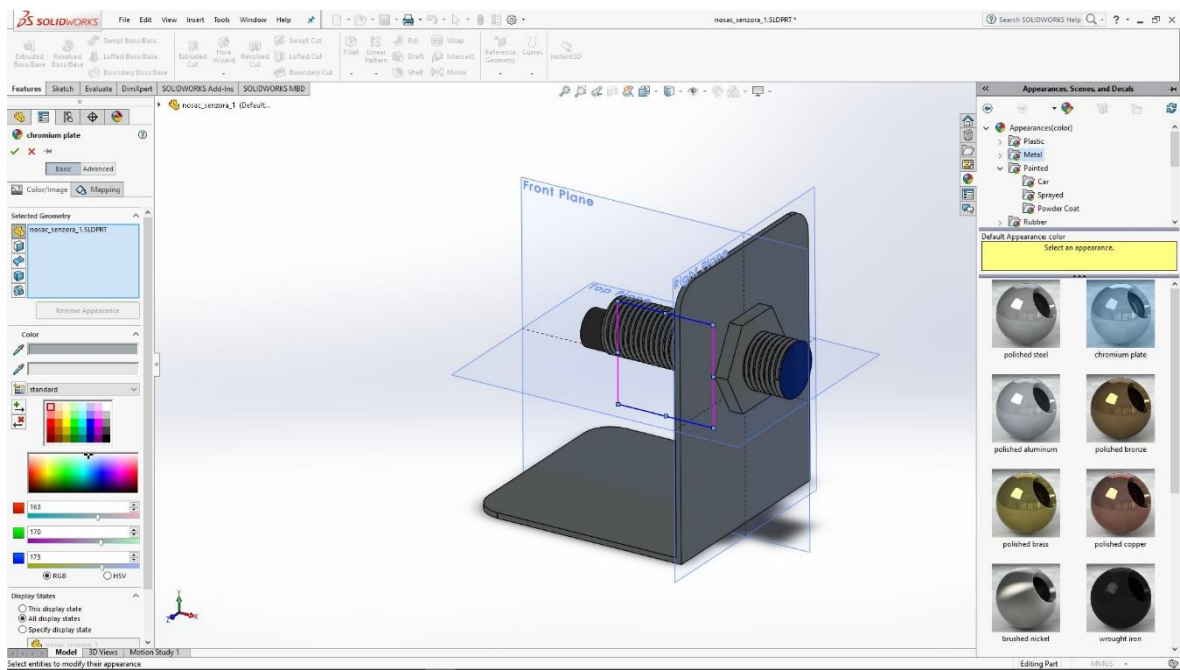


Slika 6.93: Skica zadnje matice



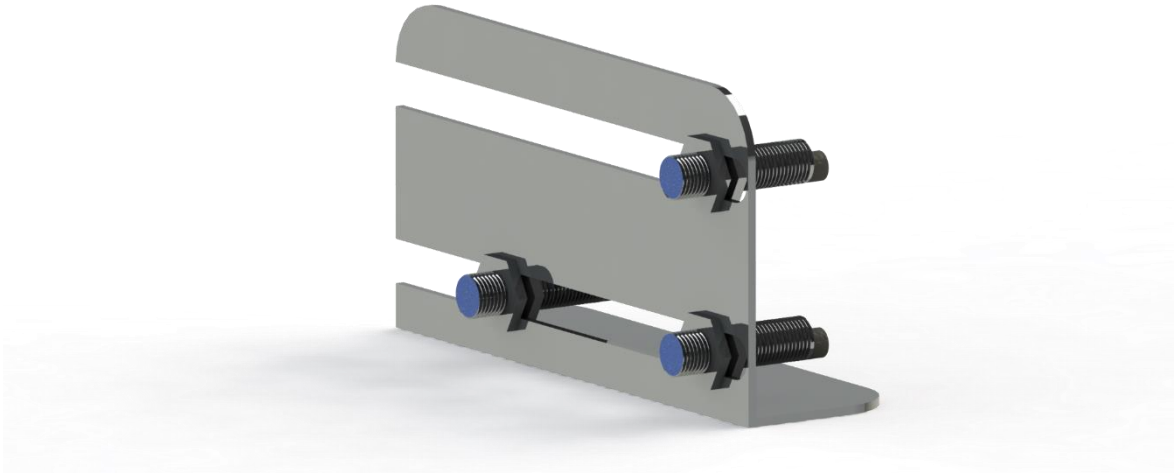
Slika 6.94: 3D model prednje i zadnje matice

S gotovim modelom držača senzora potrebno je još odabrati materijal za renderiranje slike modela.



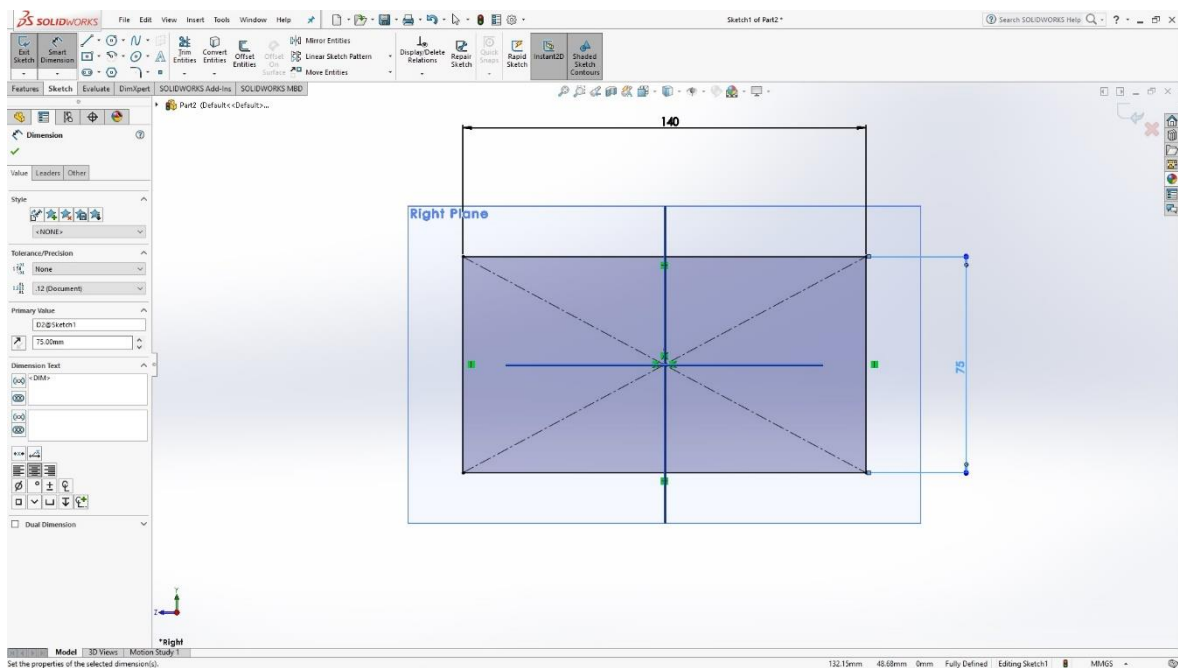
Slika 6.95: Odabir materijala za render

6.9 Nosač senzora 2.

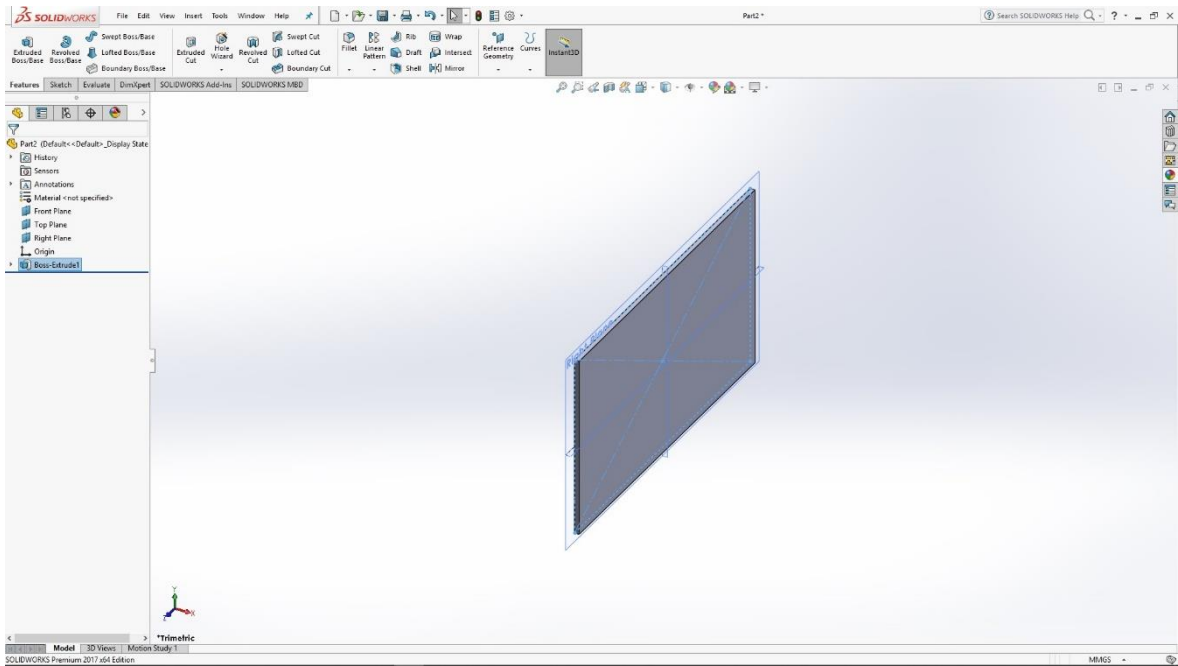


Slika 6.96: Render nosača senzora

Izrada modela nosača senzora započinje skicom u desnoj ravnini. Skicu pravokutnika naredbom Extrude izvlačimo u 3D model pravokutnika.

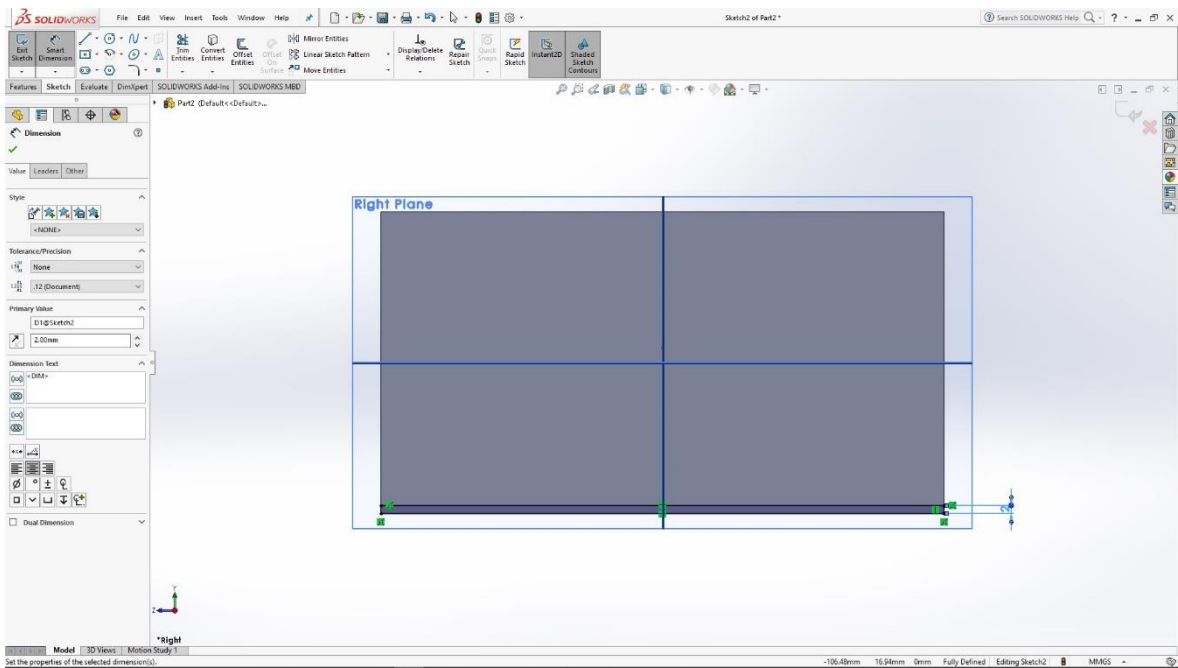


Slika 6.97: Skica pravokutnika

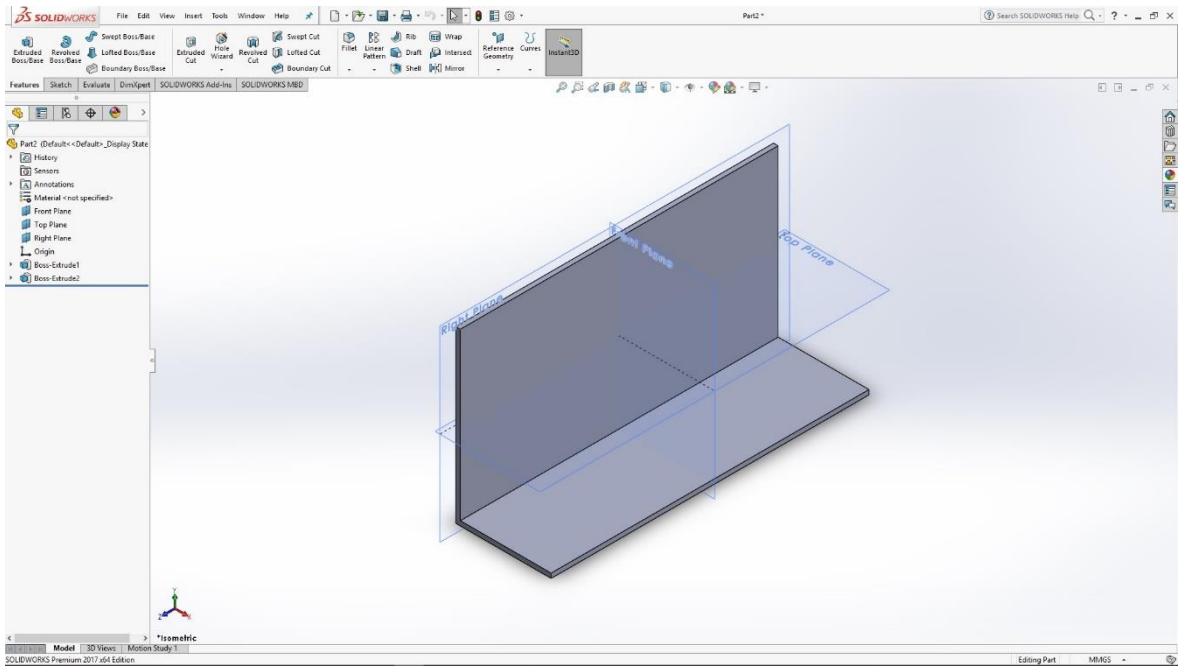


Slika 6.98: 3D model pravokutnika

Na dnu model pravokutnika skiciramo još jedan pravokutnik, te također tu skicu naredbom Extrude izvlačimo u 3D model pravokutnika i dobivamo osnovni model stalka.

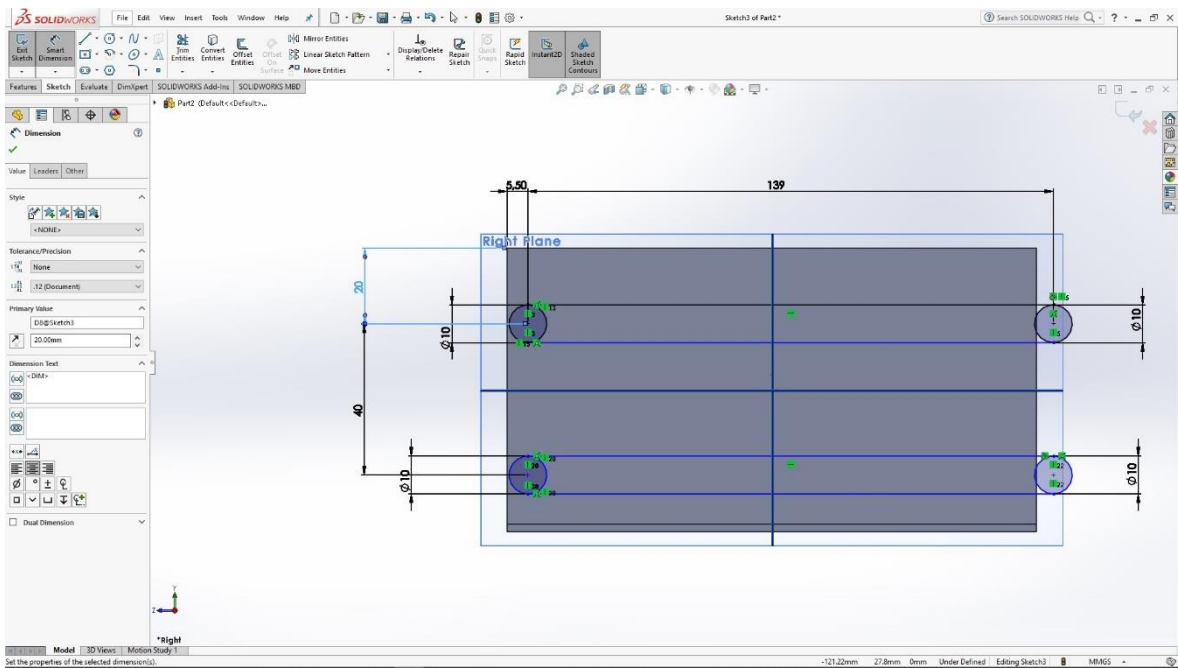


Slika 6.99: Skica pravokutnika

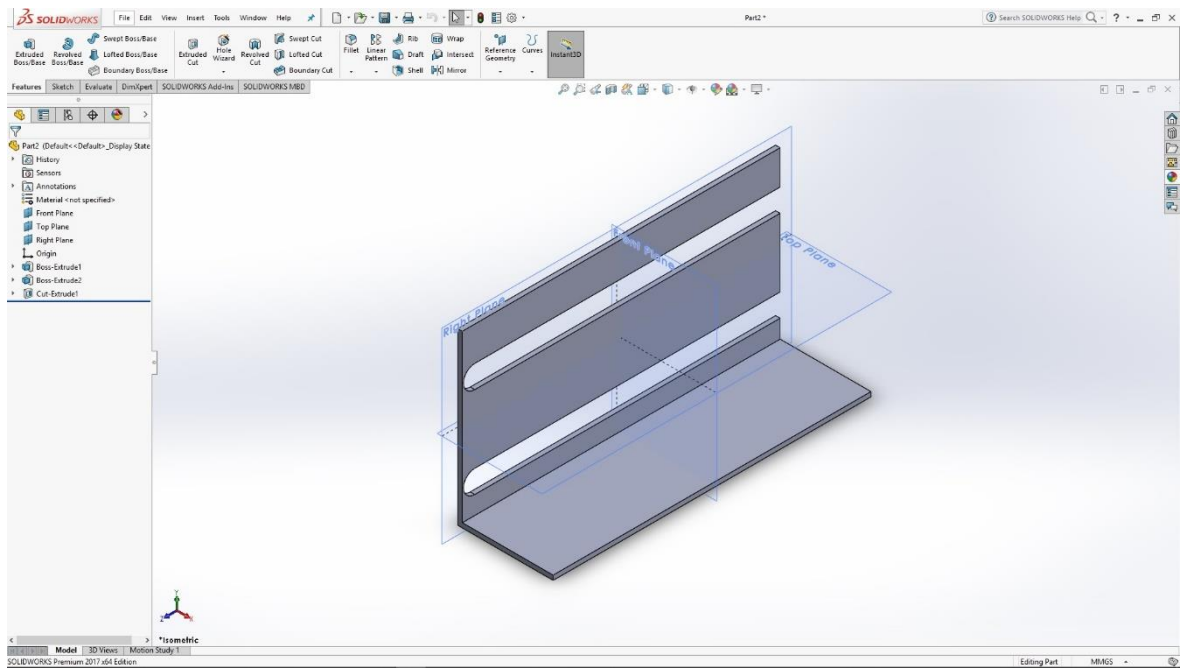


Slika 6.100: 3D model polegnutog pravokutnika

Na uspravnom modelu skiciramo zaobljenja. Ta zaobljenja naredbom Cut pretvaramo u utore elipsastog oblika.

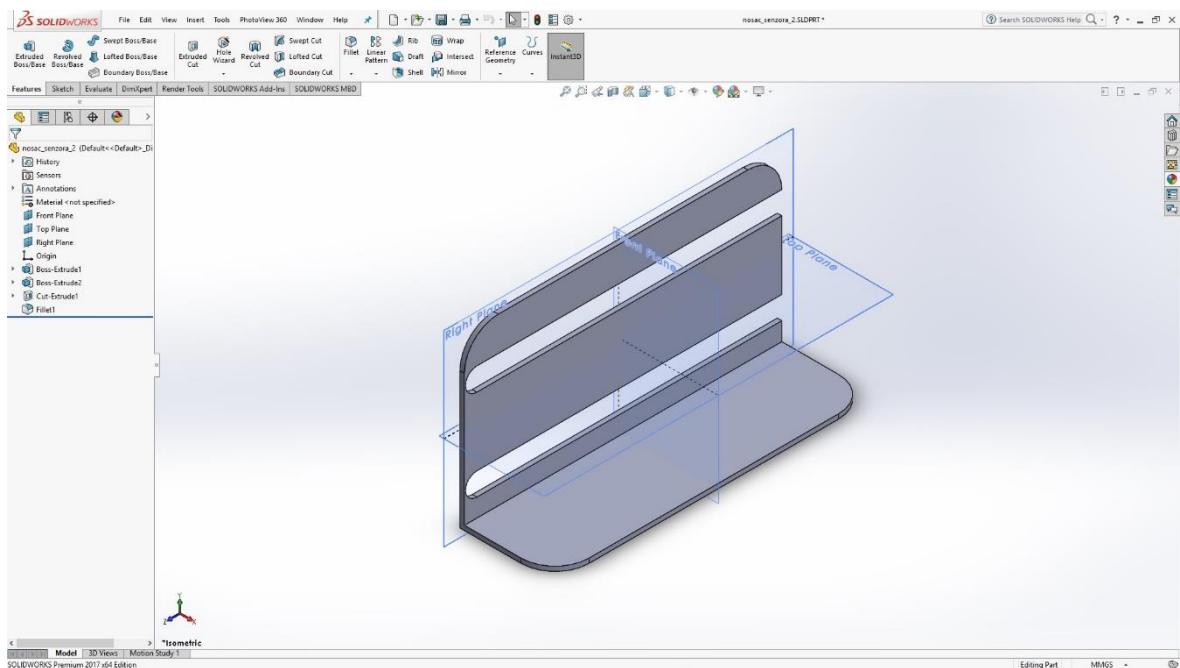


Slika 6.101: Skica elipse

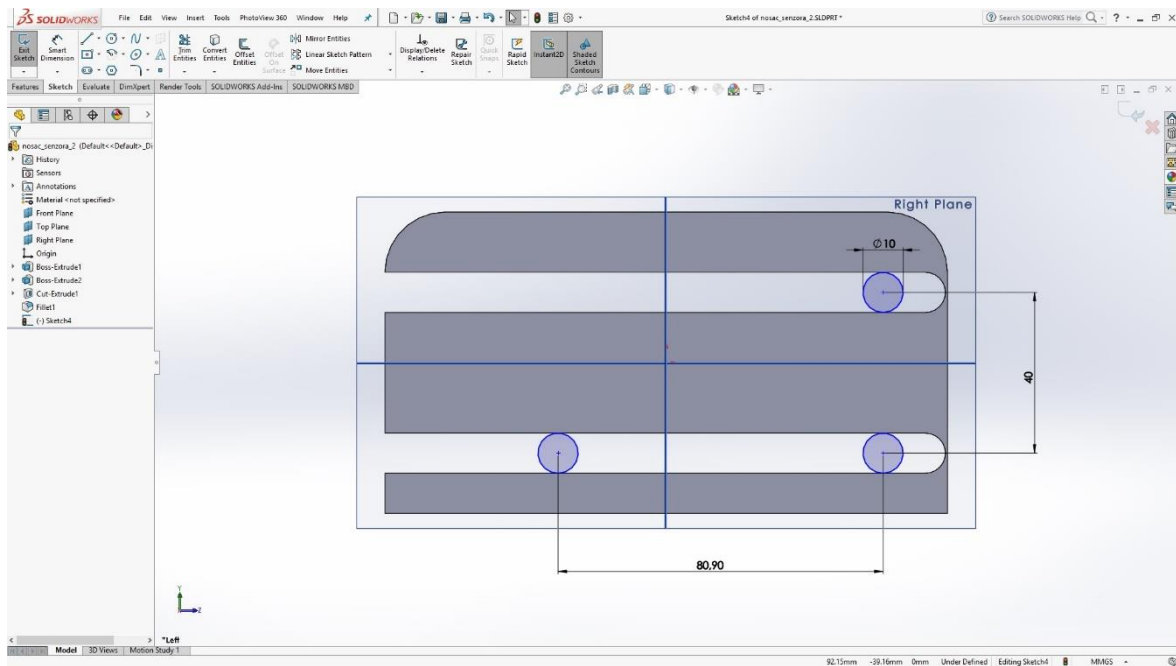


Slika 6.102: Utori u uspravnom modelu

Naredbom Fillet oblikujemo zaobljenja na rubovima modela.

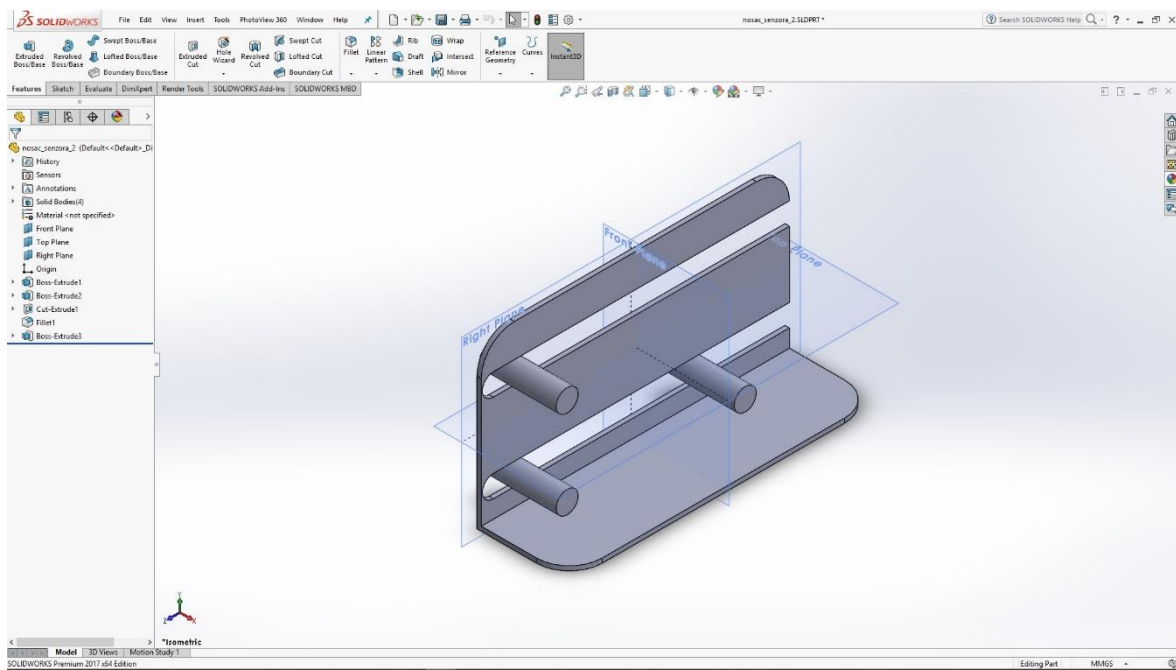


Slika 6.103: Zaobljenja na rubovima modela

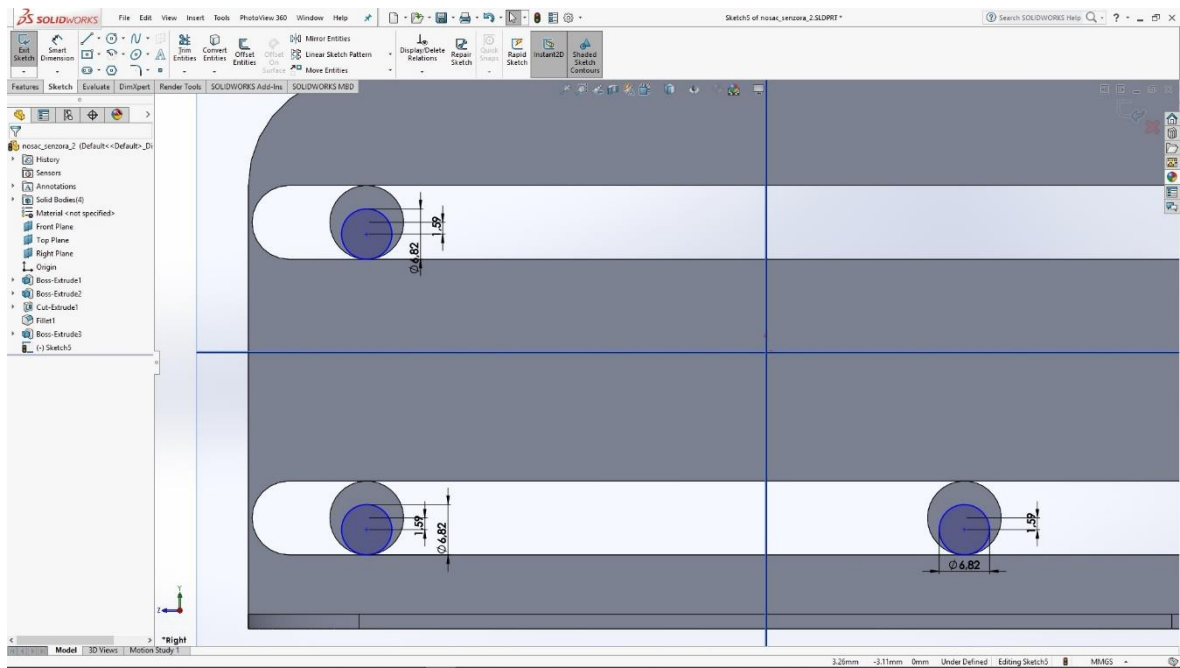


Slika 6.104: Skica kružnica u utorima

U utorima modela skiciramo kružnice koje naredbom Extrude izvlačimo u 3D modele valjkastog oblika.

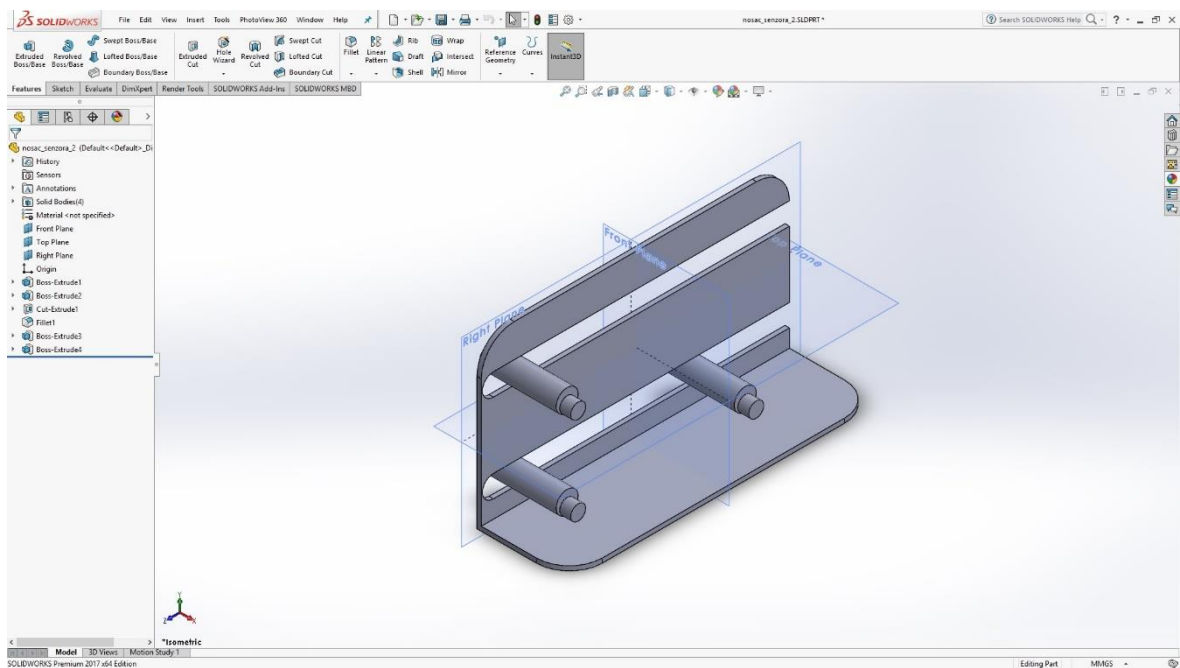


Slika 6.105: 3D modeli

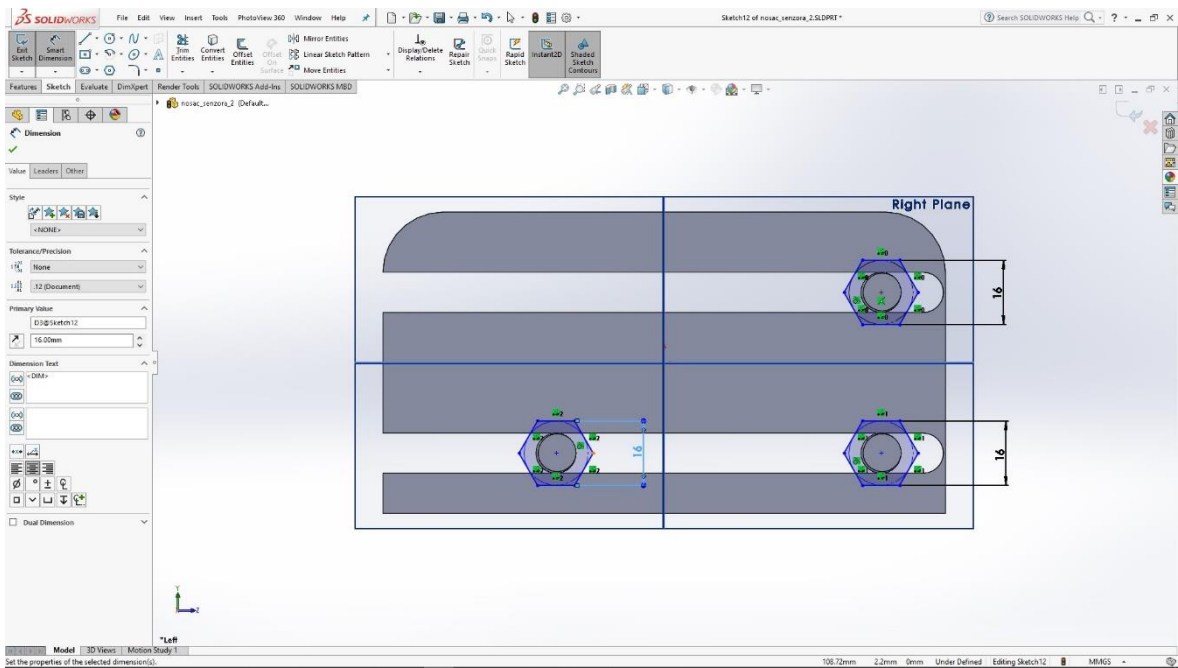


Slika 6.106: Skica kružnica

Na stražnjoj strani valjkastih modela skiciramo manje kružnice koje također naredbom Extrude izvlačimo u 3D modele.

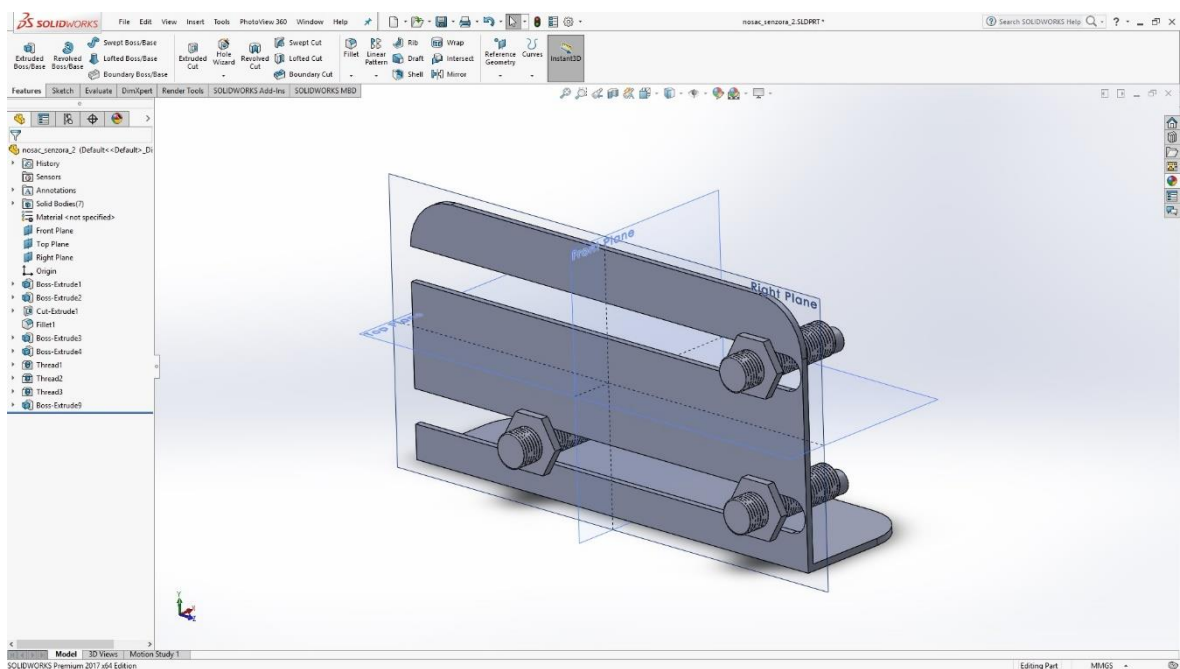


Slika 6.107: 3D model manjih valjaka

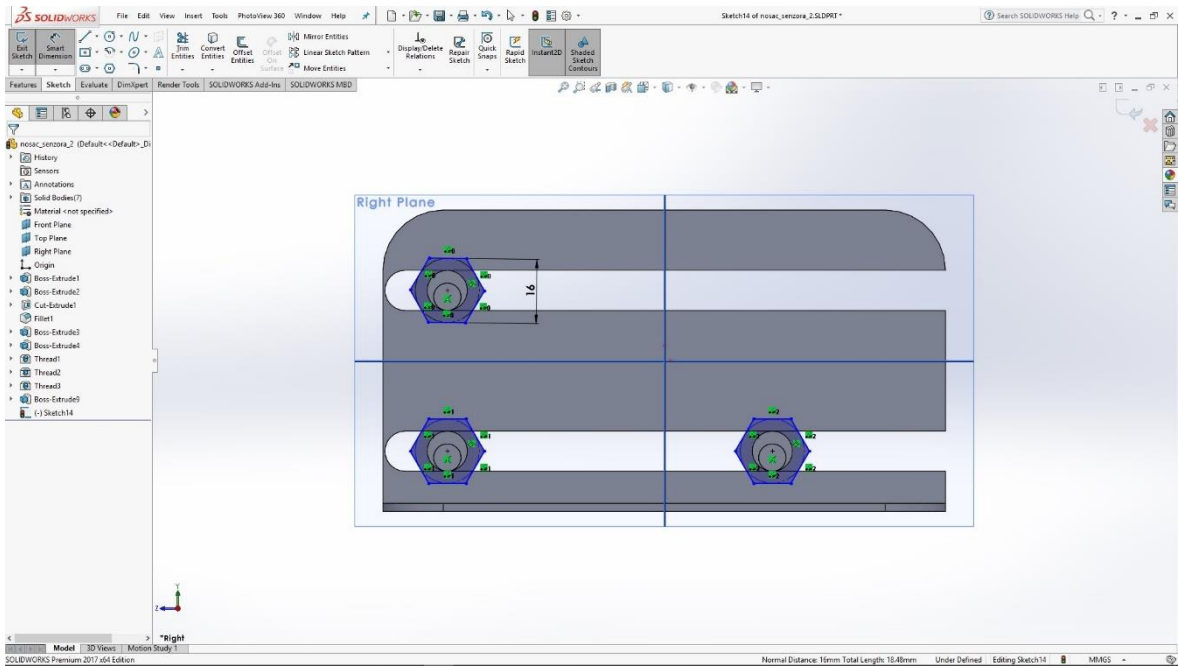


Slika 6.108: Skica matica na prednjem dijelu modela

Na prednjem dijelu modela skiciramo šesterokute koje naredbom Extrude izvlačimo u 3D model matice M16, te naredbom Thread radimo vanjski navoj na modelima valjkastog oblika.

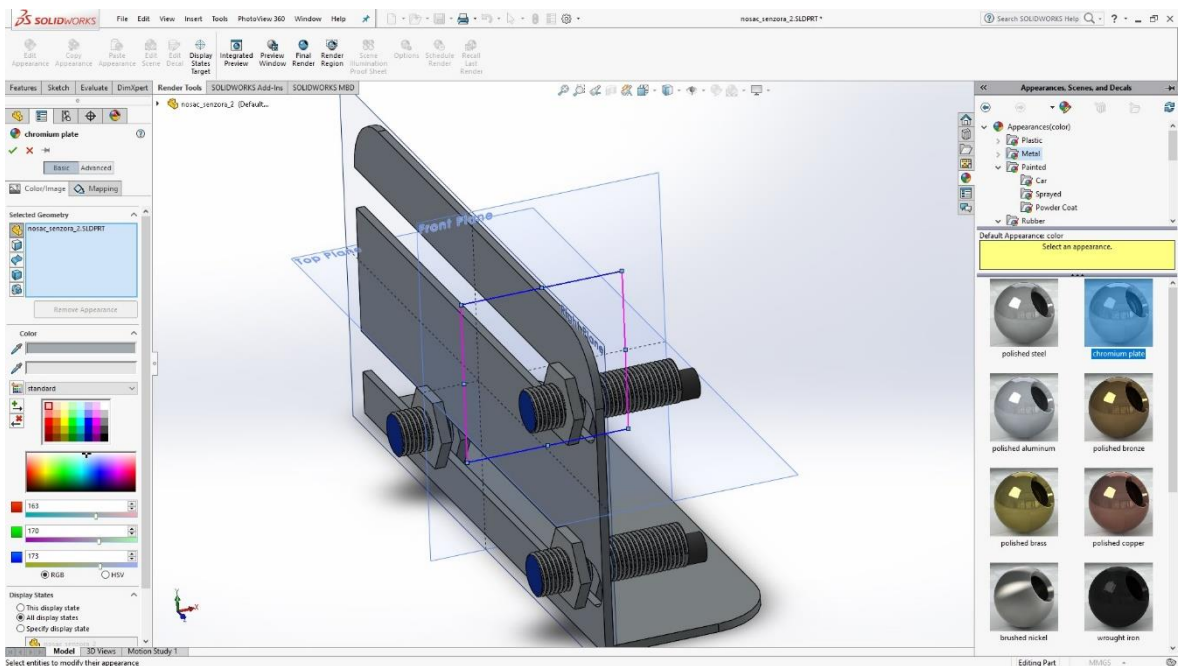


Slika 6.109: 3D model matica i vanjskog navoja na senzoru



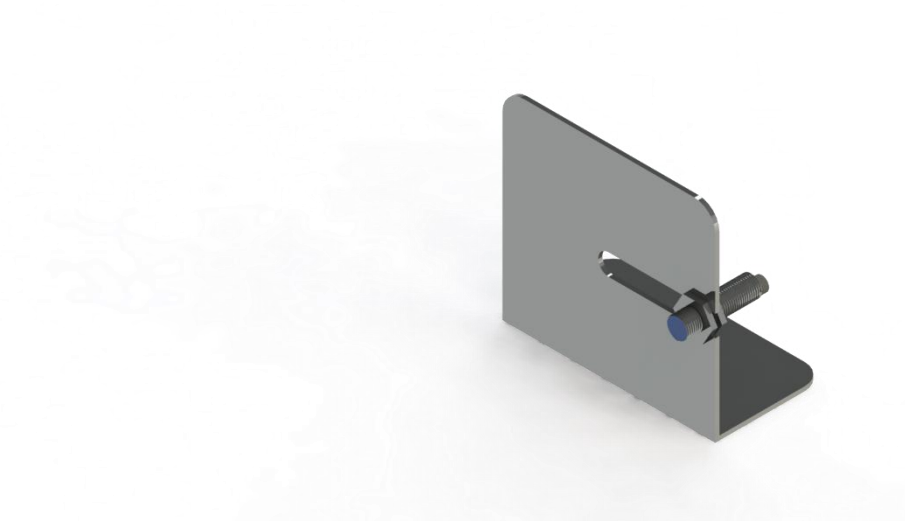
Slika 6.110: Skica matice na stražnjoj strani modela

Na stražnjoj strani modela skiciramo šesterokute koje naredbom Extrude izvlačimo u 3D model matice i time dobivamo gotov model nosača senzora. Potrebno je još odabrati materijal za renderiranje slike modela.



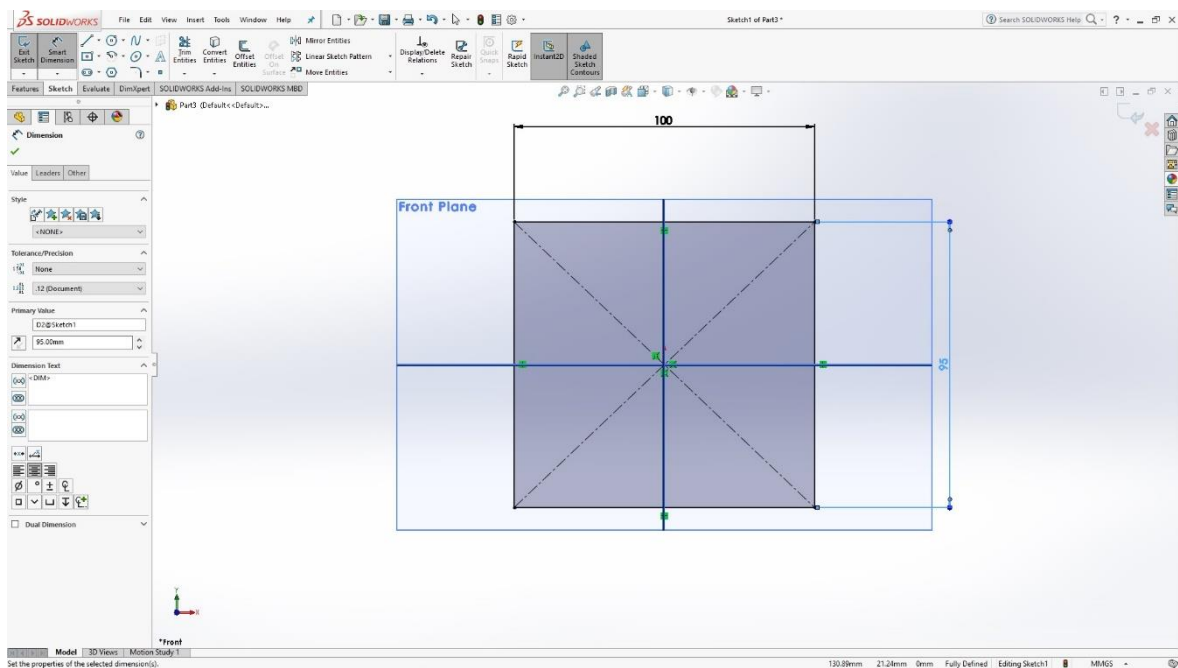
Slika 6.111: Odabir materijala za render

6.10 Nosač senzora 3.

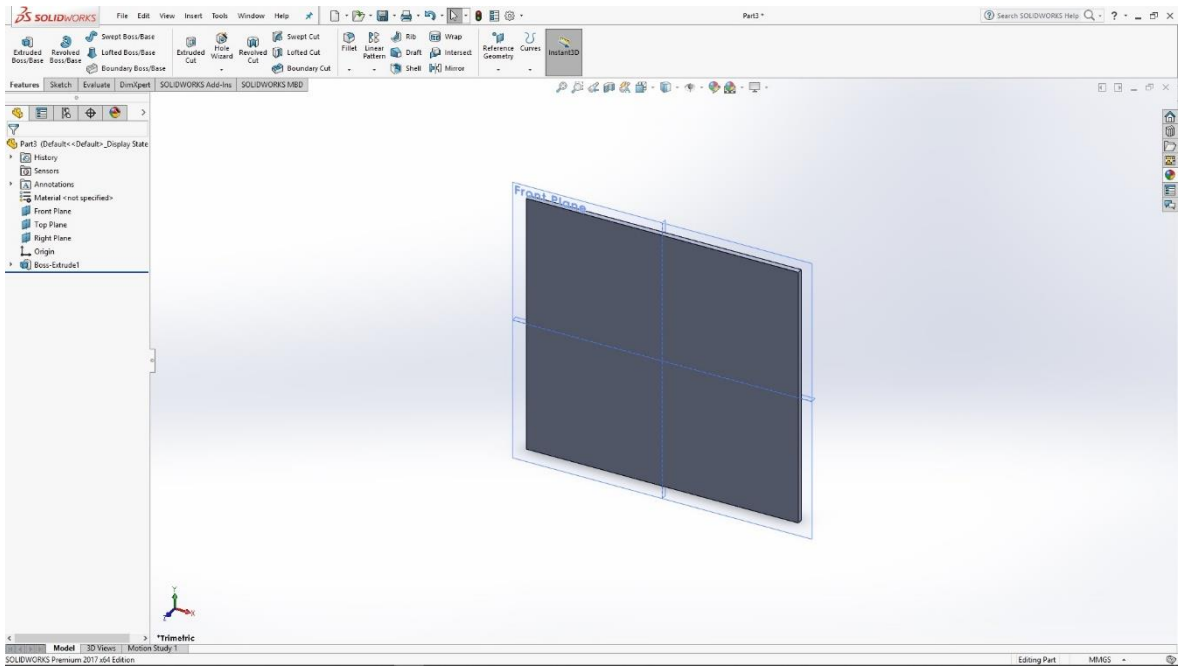


Slika 6.112: Render nosača senzora

Izrada modela nosača senzora započinje skicom pravokutnika u prednjoj ravni. Tu skicu naredbom Extrude izvlačimo u 3D model pravokutnika.

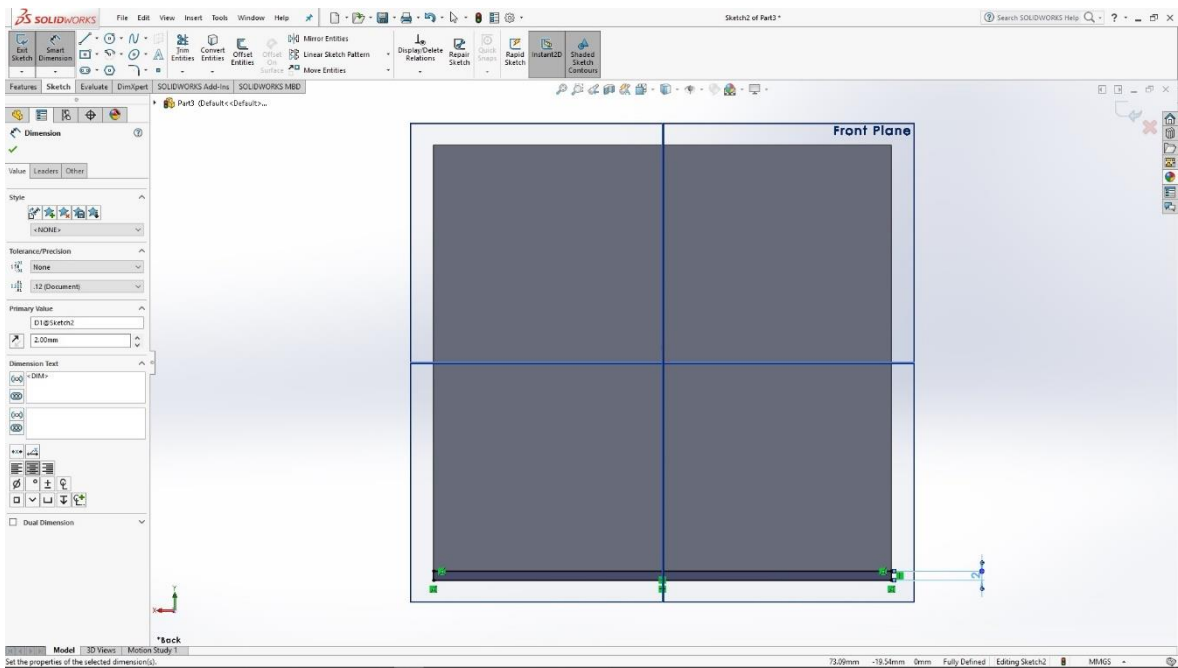


Slika 6.113: Skica pravokutnika

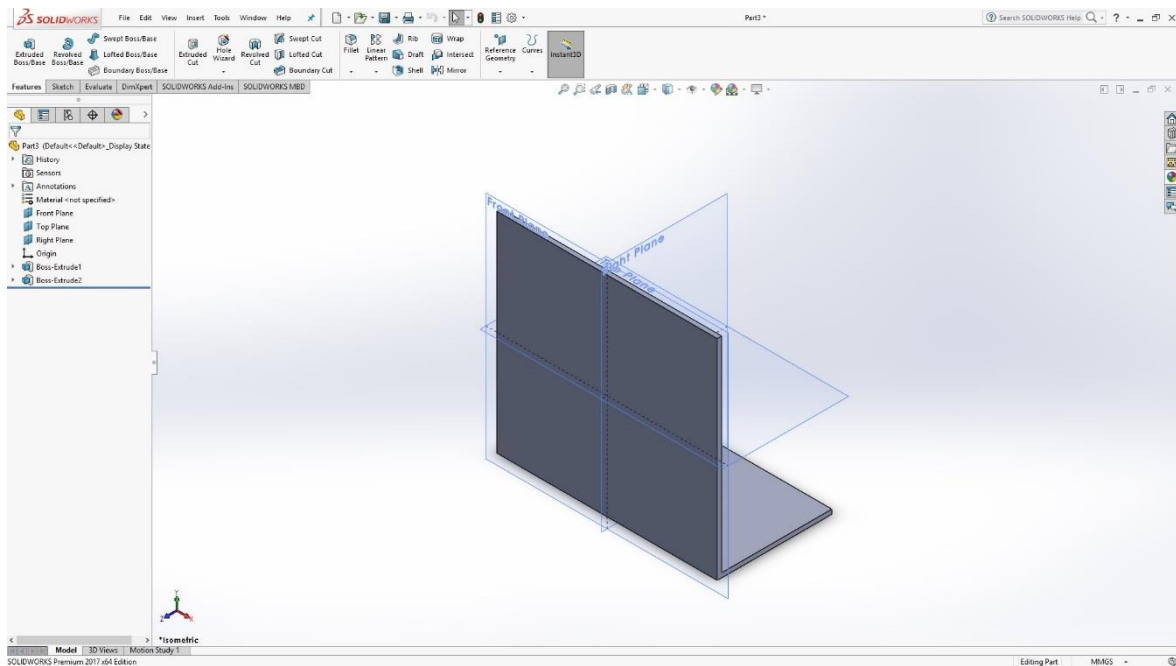


Slika 6.114: 3D model pravokutnika

Na dnu modela pravokutnika radimo skicu pravokutnika kojeg također naredbom Extrude izvlačimo u 3D model kako bismo dobili podnožje držača senzora.

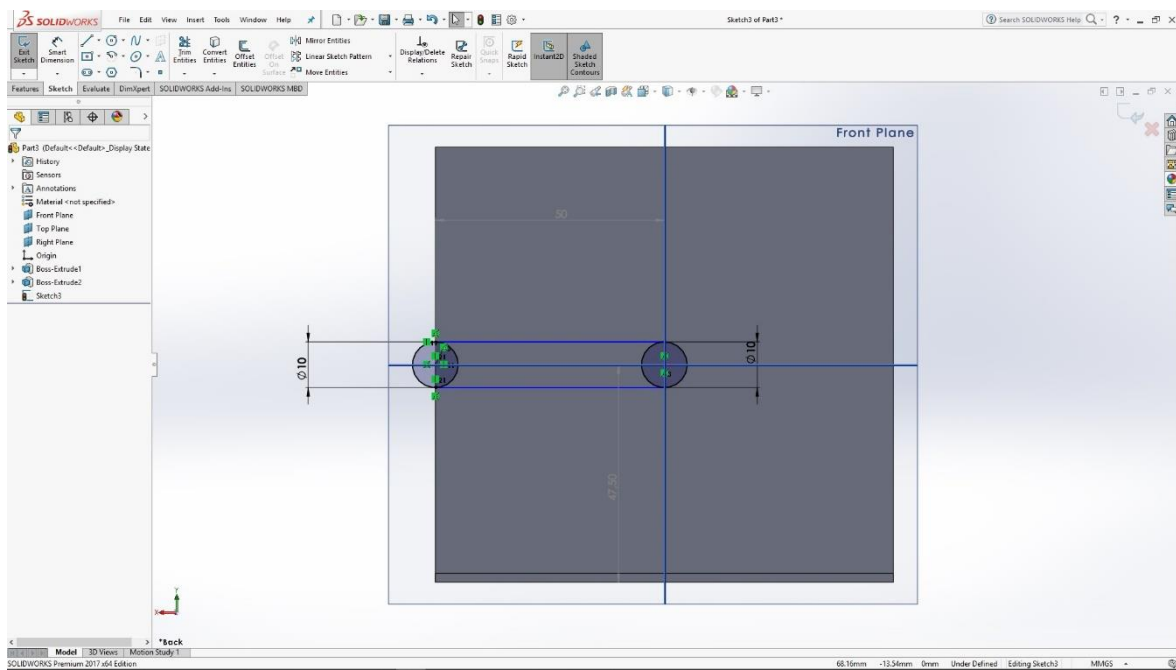


Slika 6.115: Skica pravokutnika na dnu modela

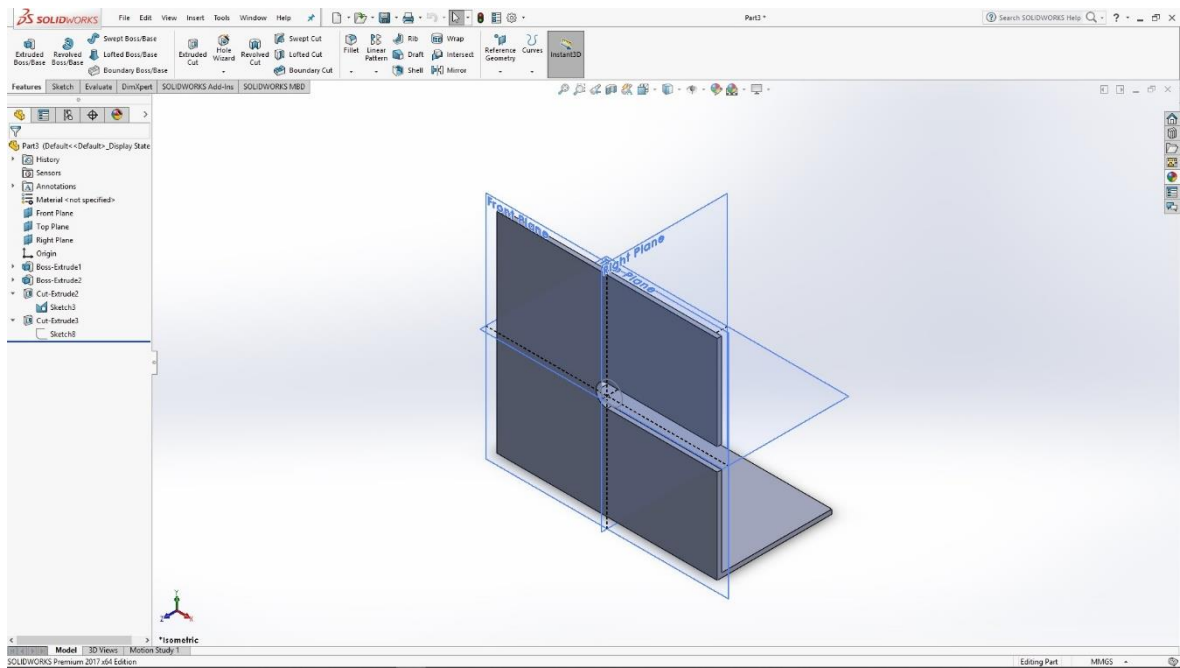


Slika 6.116: 3D model pravokutnika na dnu modela

Na uspravnom dijelu modela skiciramo zaobljenje koje naredbom Cut, izradujemo elipsasti utor u modelu.

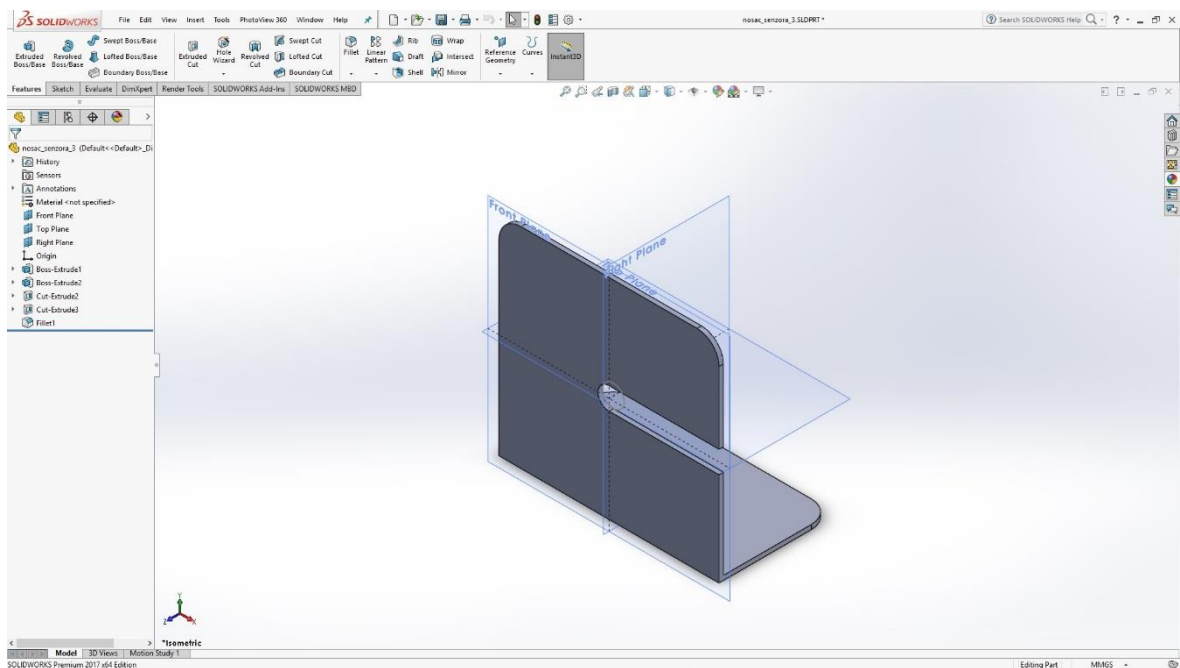


Slika 6.117: Skica elipse

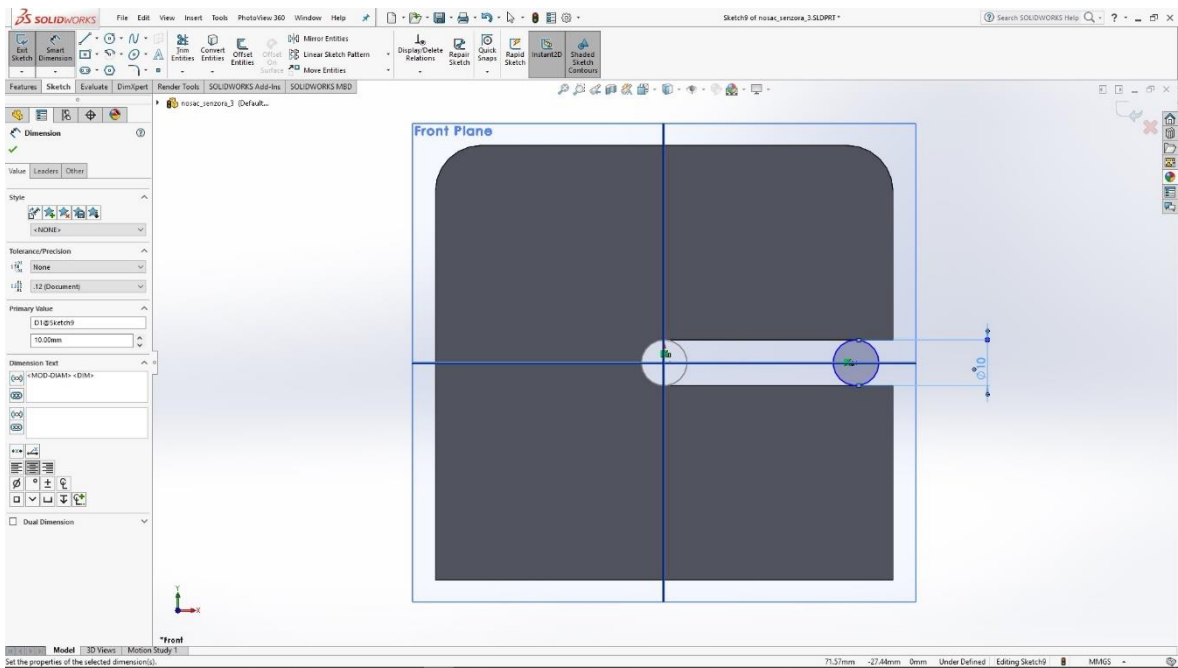


Slika 6.118: Utor u držaču senzora

Naredbom Fillet izrađujemo zaobljenja na rubovima modela.

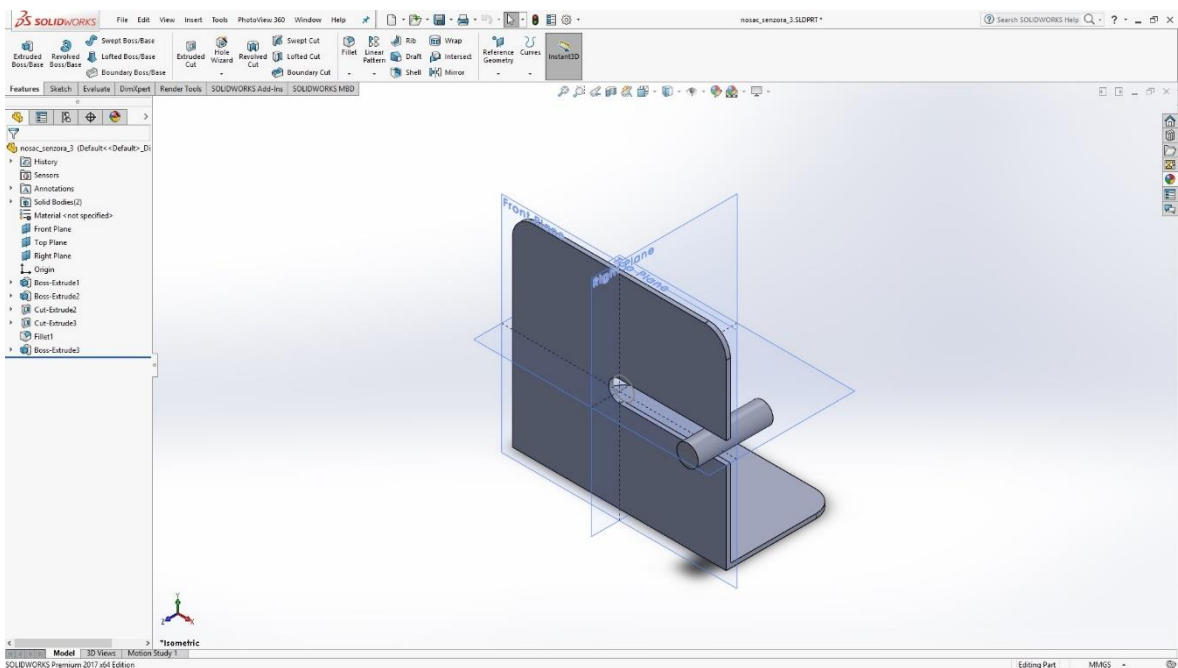


Slika 6.119: Zaobljenja na rubovima modela

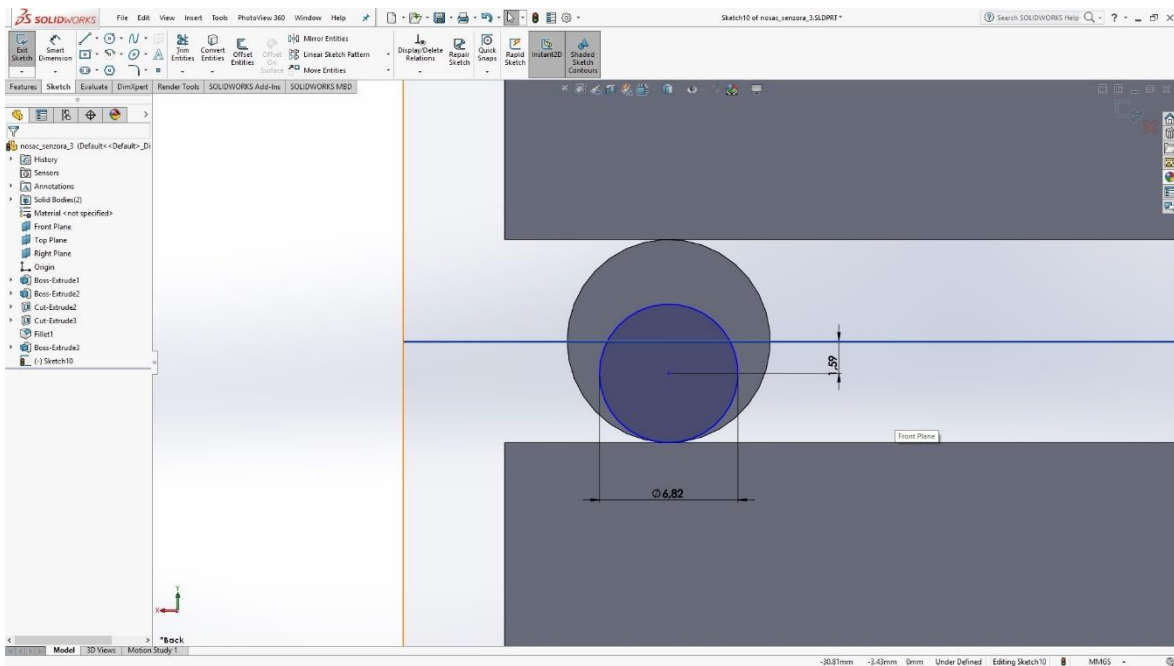


Slika 6.120: Skica kružnice

U utoru modela skiciramo kružnicu koju naredbom Extrude izvlačimo u valjak.

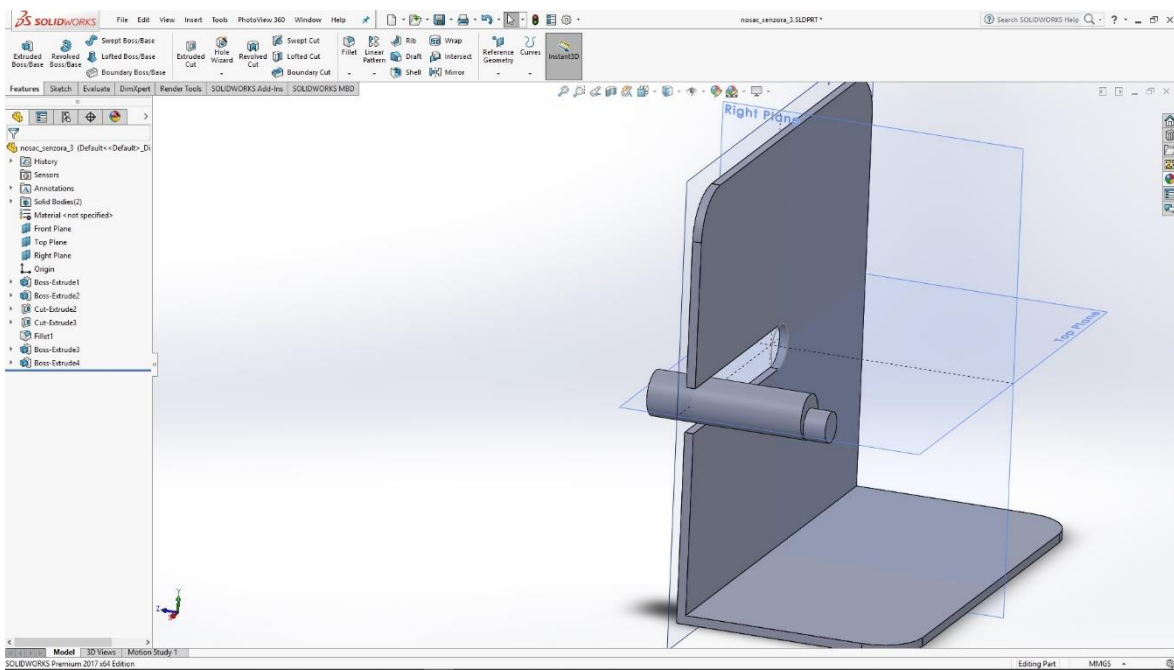


Slika 6.121: 3D model valjka

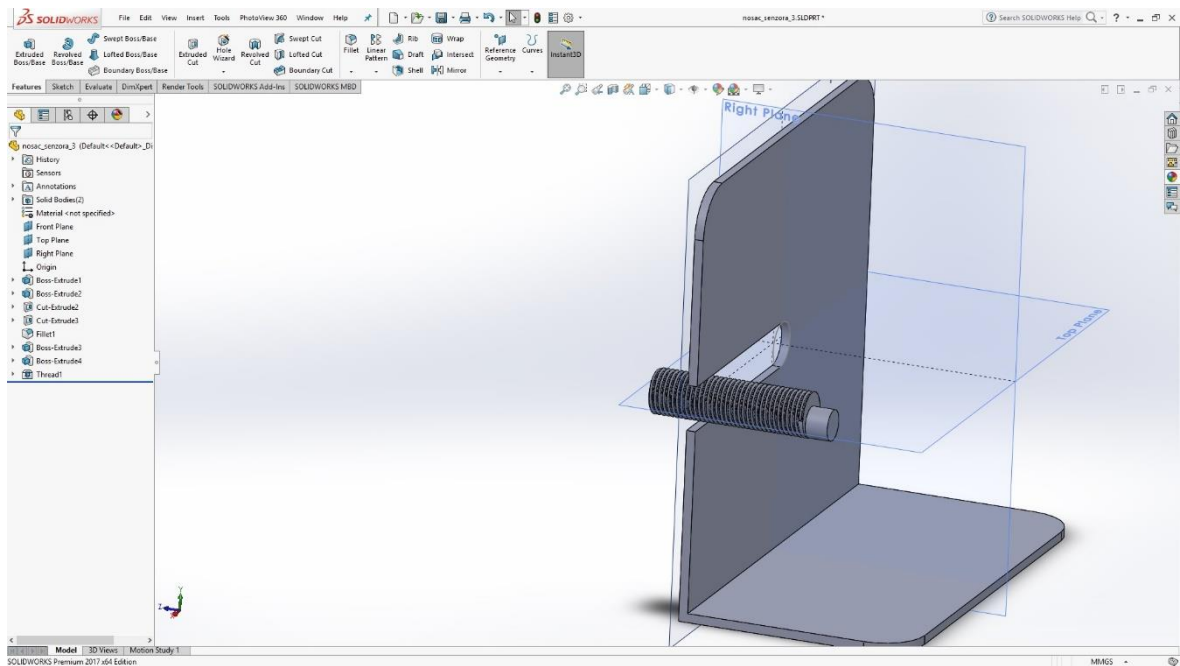


Slika 6.122: Skica kružnice

Na stražnjem dijelu 3D modela valjka skiciramo još jednu kružnicu koju također naredbom Extrude izvlačimo u 3D model manjeg valjka.

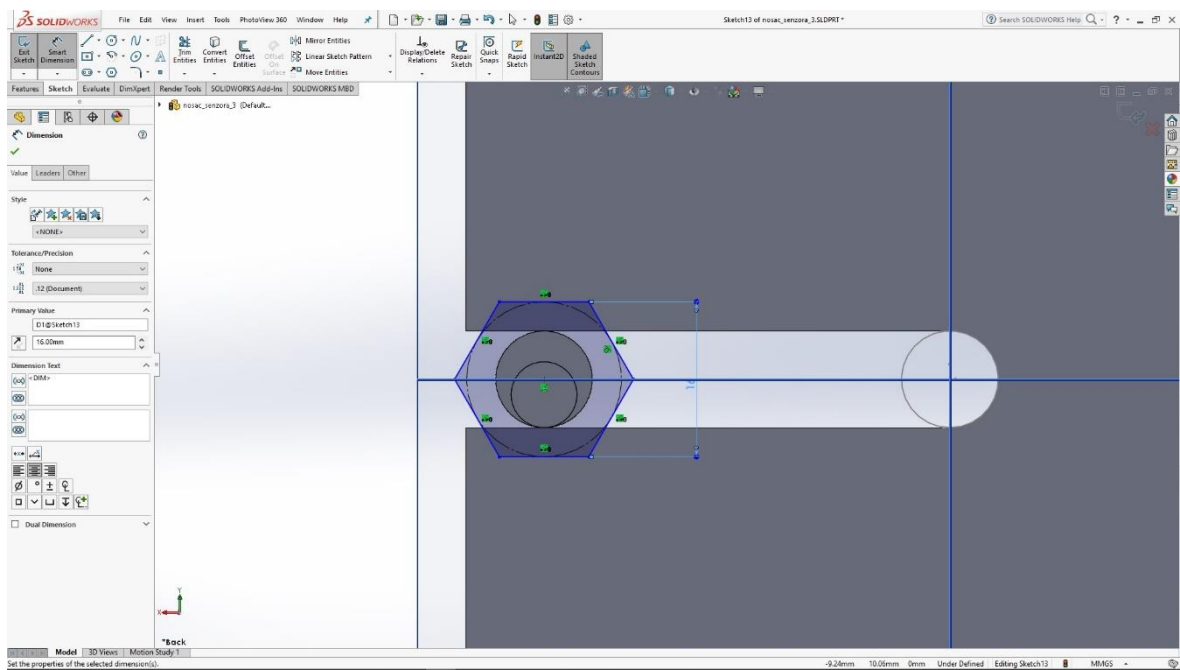


Slika 6.123: 3D model manjeg valjka

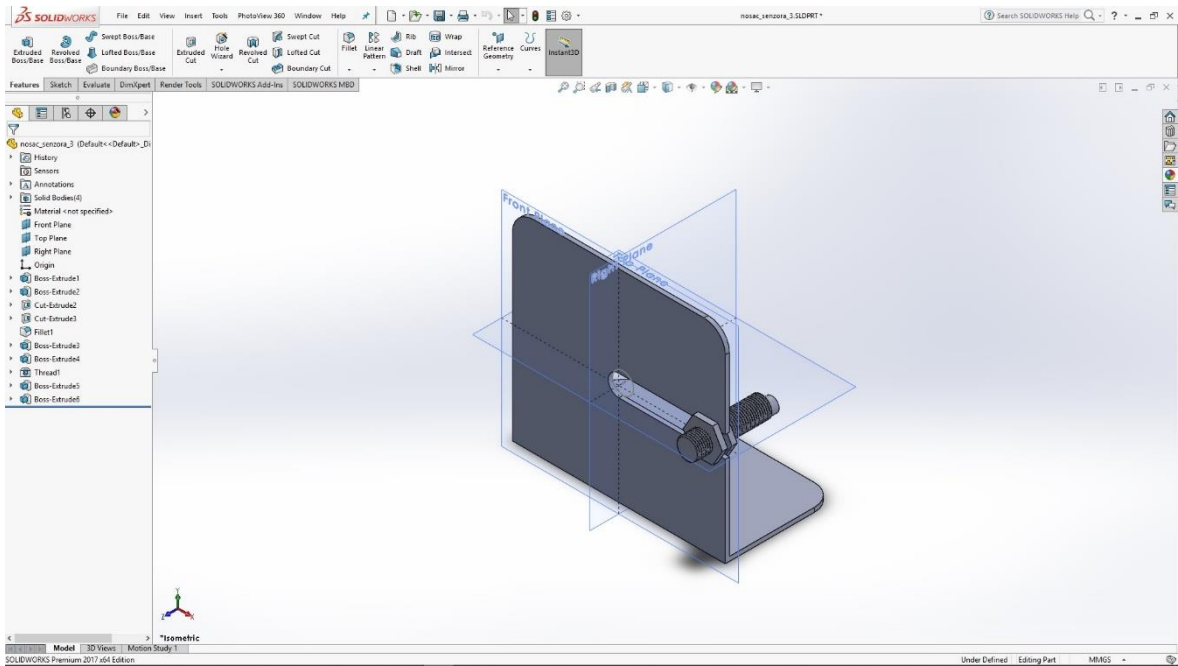


Slika 6.124: Vanjski navoj na senzoru

Naredbom Thread izrađujemo vanjski navoj na modelu većeg valjka. Sa obje strane modela skiciramo šesterokut koji naredbom Extrude izvlačimo u model matice.

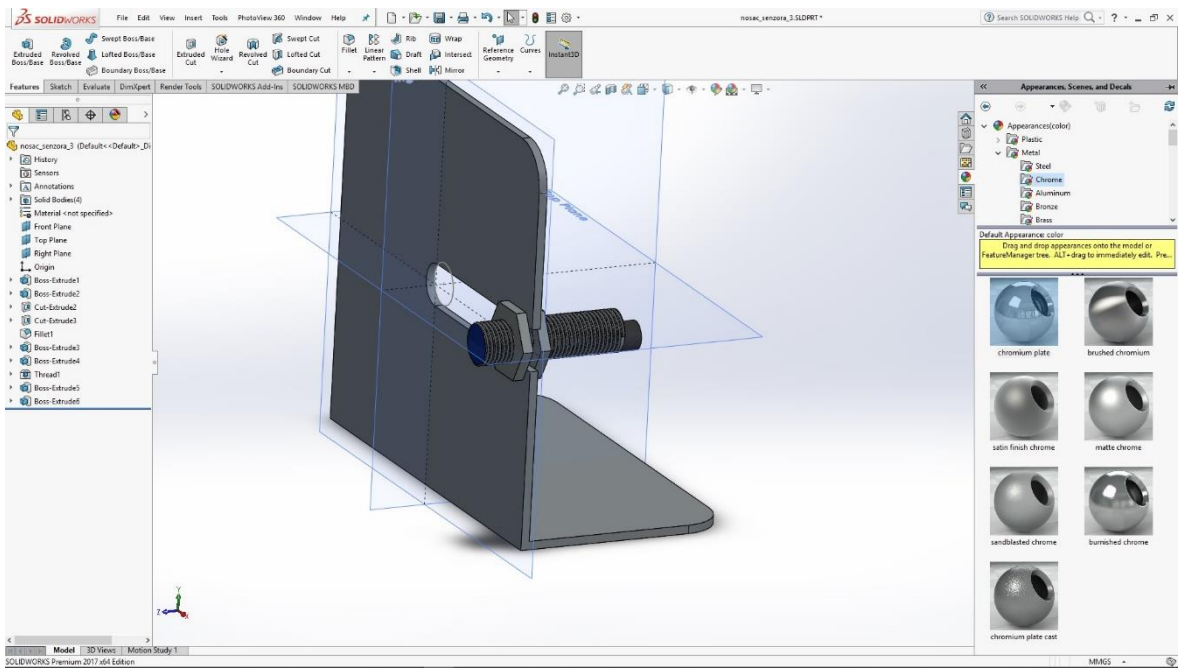


Slika 6.125: Skica šesterokuta



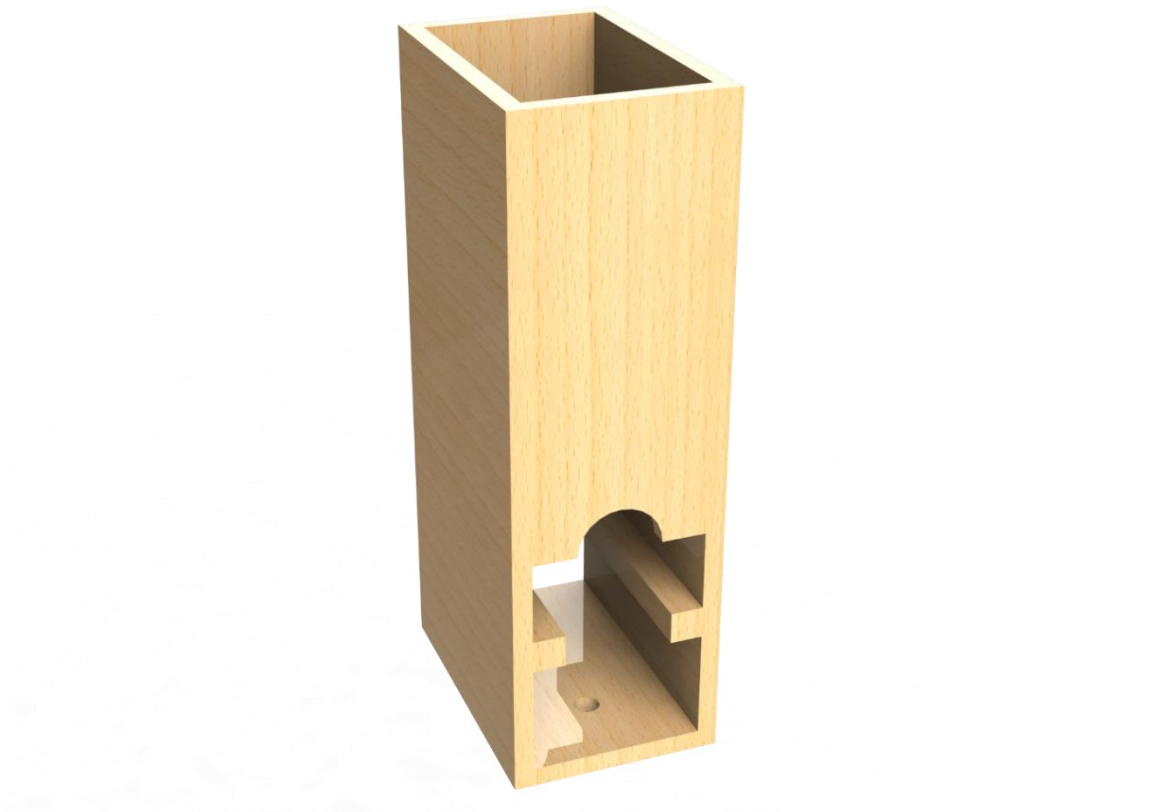
Slika 6.126: 3D model matica

Gotovom modelu nosača senzora potrebno je još odabrati materijal kako bismo mogli renderirati sliku modela.



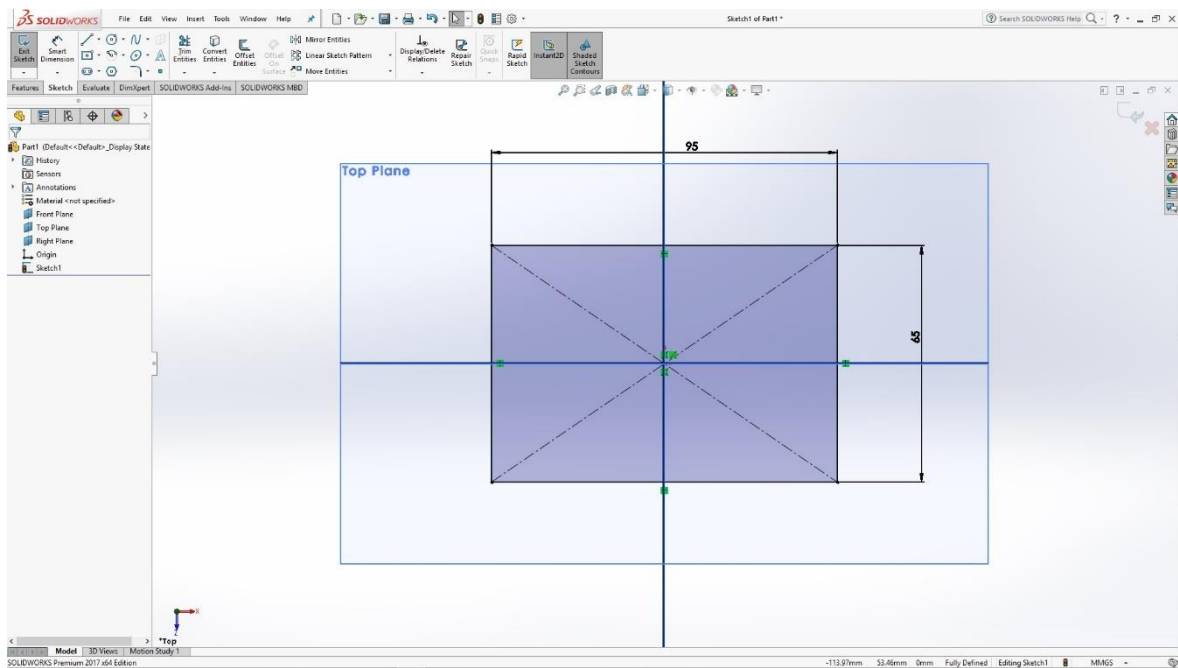
Slika 6.127: Odabir materijala za render

6.11 Spremnik materijala

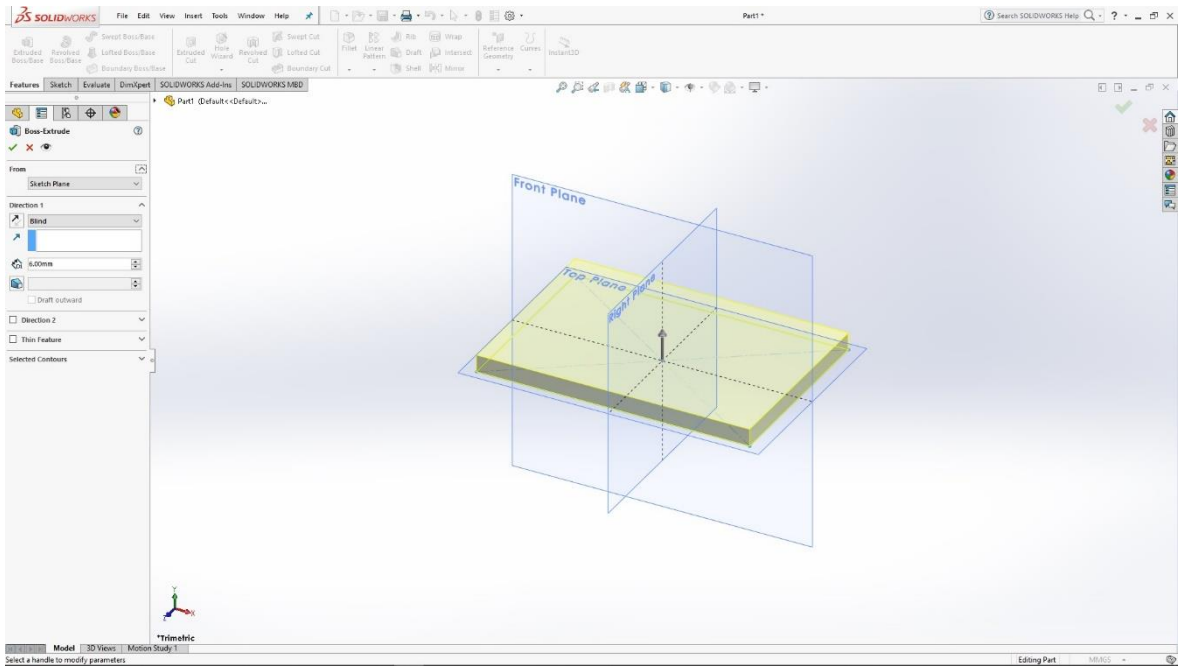


Slika 6.128: Render modela spremnika materijala

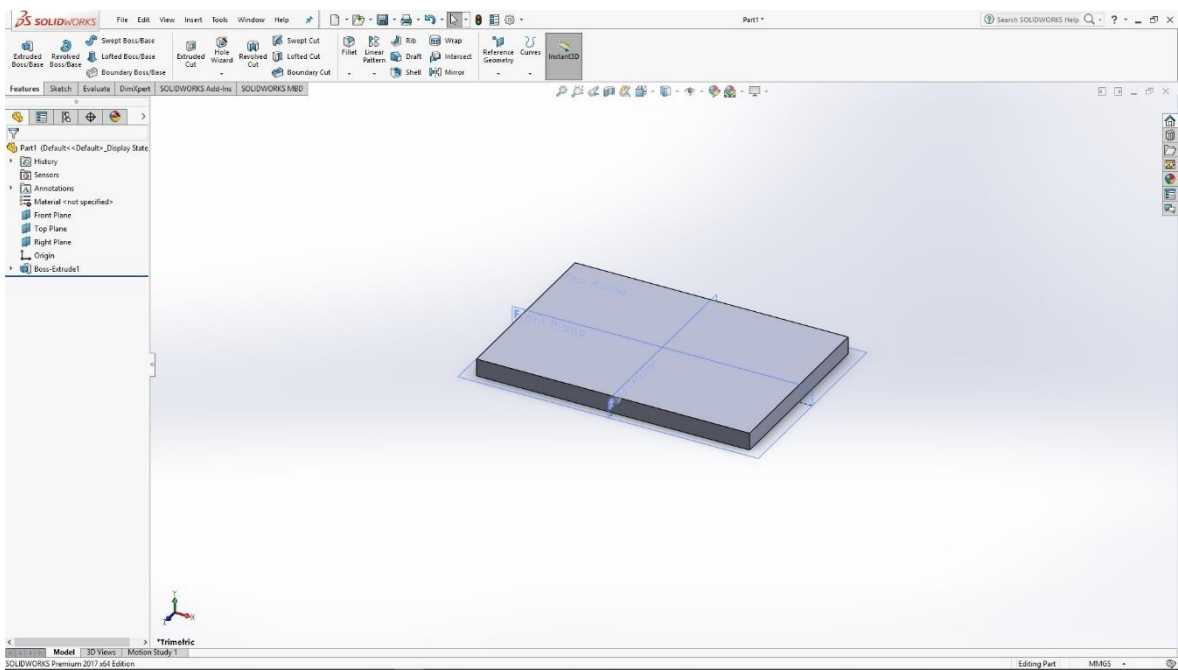
Izrada modela započinje u gornjoj ravnini skicom pravokutnika koju naredbom Extrude izvlačimo u 3D model pravokutnika.



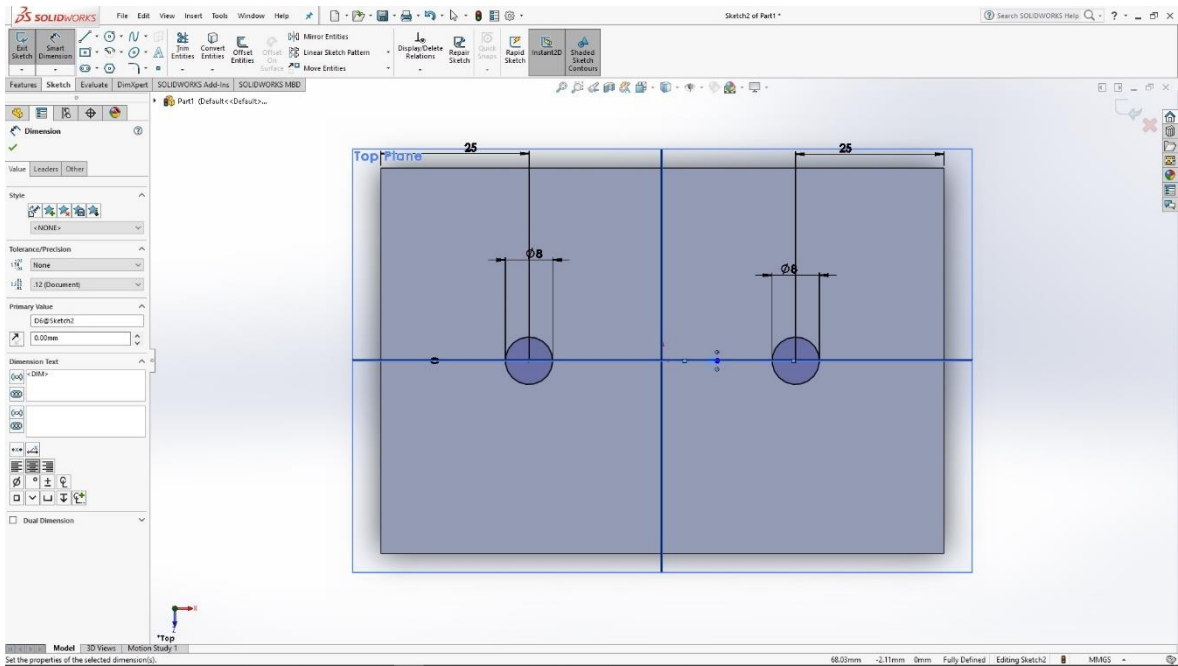
Slika 6.129: Skica pravokutnika



Slika 6.130: Naredba Extrude

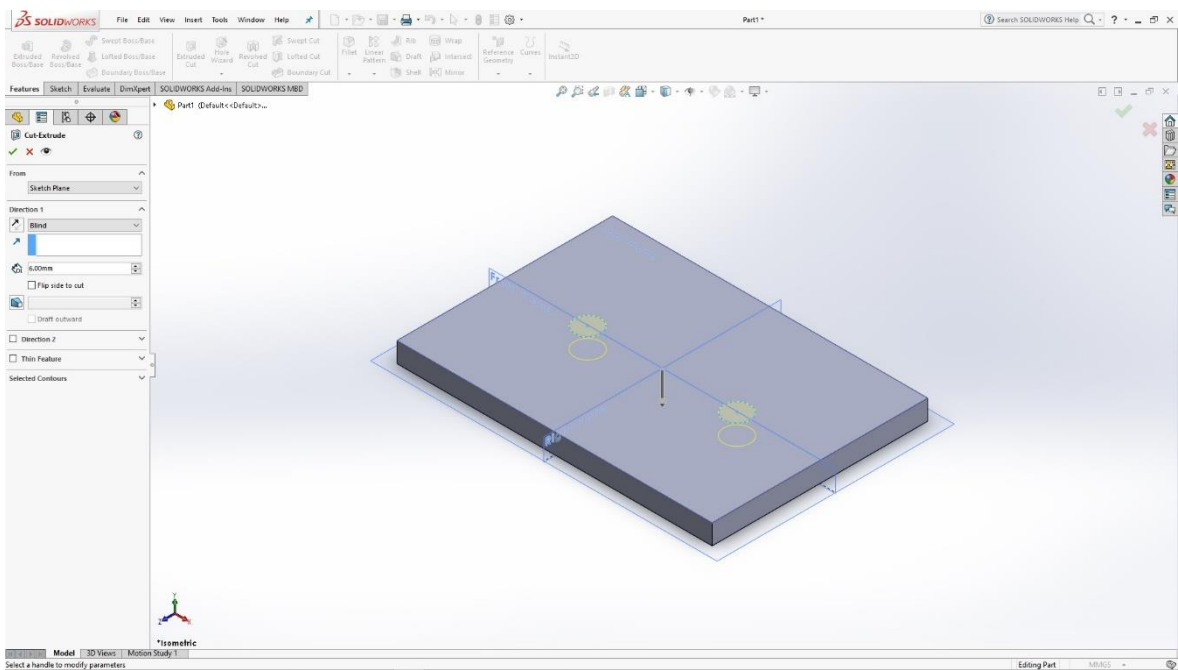


Slika 6.131: 3D model pravokutnika

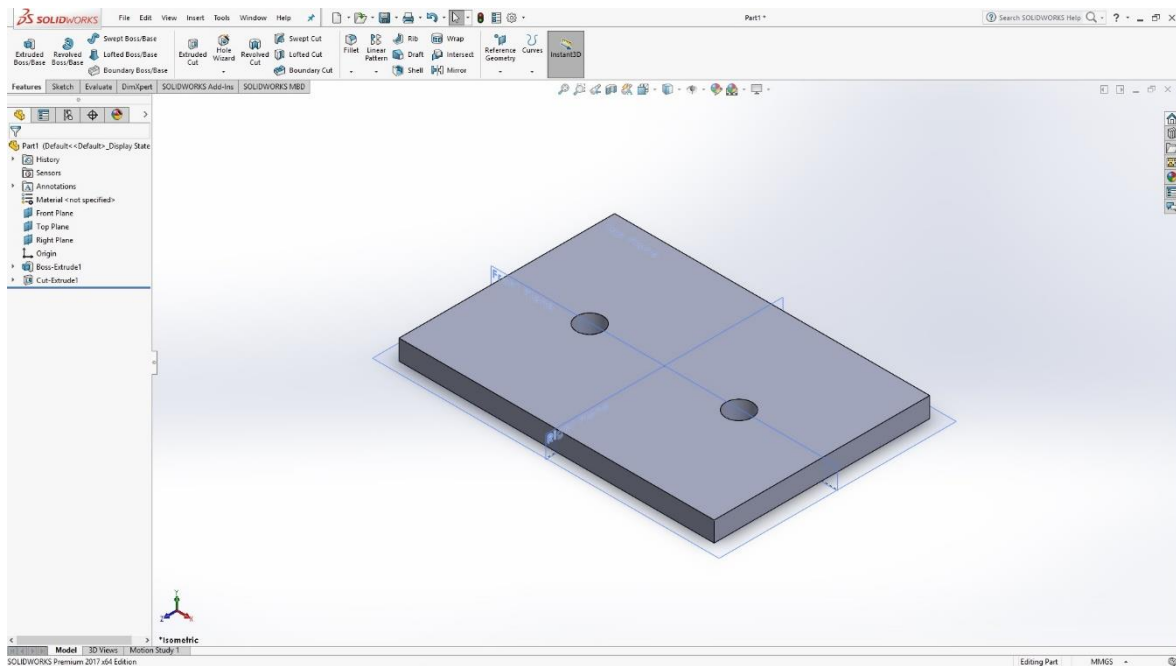


Slika 6.132: Skica kružnica

Na tom modelu skiciramo dvije kružnice koje naredbom Cut izrađujemo provrte u modelu.

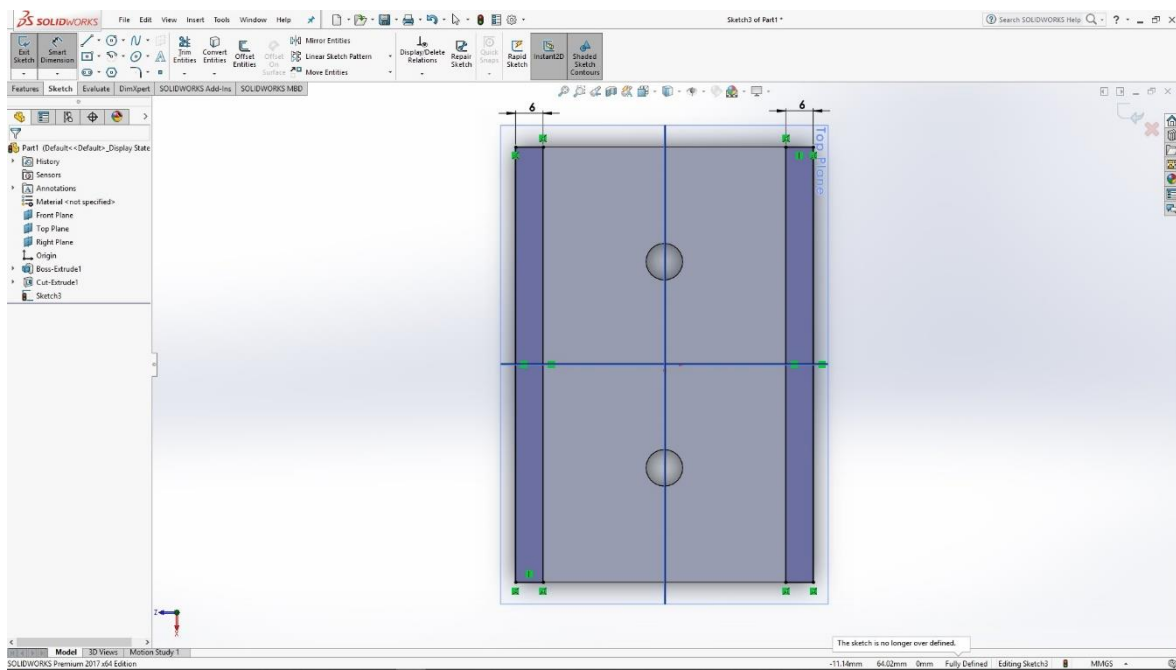


Slika 6.133: Naredba Cut

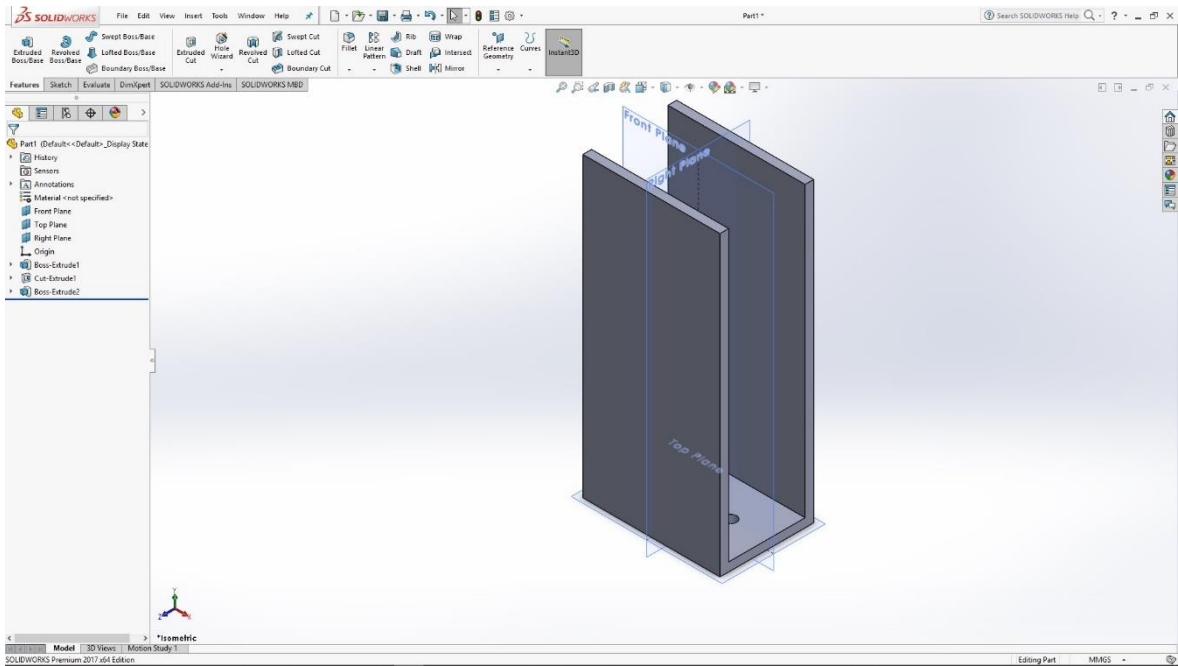


Slika 6.134: Provrt u modelu

Na stranama modela skiciramo pravokutnike koje ćemo također naredbom Extrude izvući u uspravne 3D modele pravokutnika.

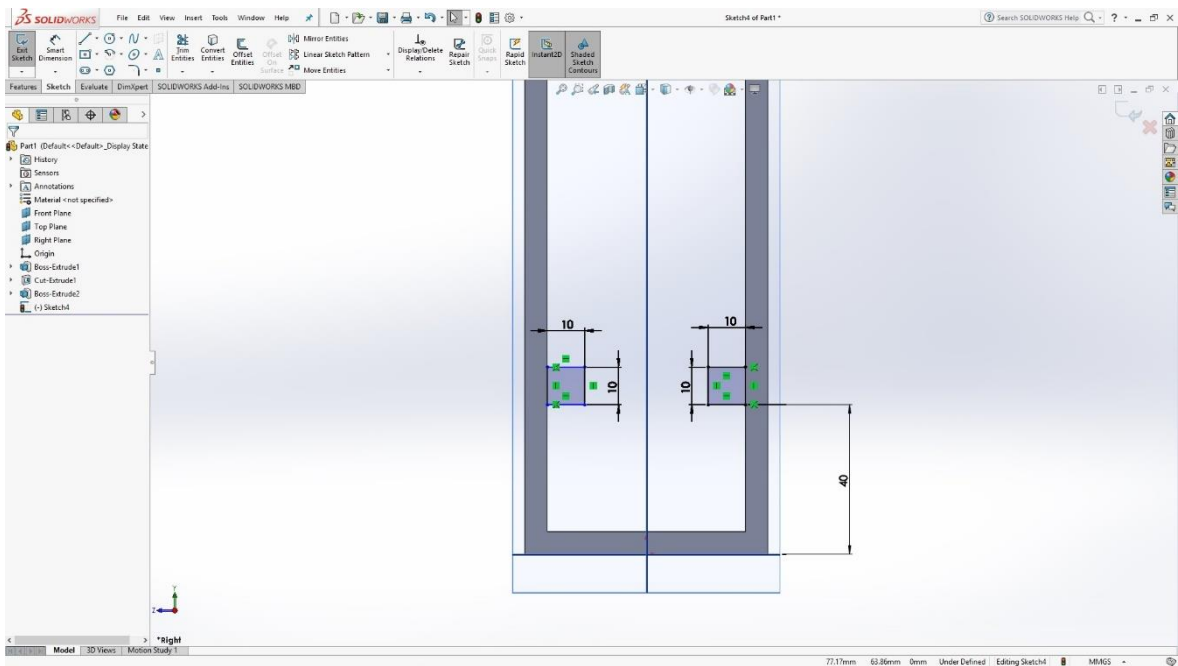


Slika 6.135: Skica pravokutnika na modelu

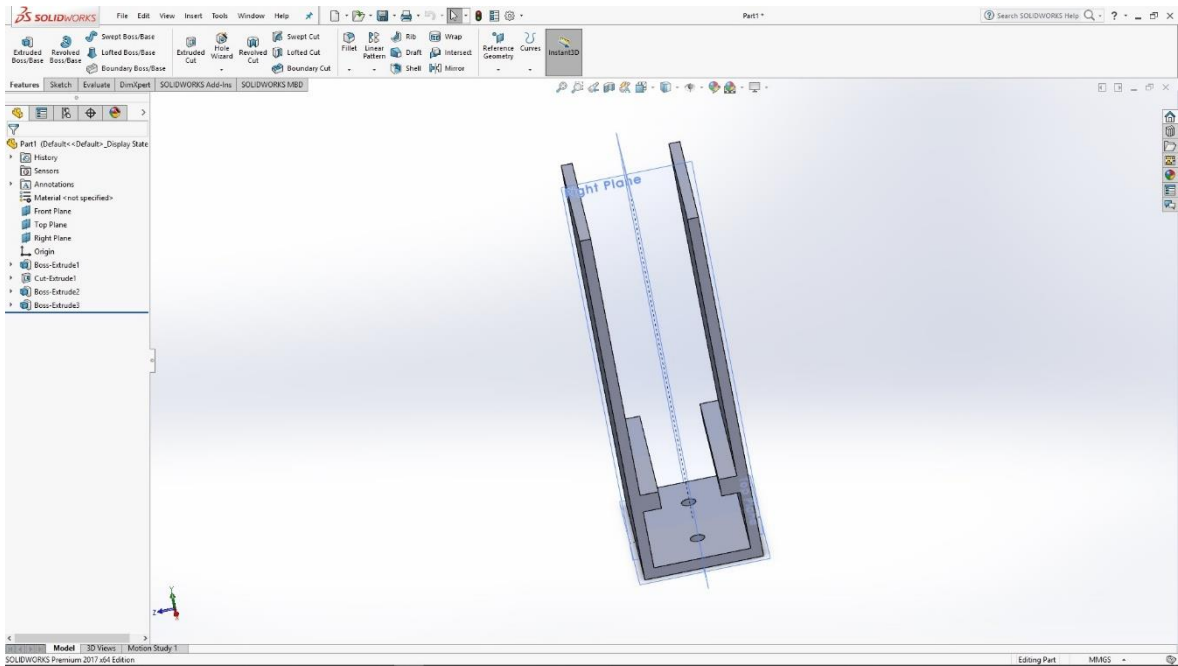


Slika 6.136: 3D model uspravnih pravokutnika

Unutar uspravnih modela pravokutnika skiciramo dvije kocke koje naredbom Extrude izvlačimo u pravokutnike i time dobijemo držače radnog materijala.

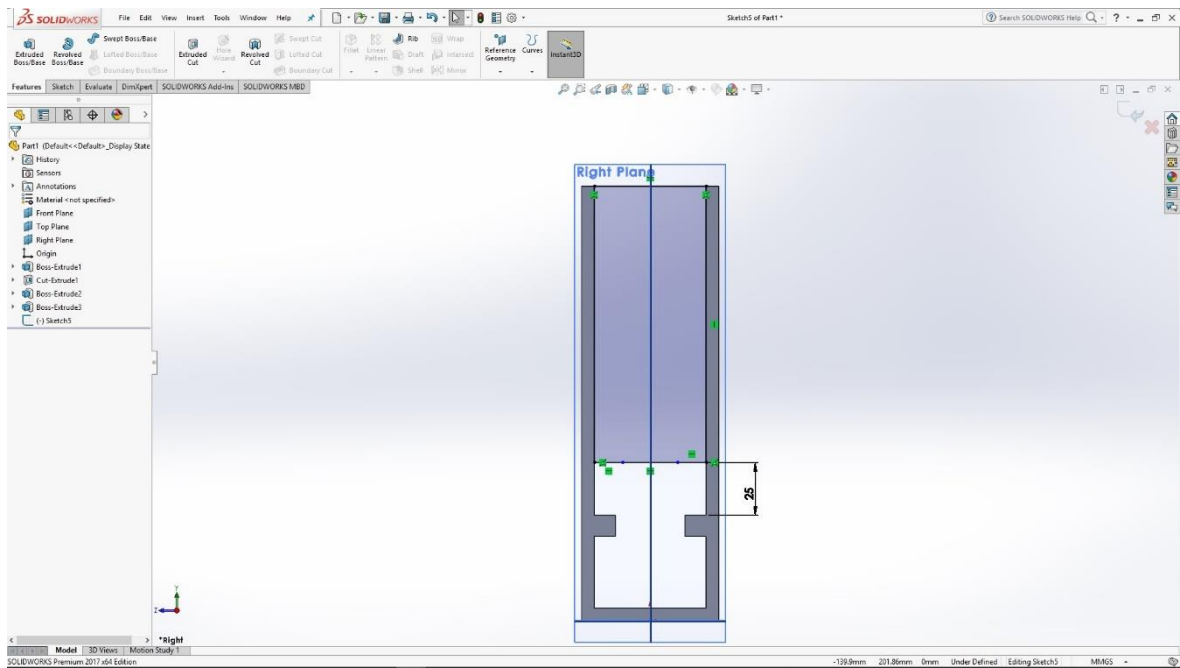


Slika 6.137: Skica kocke

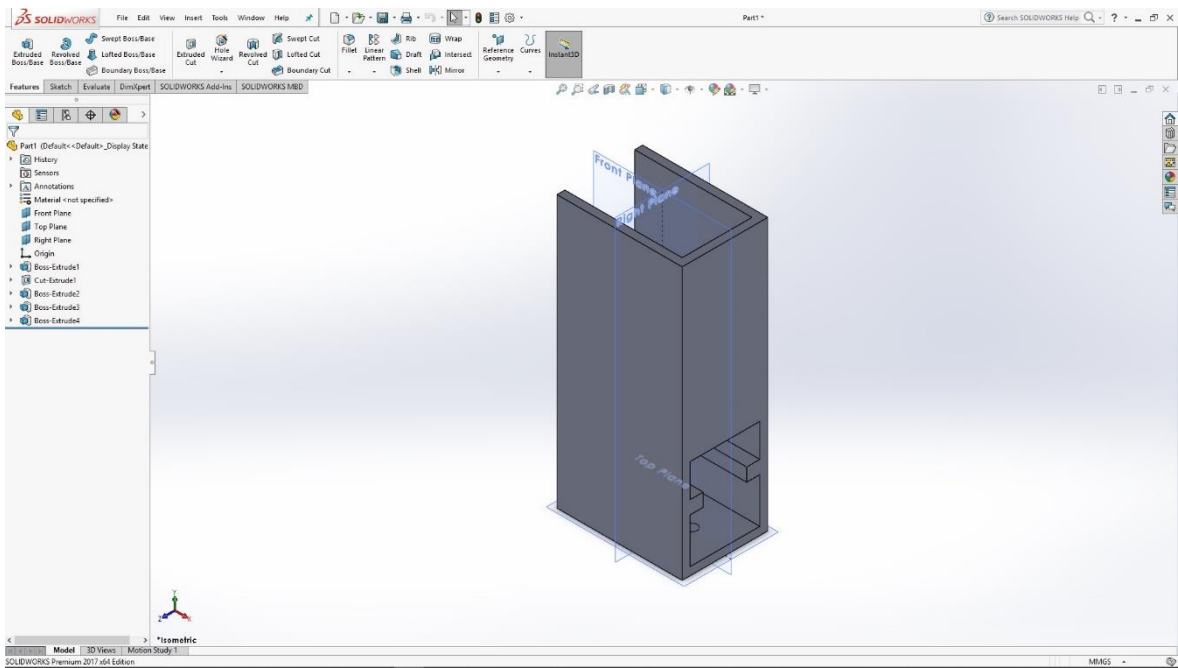


Slika 6.138: 3D model držača materijala

U prednjoj ravni s objiju strana modela skiciramo pravokutnike koje naredbom Extrude izvlačimo i time dobijemo utor kroz koji će se radni materijal dostavljati.

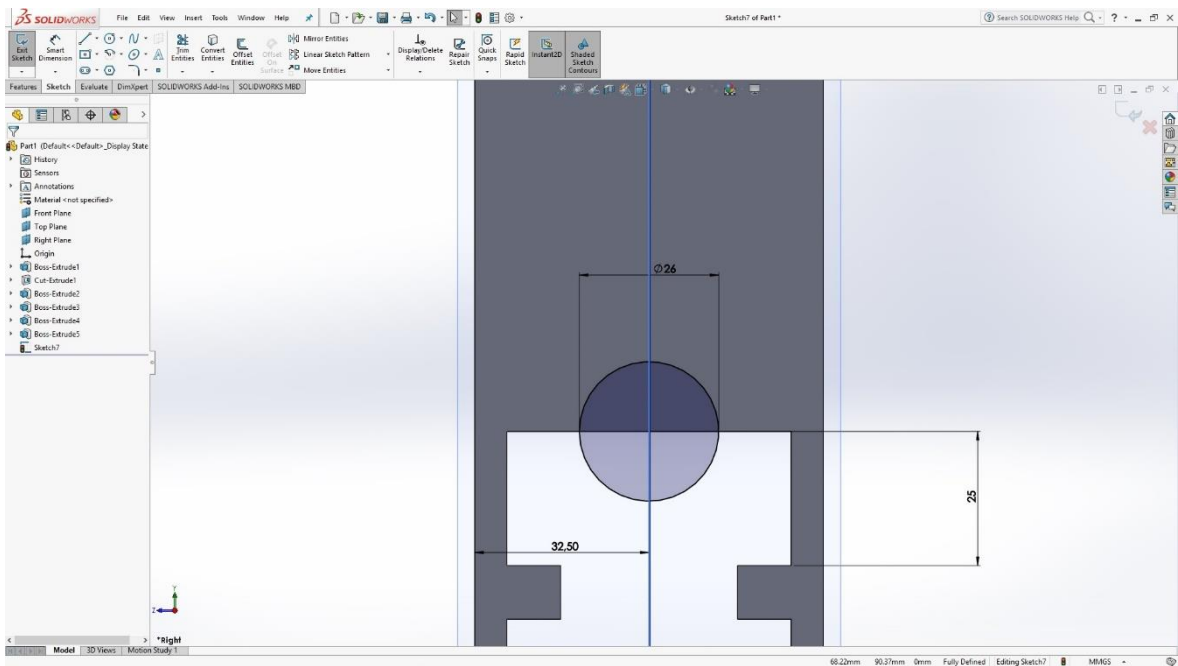


Slika 6.139: Skica pravokutnika u desnoj ravni

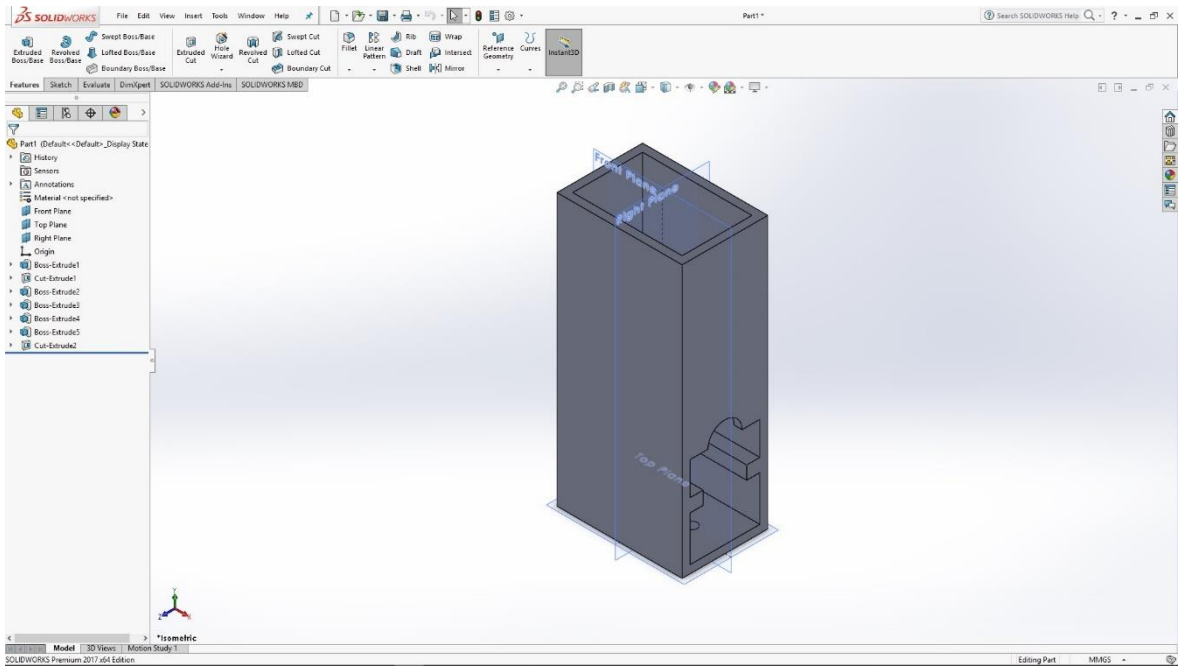


Slika 6.140: 3D model pravokutnika u desnoj ravnini

U prednjoj ravnini skiciramo kružnicu s kojom pomoću naredbe Cut izrađujemo provrt kroz cijeli model.

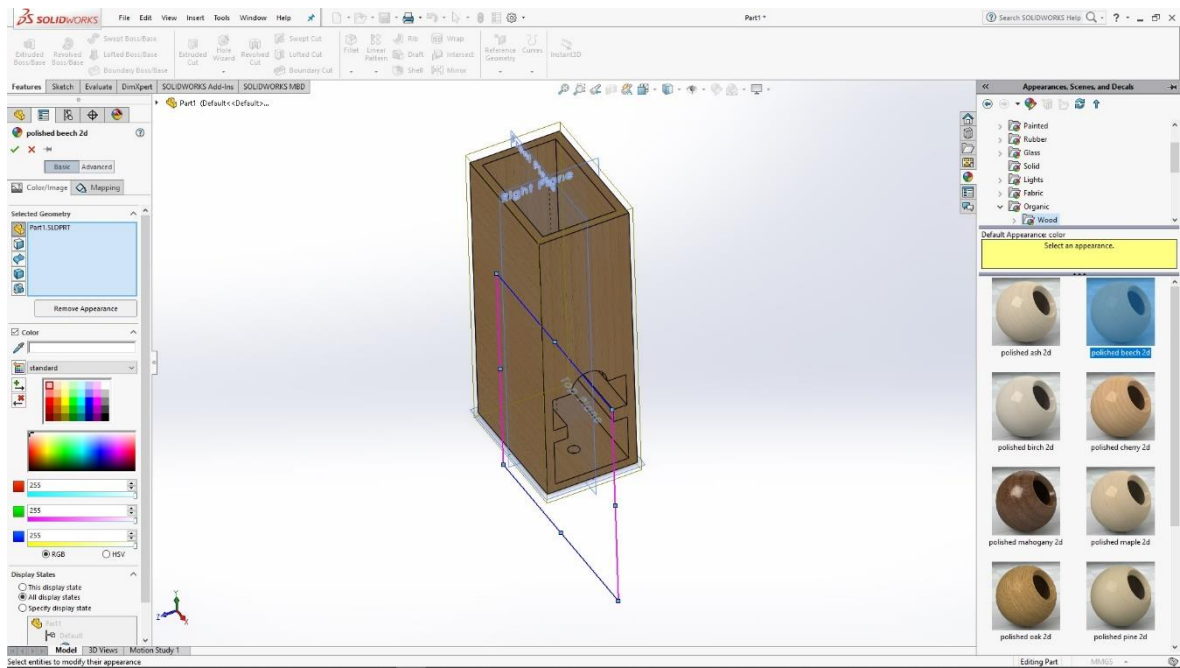


Slika 6.141: Skica kružnice u desnoj ravnini



Slika 6.142: 3D model spremnika materijala

Gotovom modelu spremnika materijala potrebno je još odabrati materijal kako bismo mogli renderirati sliku modela.



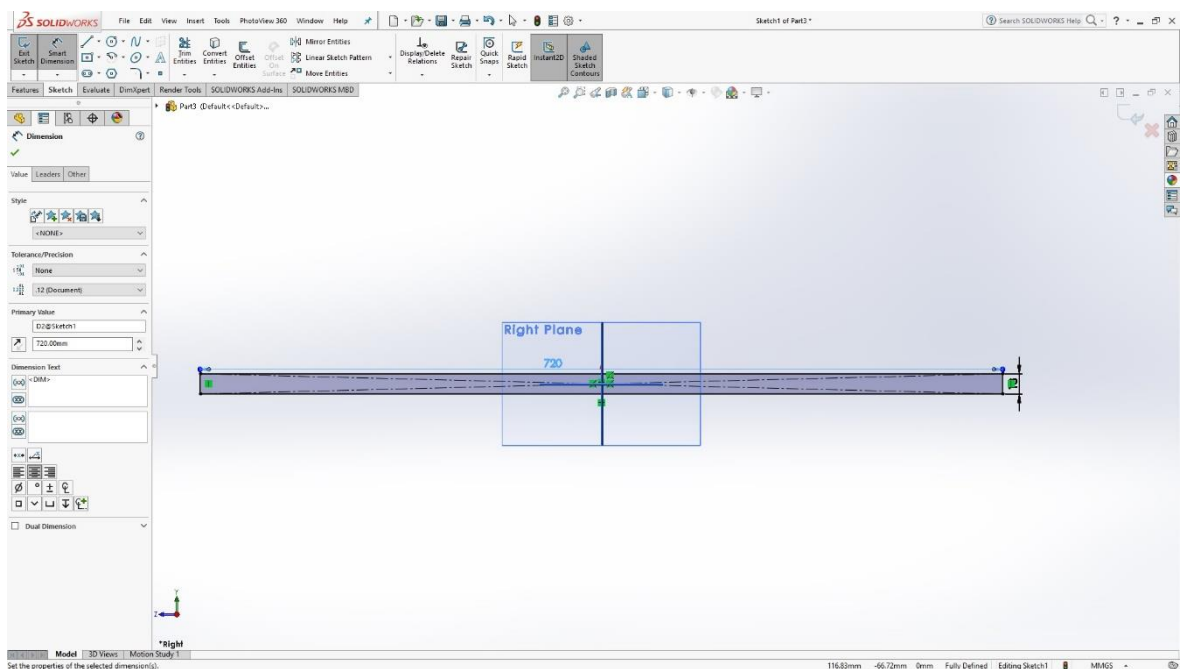
Slika 6.143: Odabir materijala za render

6.12 Radni stol

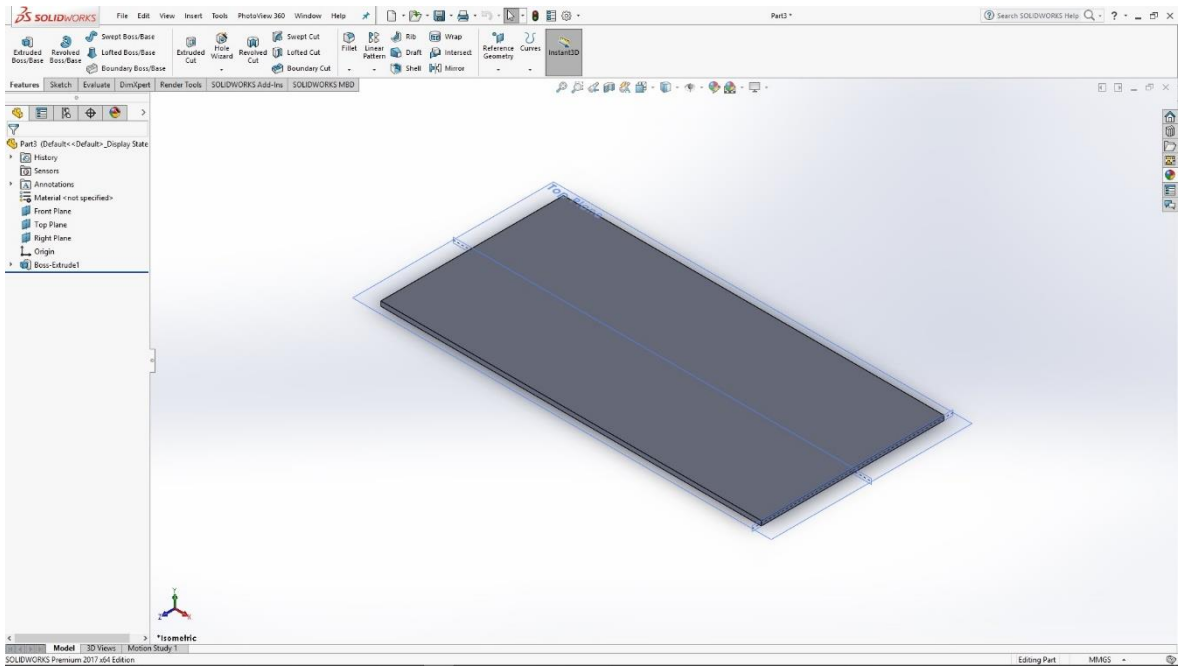


Slika 6.144: Render Radnog stola

Izrada modela radnog stola započinje u desnoj ravni skicom pravokutnika kojeg naredbom Extrude izvlačimo u 3D model pravokutnika.

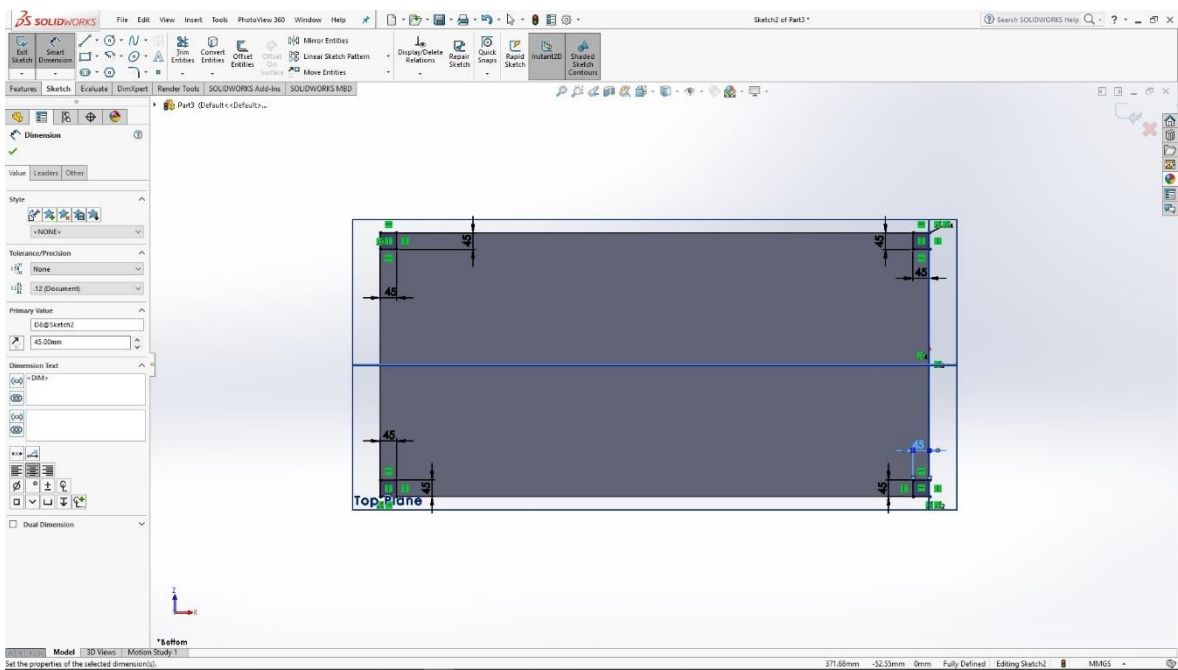


Slika 6.145: Skica pravokutnika

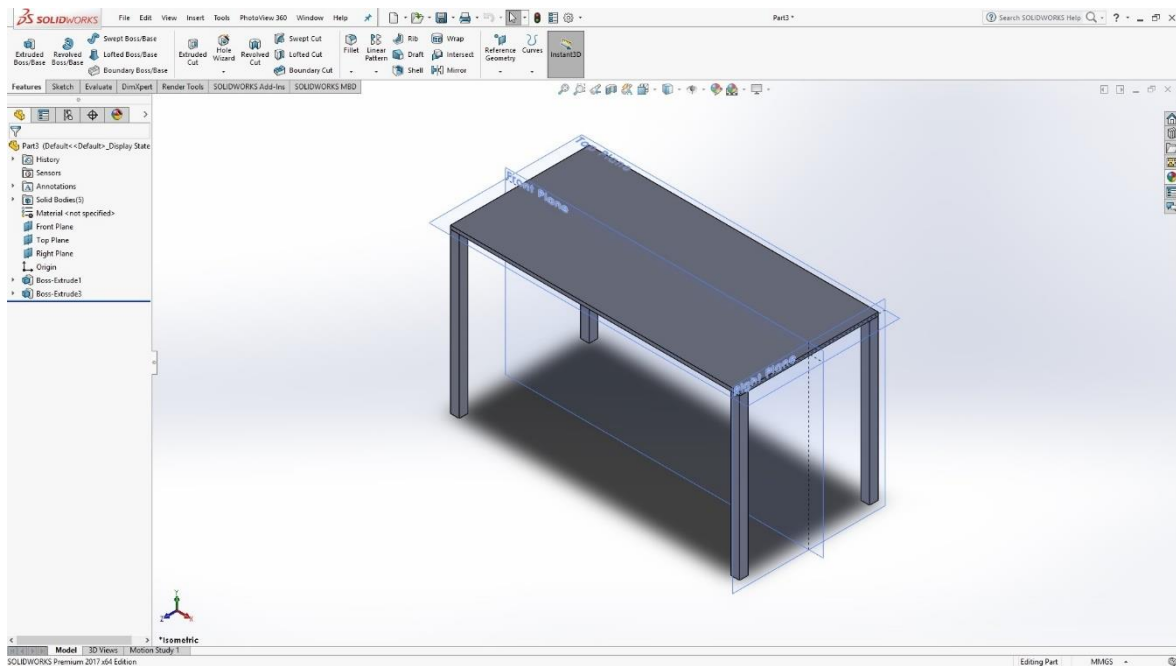


Slika 6.146: 3D model pravokutnika

Na donjoj strani modela skiciramo četiri kocke koje također naredbom Extrude izvlačimo u 3D model pravokutnika i time dobijemo noge radnog stola.

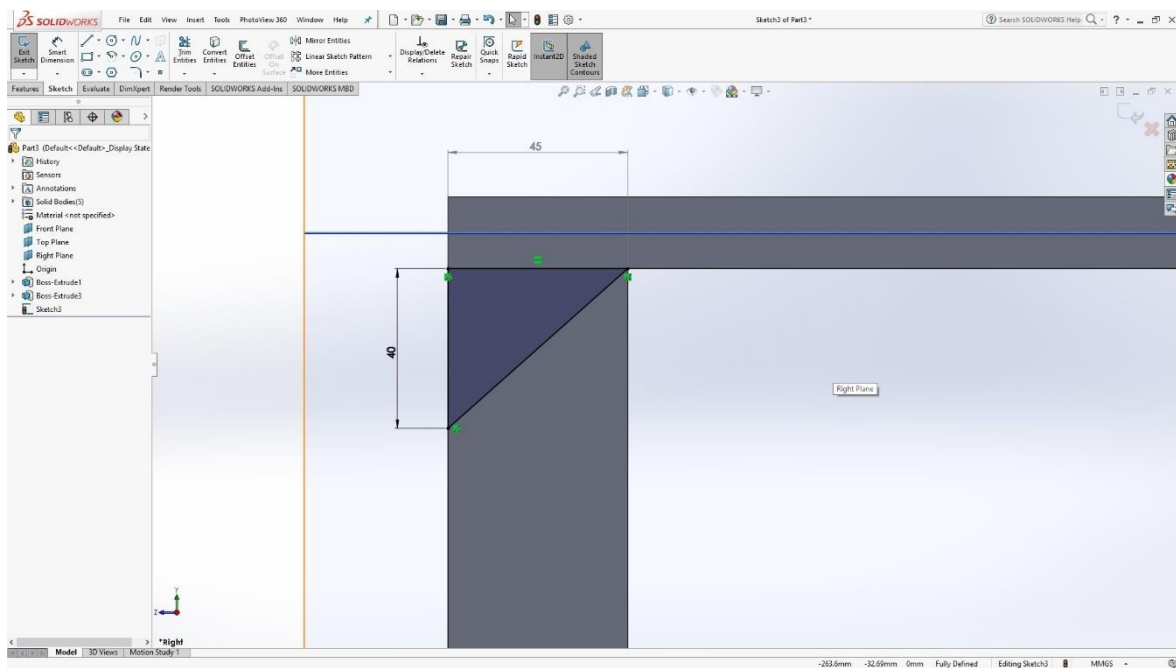


Slika 6.147: Skica kocke na dnu modela

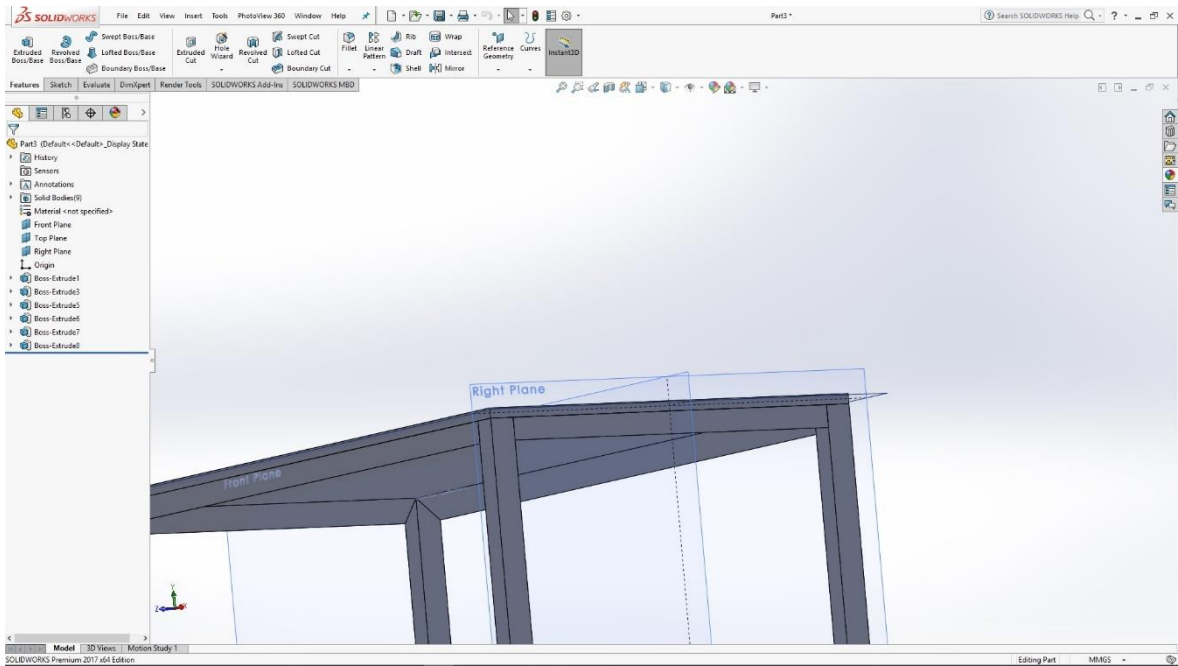


Slika 6.148: 3D modeli noga radnog stola

U desnoj i prednjoj ravni skiciram trokut koji naredbom Extrude izdužujemo između svih noga stola.

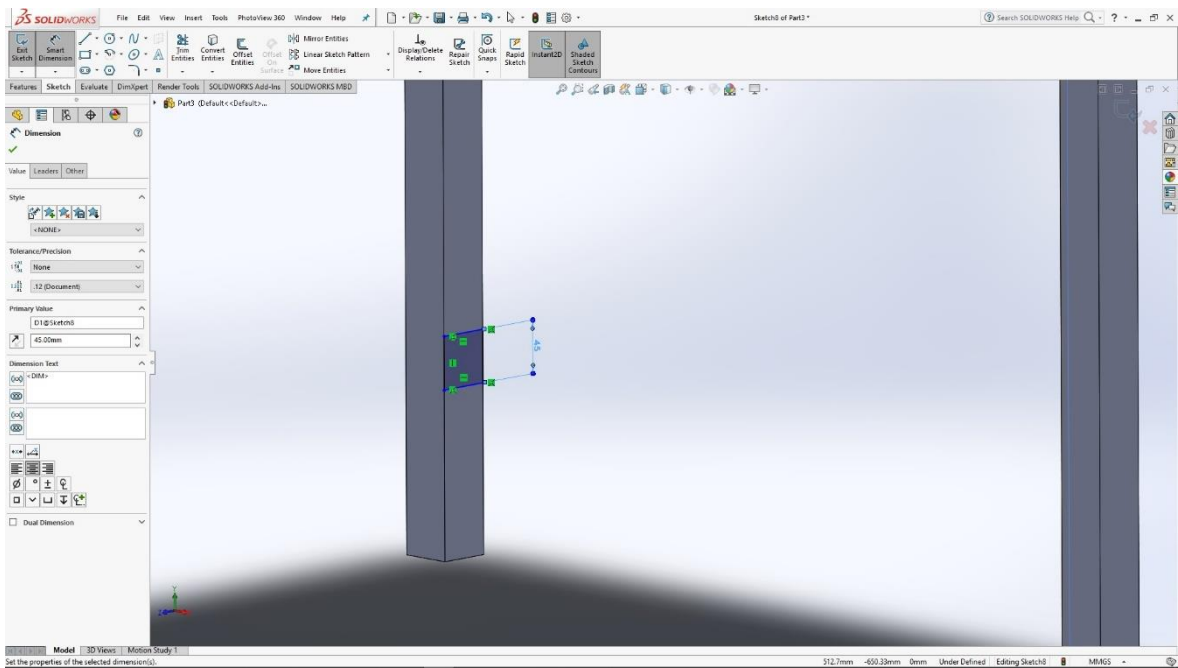


Slika 6.149: Skica trokuta

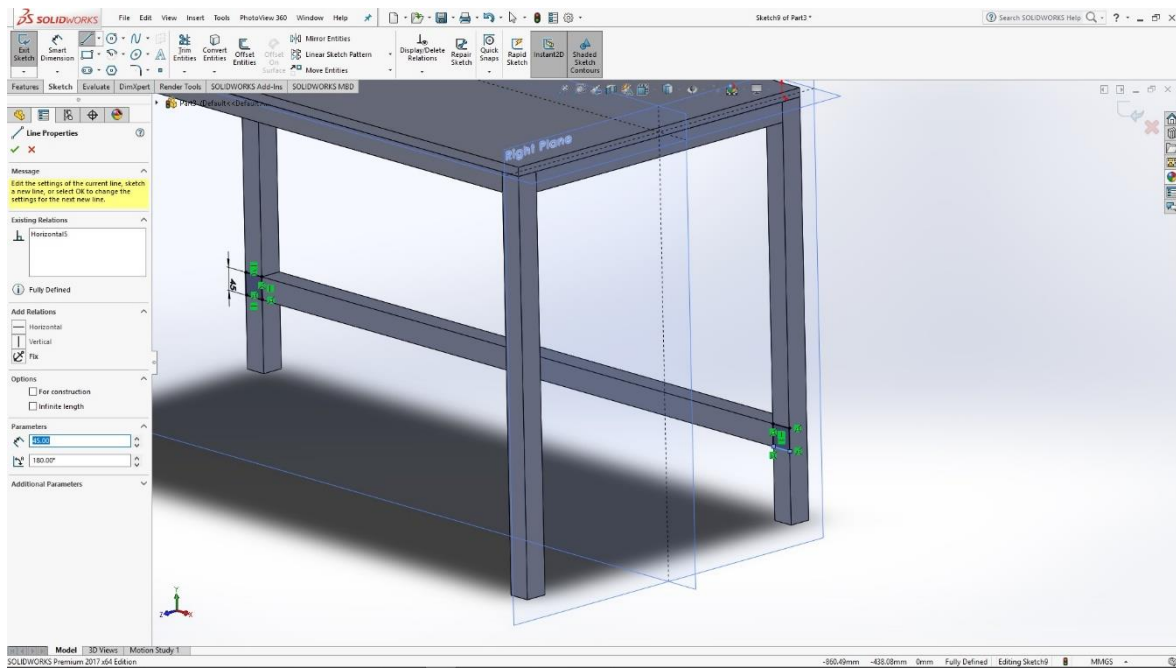


Slika 6.150: Držači stola

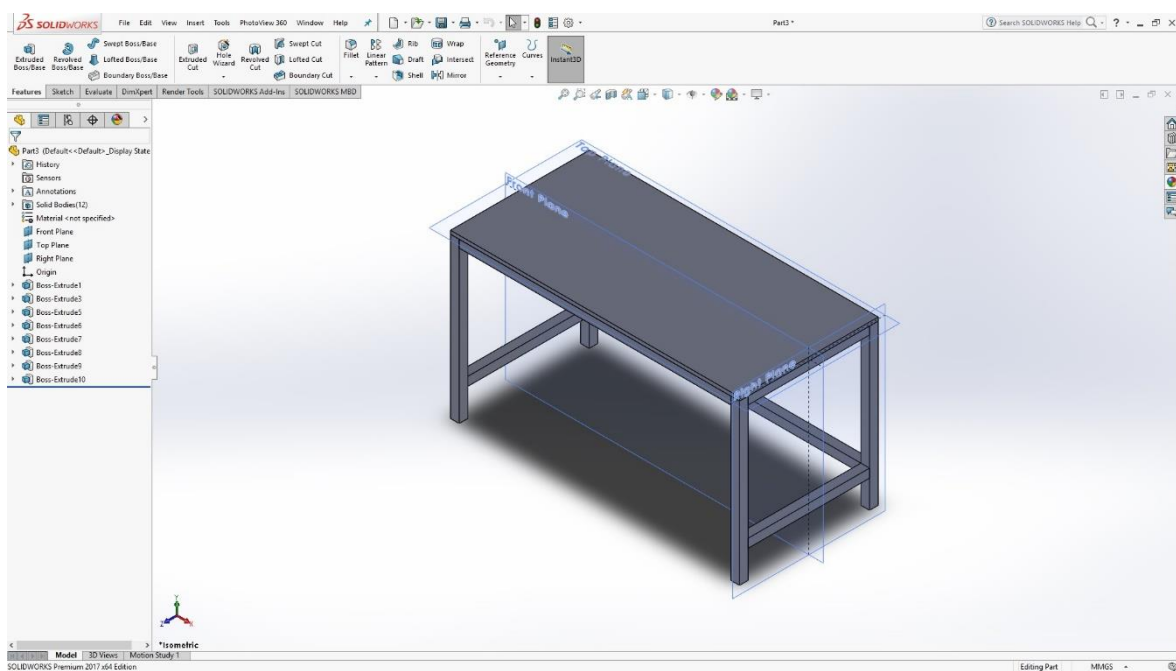
U donjem dijelu radnog stola skiciramo pravokutnike koje naredbom Extrude izvlačimo i time dobivamo držače noga.



Slika 6.151: Skica kocke

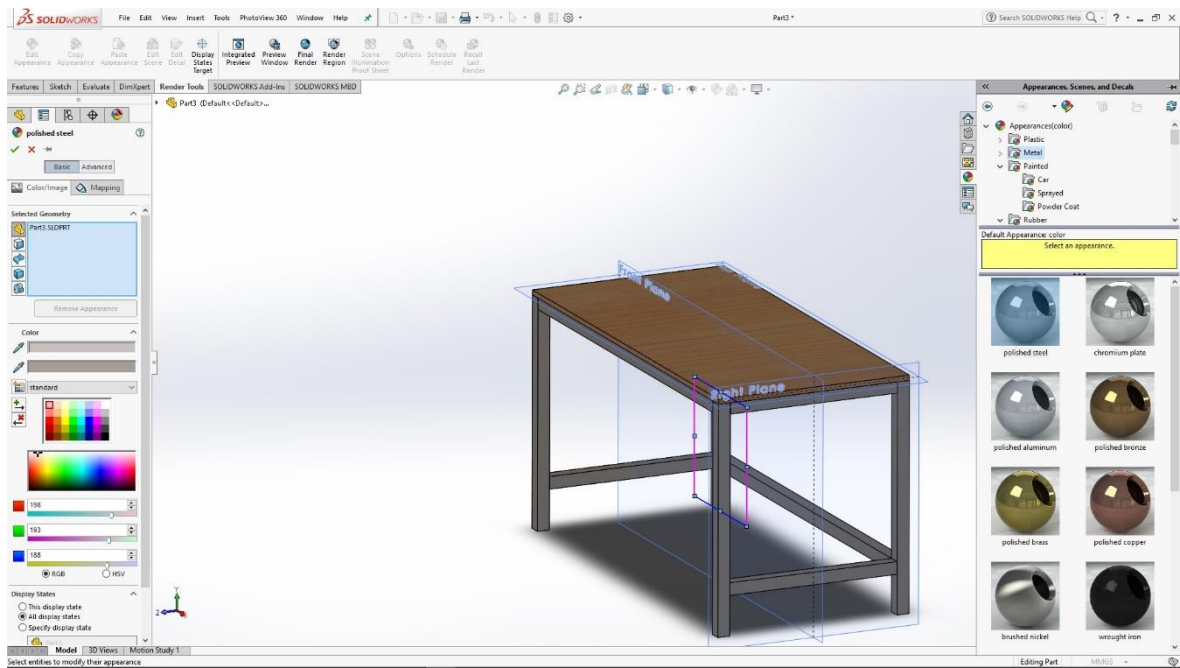


Slika 6.152: 3D model pravokutnika



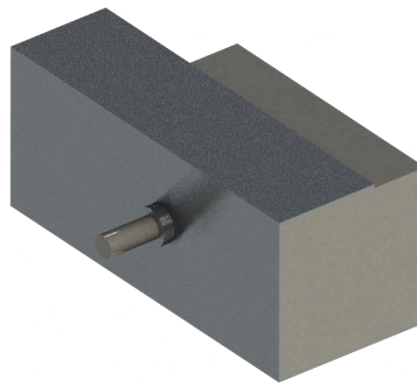
Slika 6.153: 3D model radnog stola

S gotovim modelom radnog stola potrebno je još odabrati materijal za renderiranje slike modela.

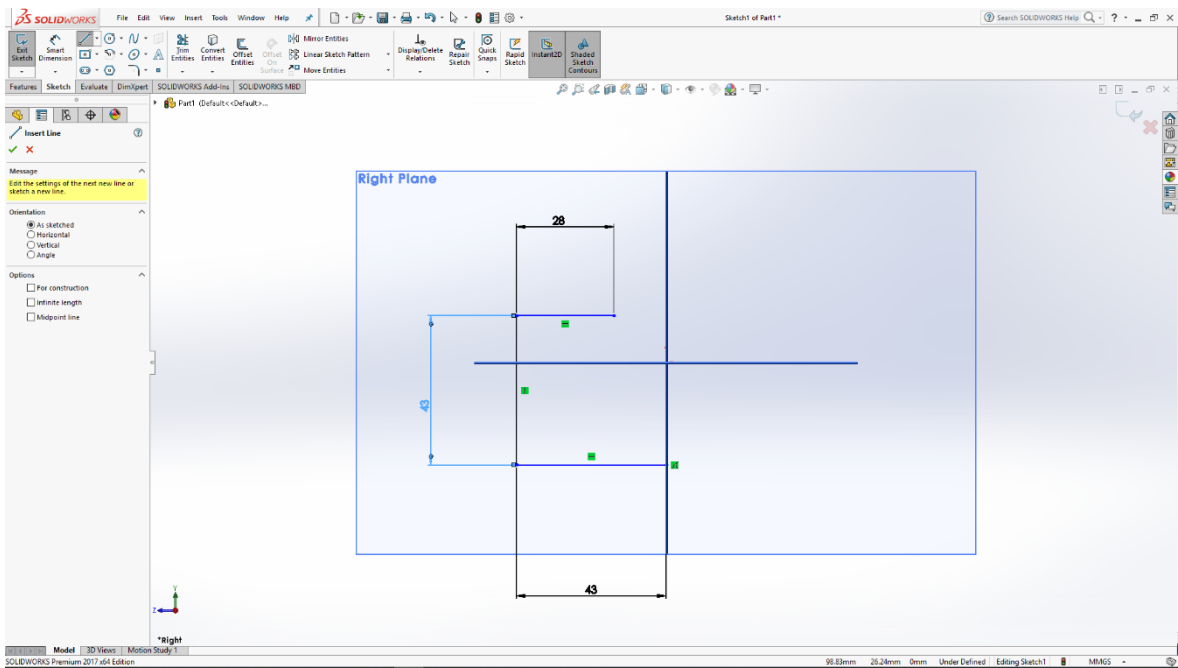


Slika 6.154: Odabir materijala za render

6.13 Motor pokretne trake

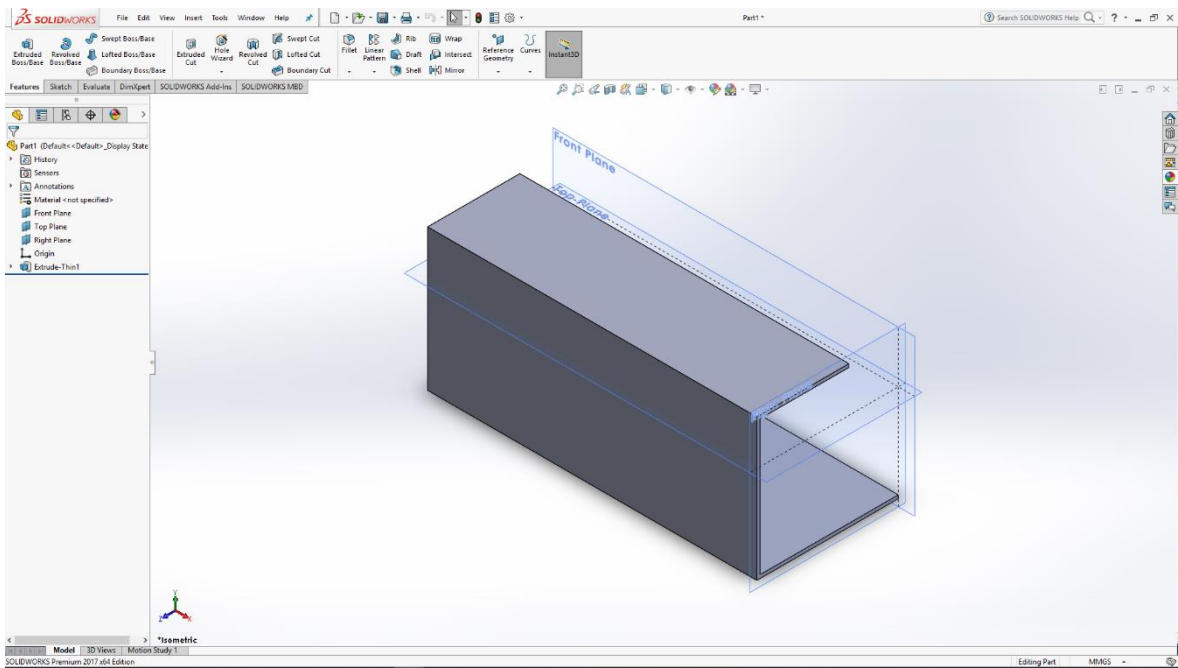


Slika 6.155: Render motora pokretne trake

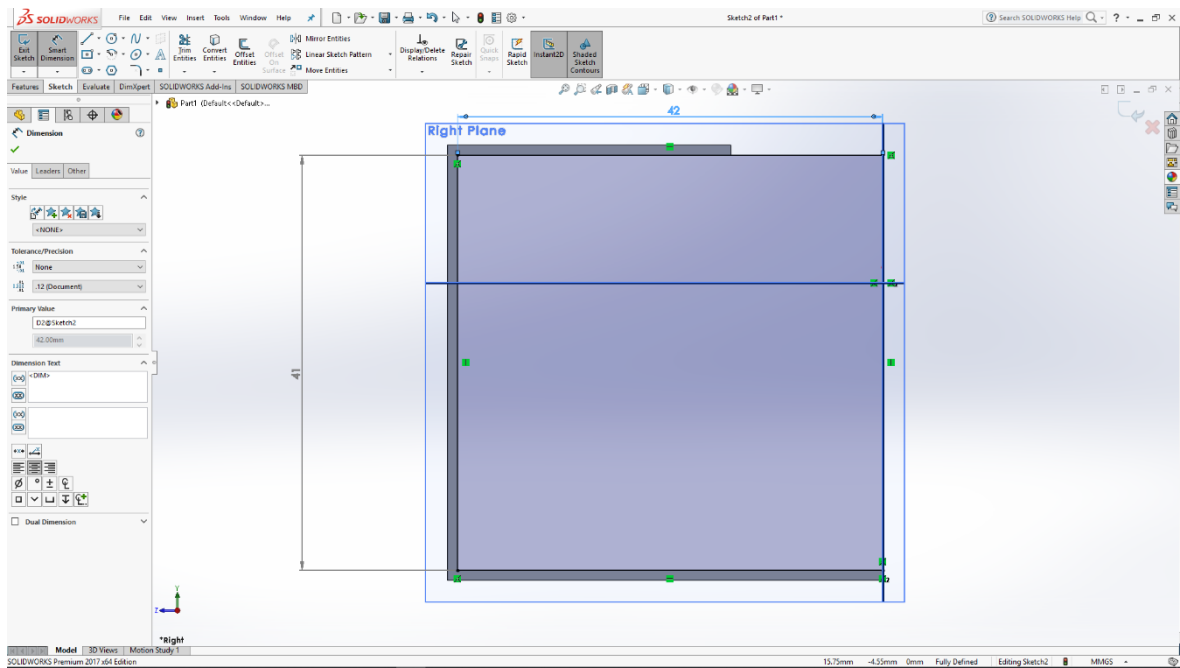


Slika 6.156: Skica u desnoj ravnini

Izrada modela započinje u desnoj ravnini skicom koju naredbom Extrude thin izvlačimo u 3D model.

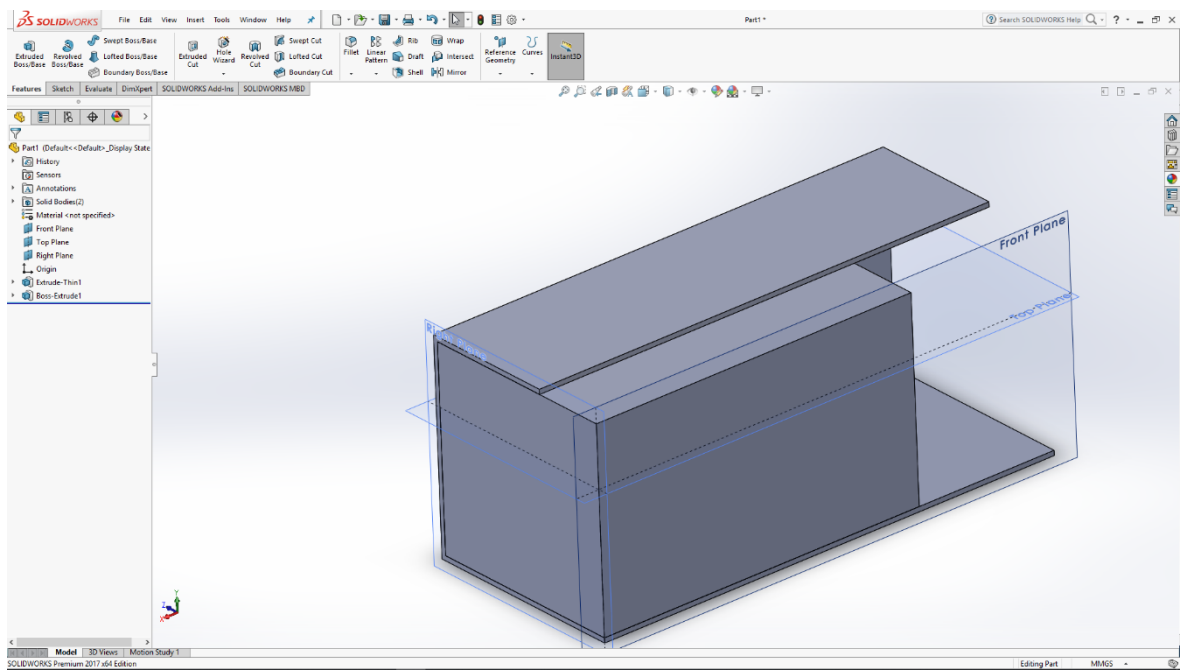


Slika 6.157: Izvučeni 3D model

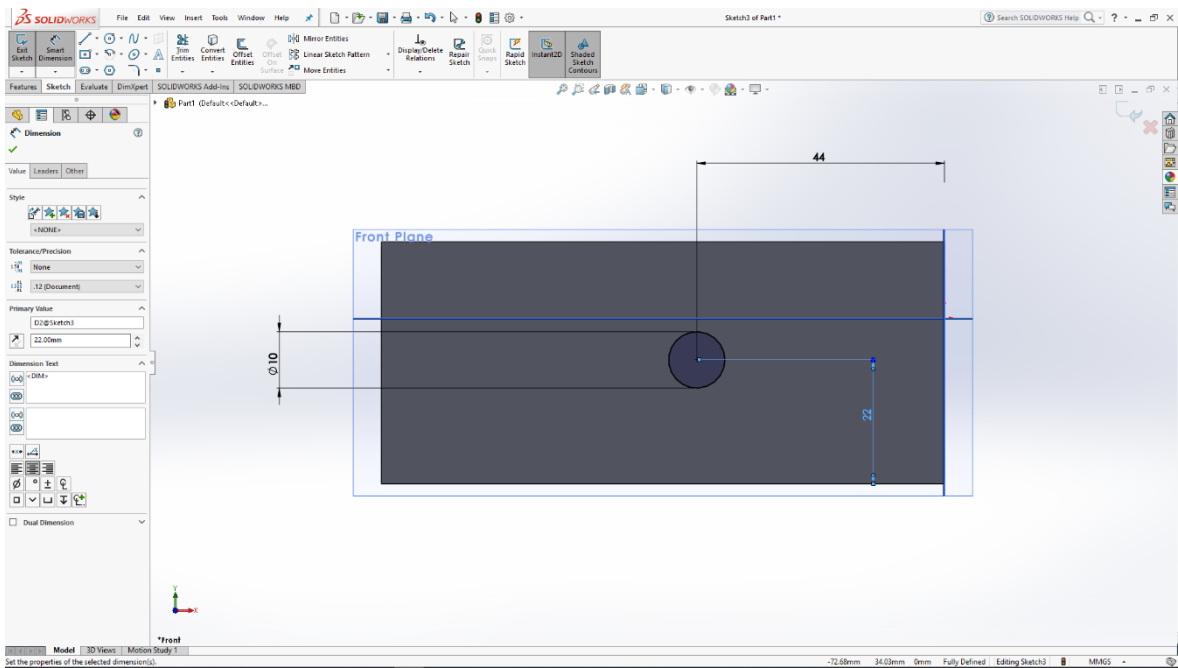


Slika 6.158: Skica kocke

U desnoj ravni skiciramo kocku koju naredbom Extrude izvlačimo u 3D model pravokutnika i time dobivamo kućište motora.

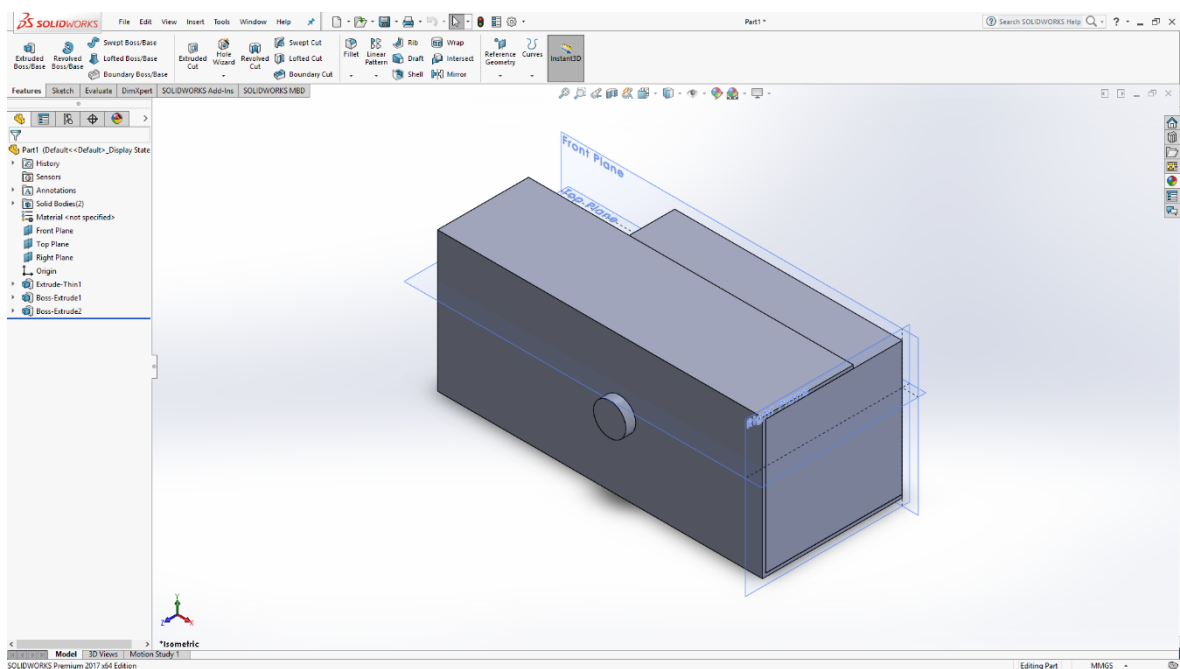


Slika 6.159: 3D model pravokutnika

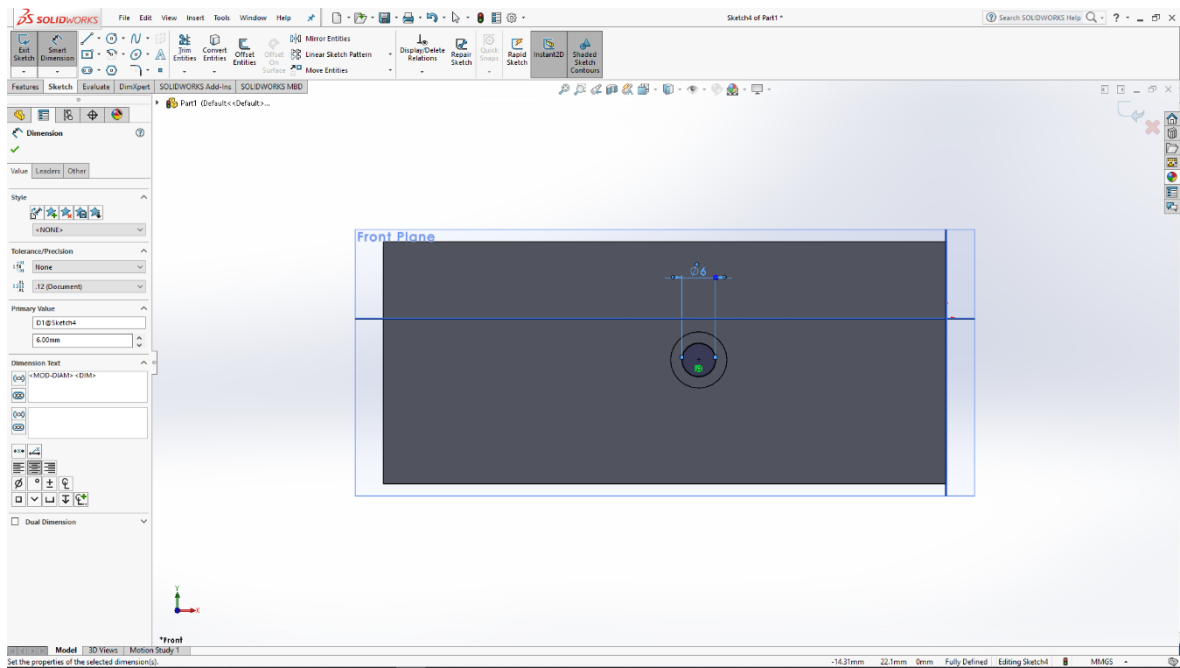


Slika 6.160: Skica kružnice

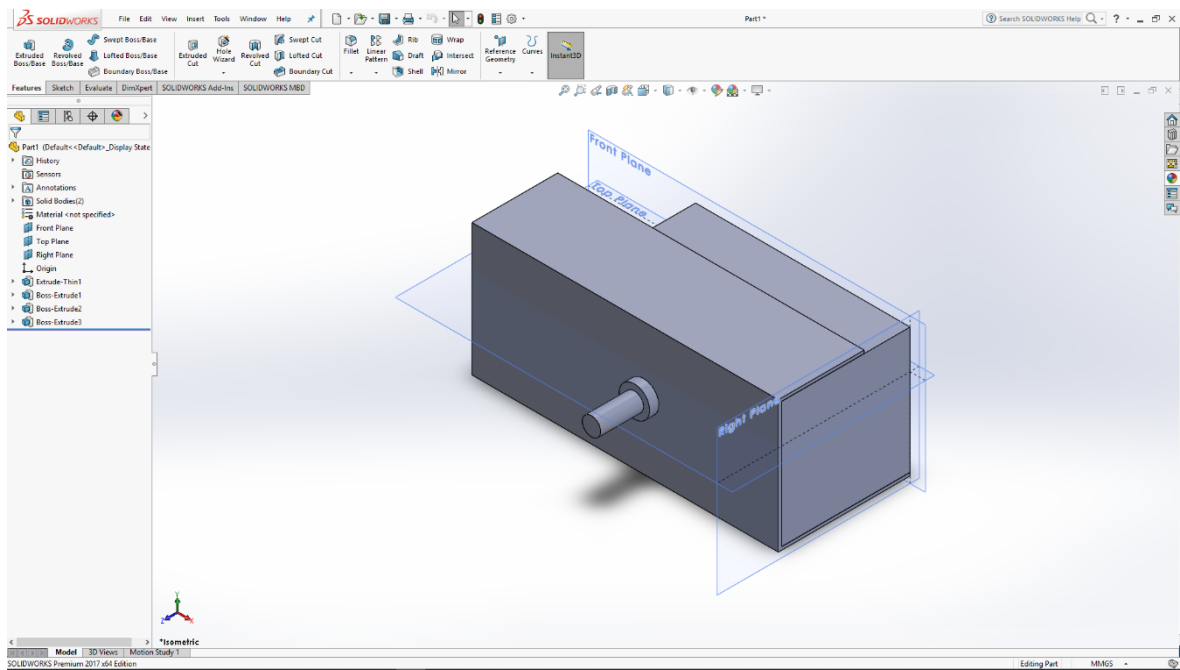
Na prednjoj strani modela skiciramo kružnicu koju naredbom Extrude izvlačimo u 3D model manjeg valjka. Na površini tog valjka skiciramo još jednu manju kružnicu koju također naredbom Extrude izvlačimo u 3D model valjka.



Slika 6.161: 3D model manjeg valjka

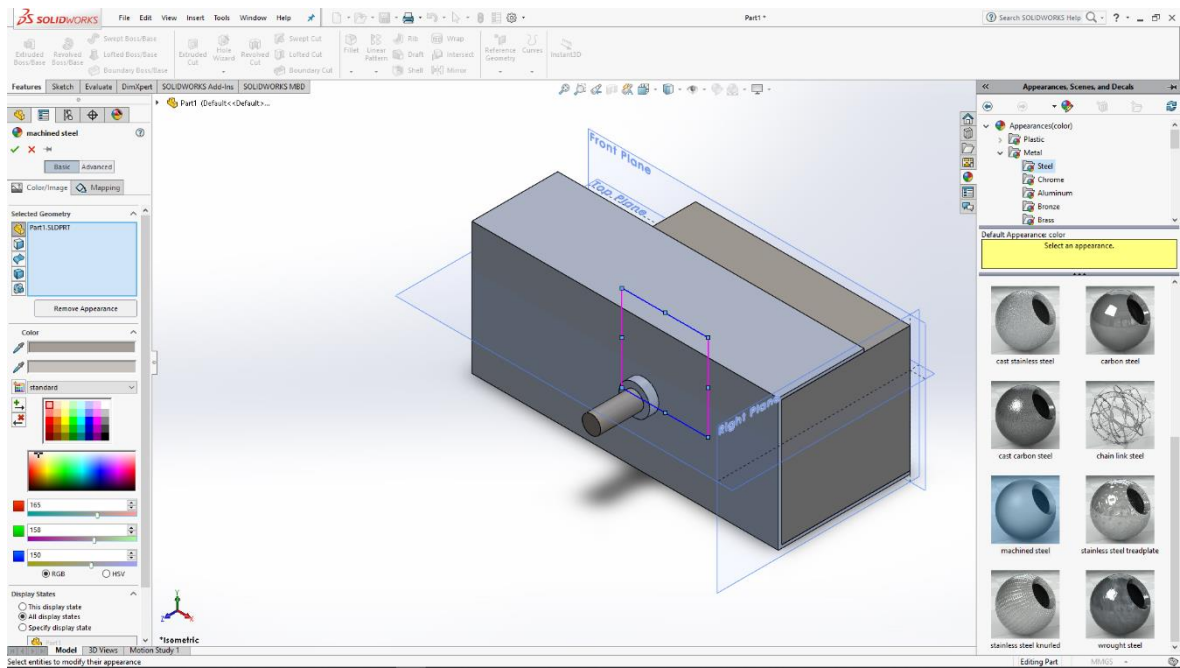


Slika 6.162: Skica kružnice



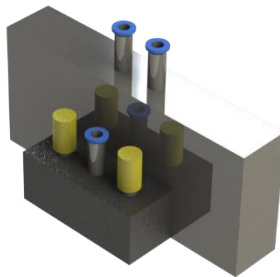
Slika 6.163: Model motora pokretne trake

S gotovim modelom motora pokretne trake potrebno je još odabrati njegov materijal za renderiranje slike modela.

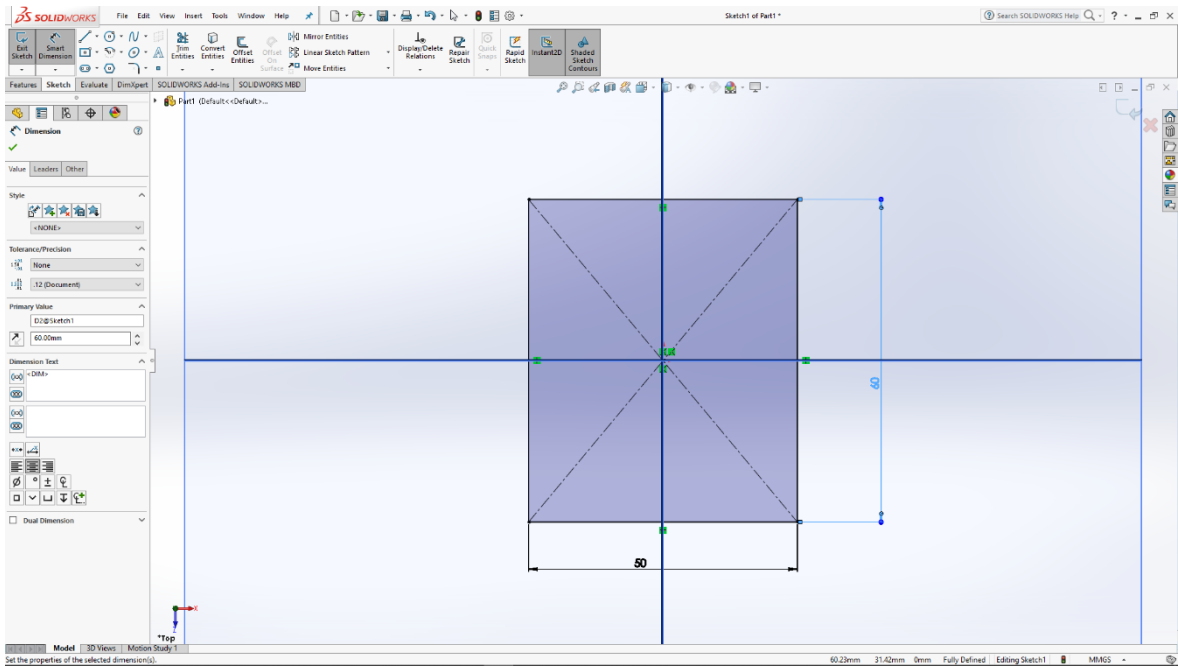


Slika 6.164: Odabir materijala za render

6.14 Pneumatski razvodnik

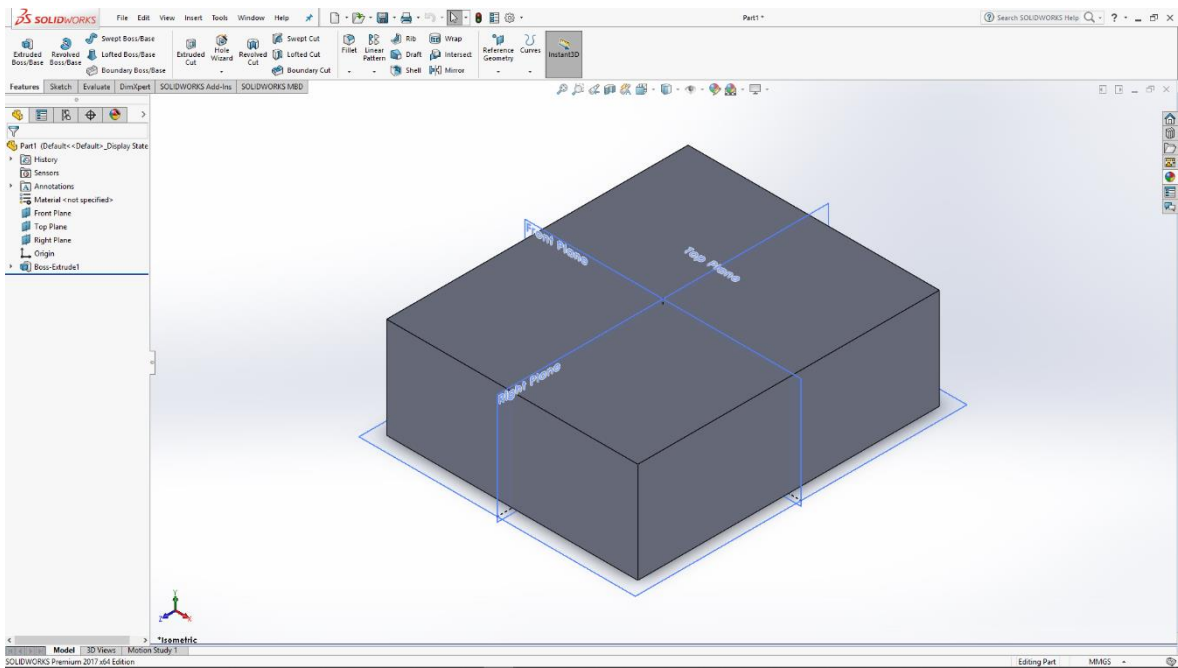


Slika 6.165: Render pneumatskog razvodnika

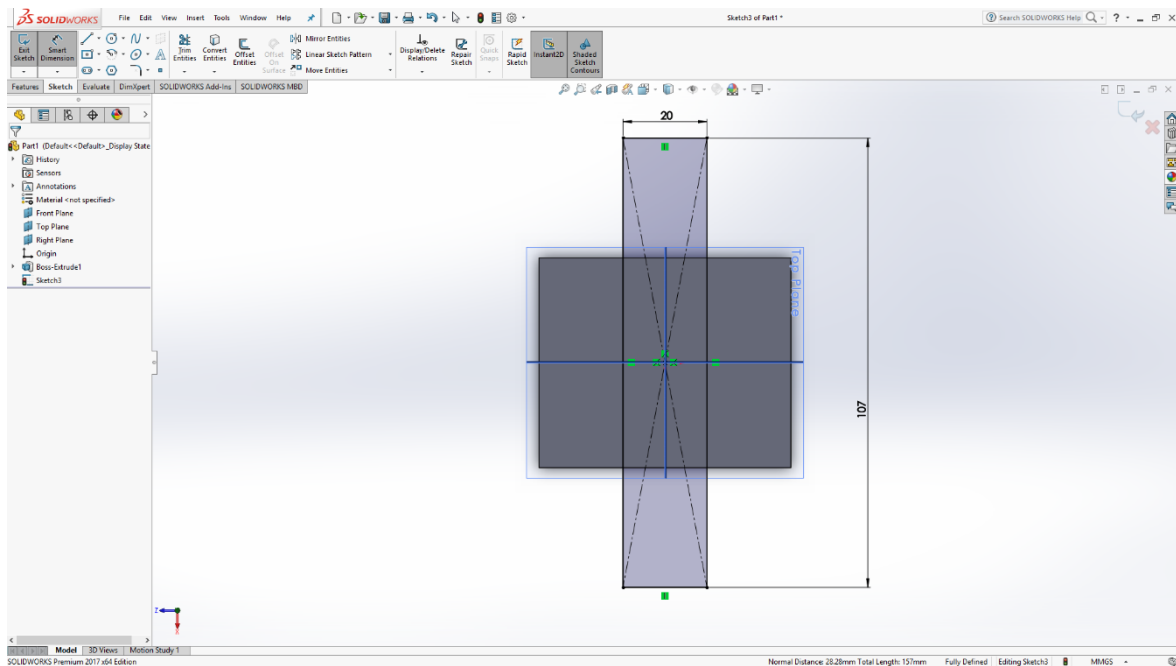


Slika 6.166: Skica pravokutnika

U prednjoj ravni skiciramo pravokutnik koji naredbom Extrude izvlačimo u 3D model pravokutnika.

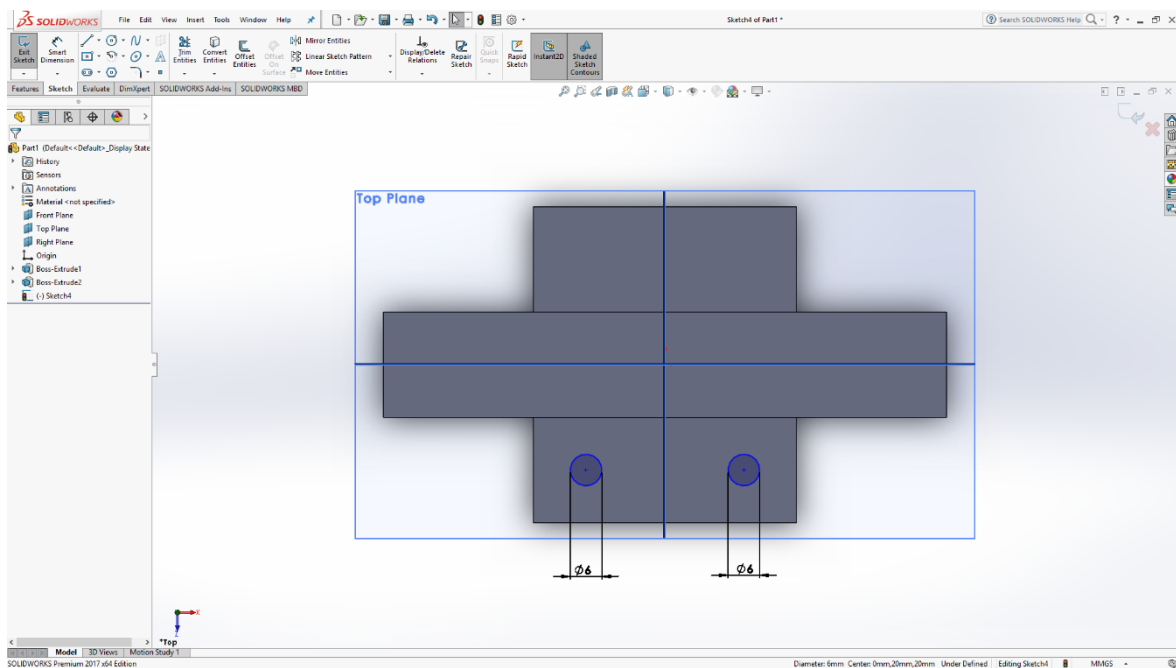


Slika 6.167: 3D model pravokutnika



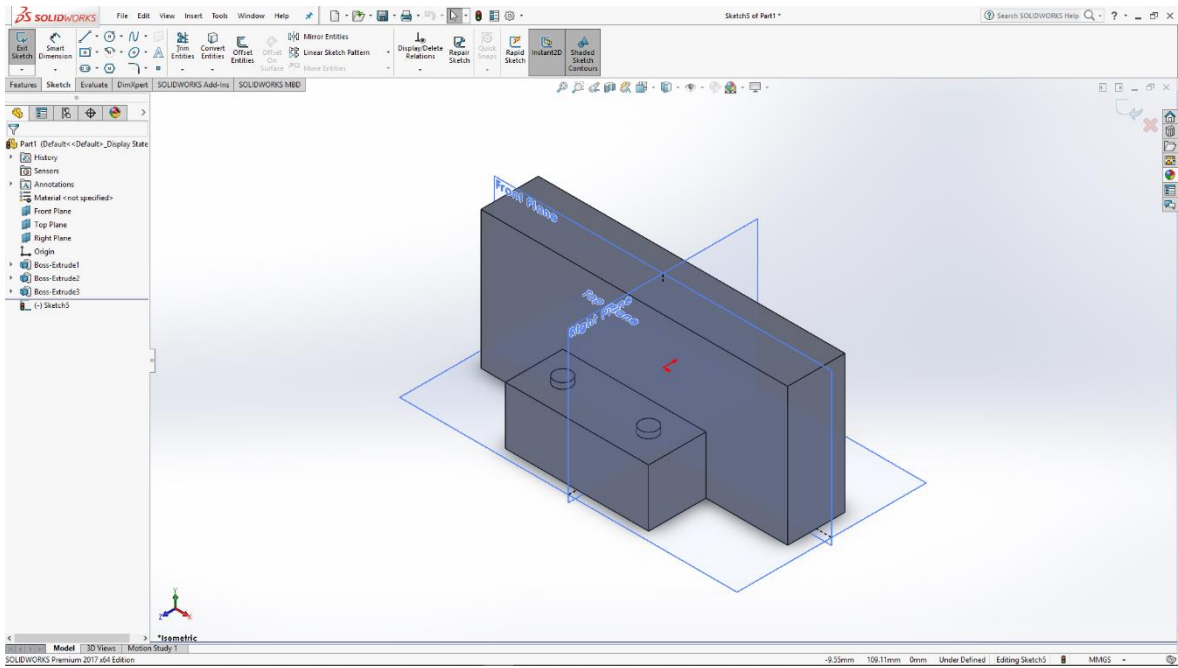
Slika 6.168: Skica pravokutnika

U gornjoj ravni skiciramo još jedan pravokutnika koji također naredbom Extrude izvlačimo u 3D model pravokutnika te dobivamo osnovni oblik pneumatskog razvodnika.



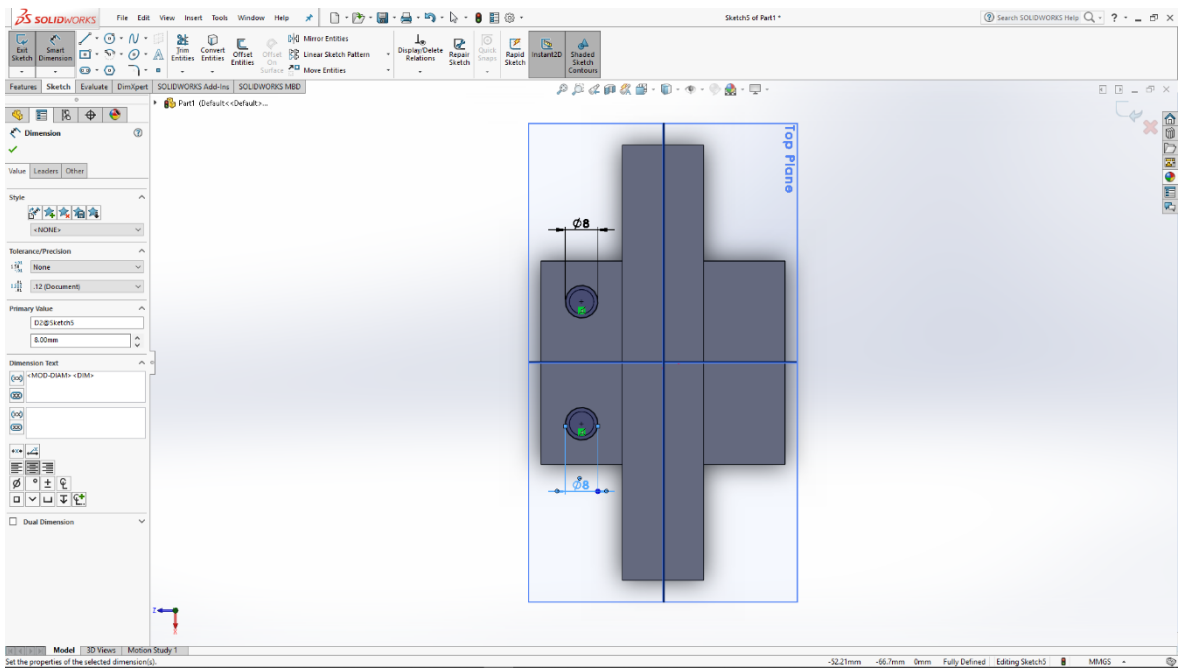
Slika 6.169: Skica kružnica

Na donjem modelu pravokutnika skiciramo kružnice koje pomoću naredbe Extrude izvlačimo u 3D model manjeg valjka.

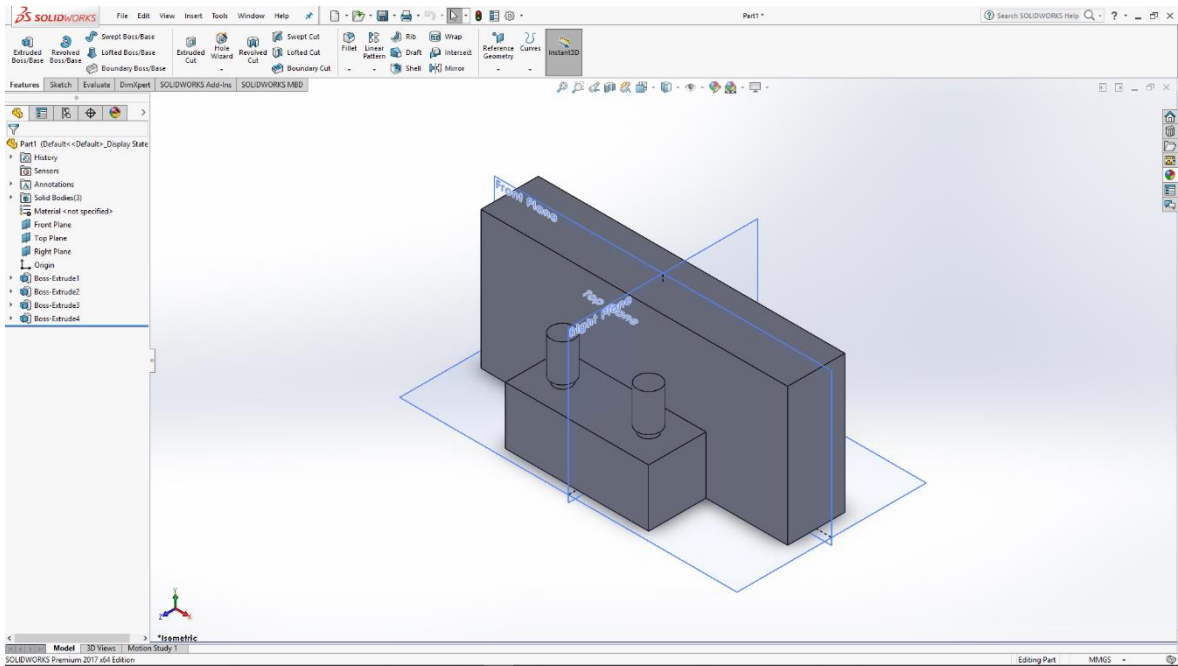


Slika 6.170: 3D model manjih valjaka

Na 3D modele manjih valjaka skiciramo veće kružnice koje naredbom Extrude izvlačimo u veće 3D modele valjaka.

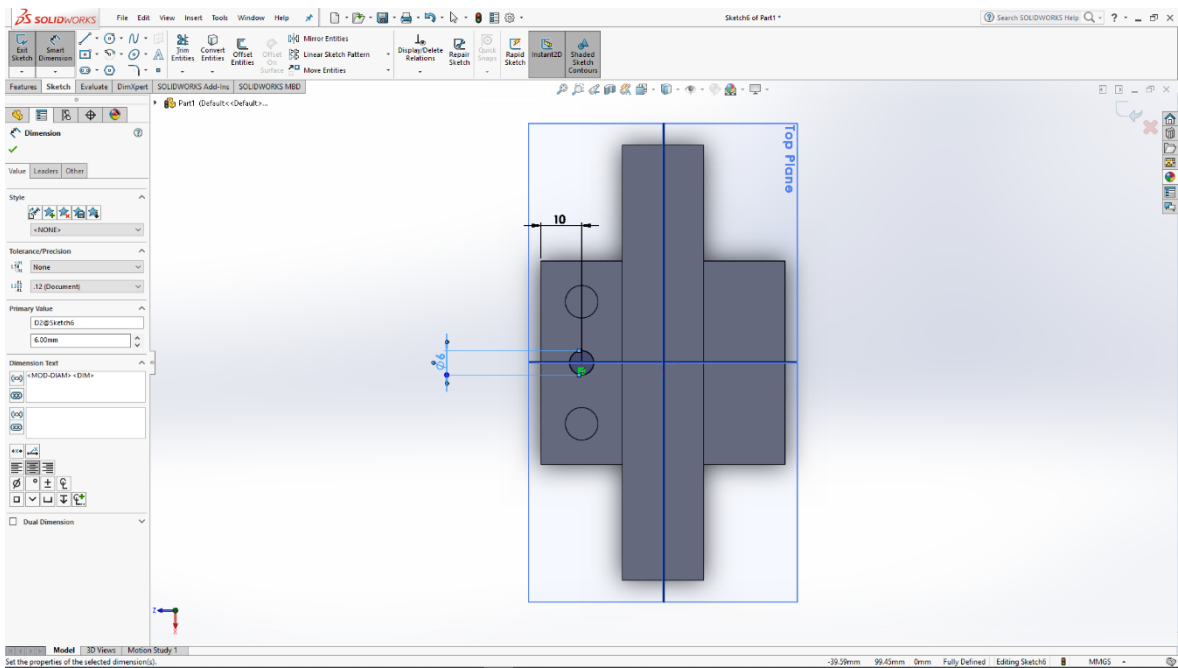


Slika 6.171: Skica kružnica

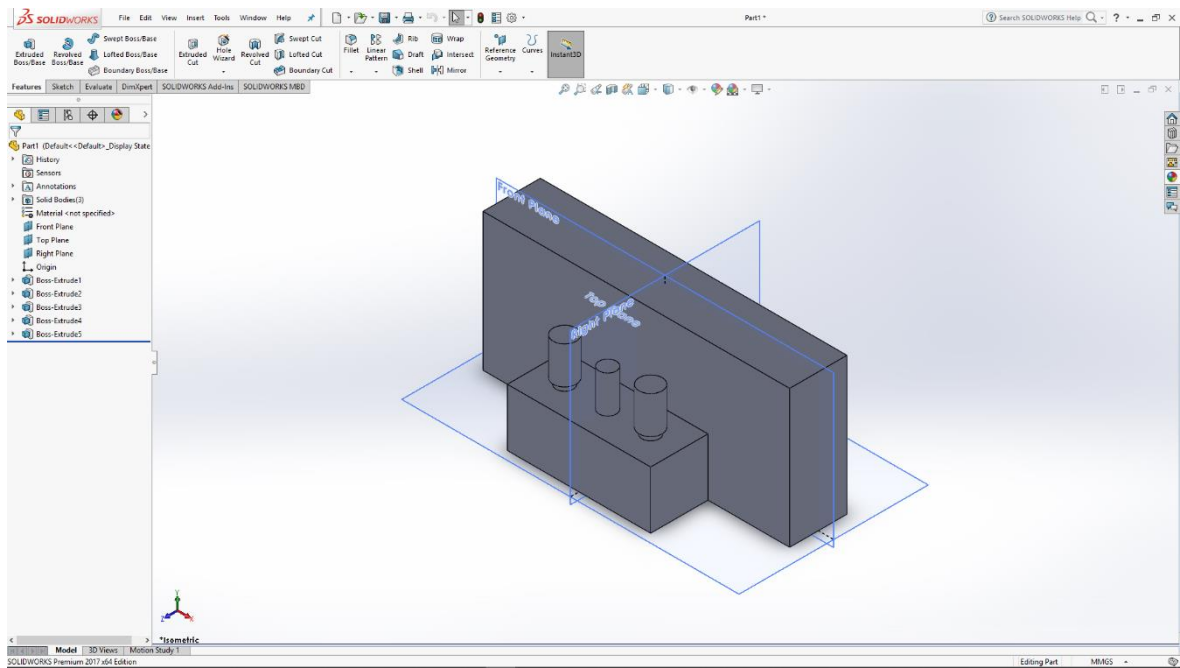


Slika 6.172: 3D modeli većih valjaka

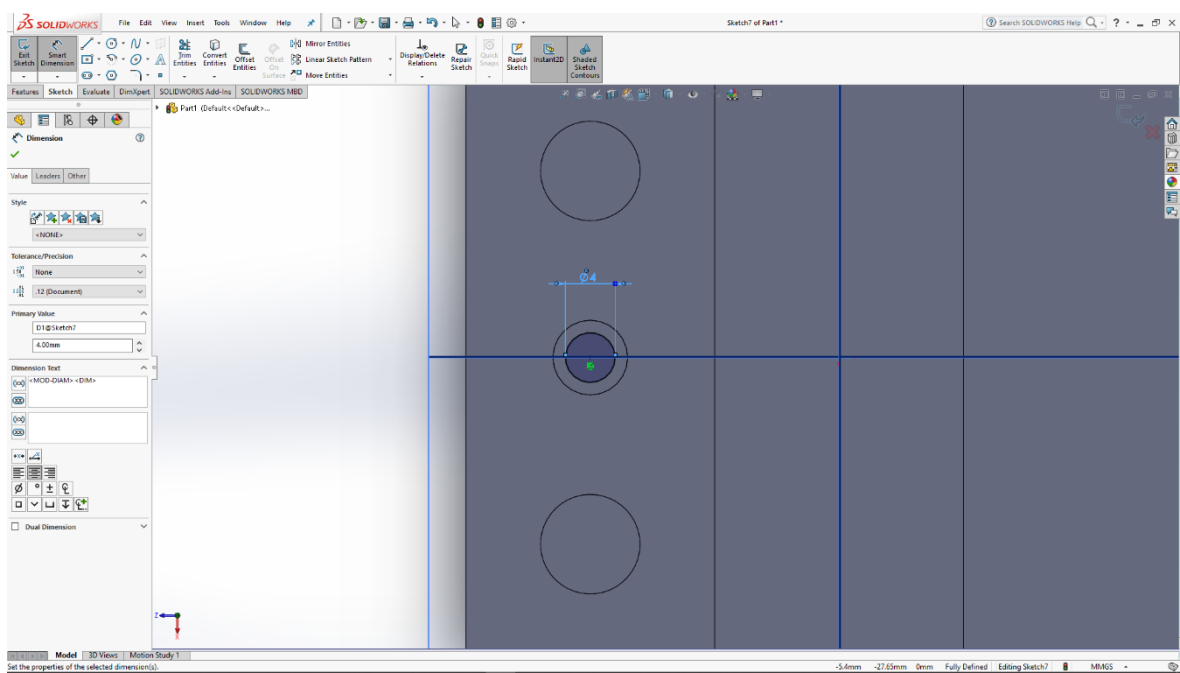
Između modeliranih valjaka skiciramo kružnicu koju također izvlačimo u 3D model valjka te na vrhu tog valjka skiciramo manju kružnicu kako bismo dobili manji model valjka.



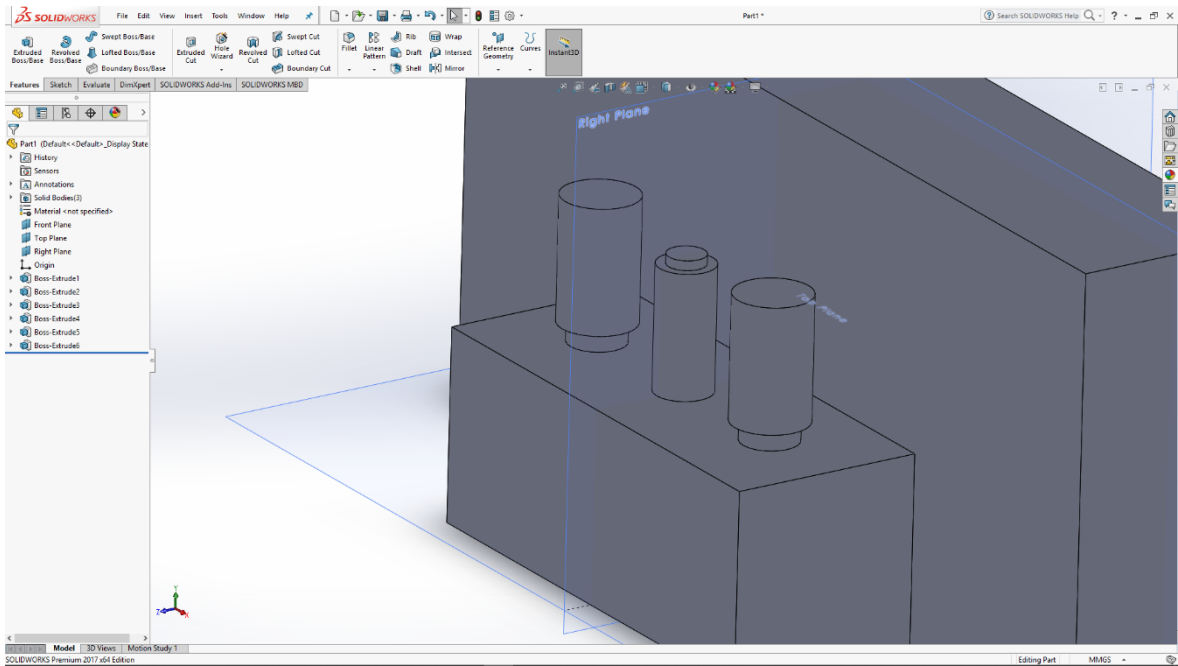
Slika 6.173: Skica kružnice



Slika 6.174: 3D model valjka

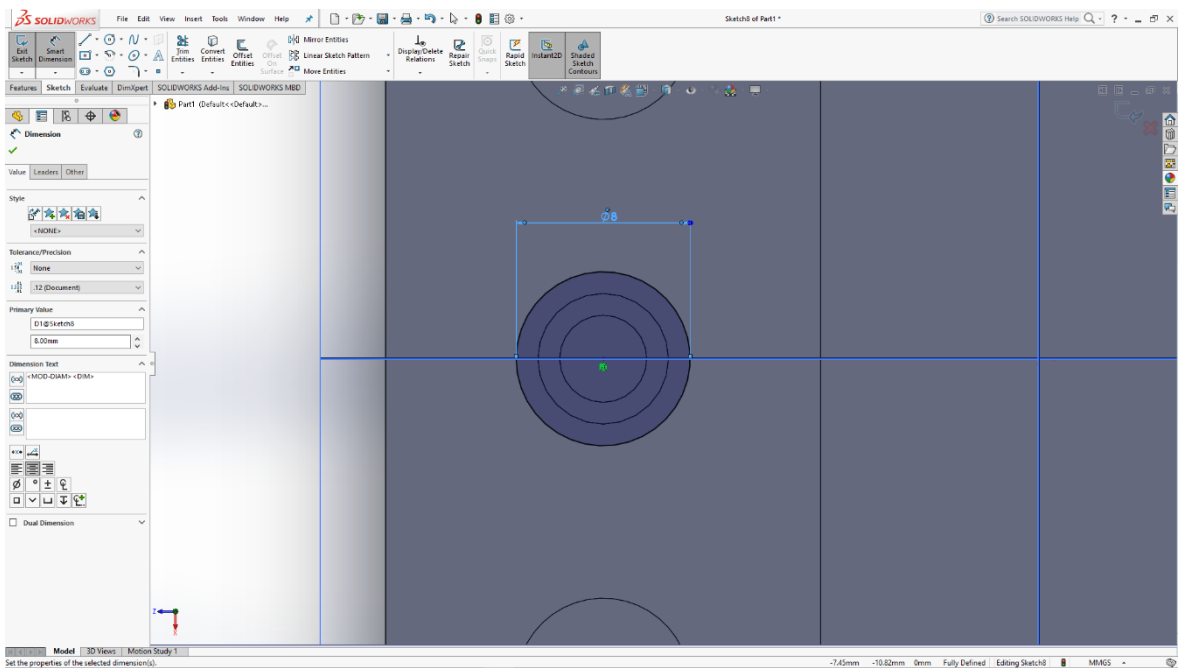


Slika 6.175: Skica kružnice

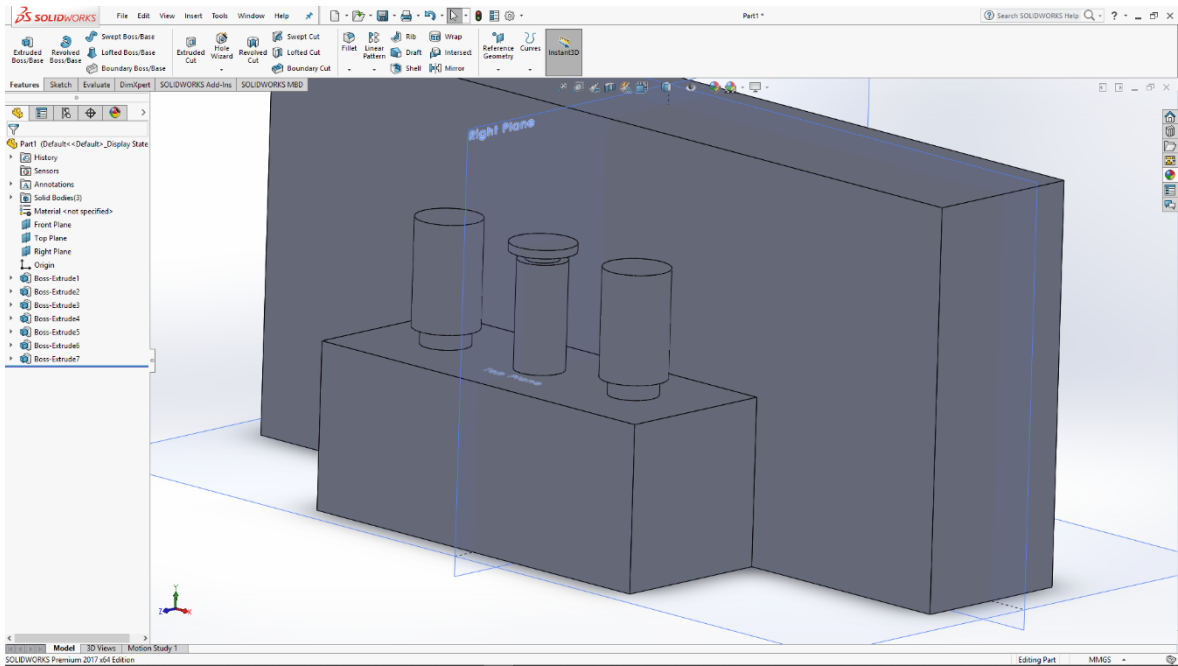


Slika 6.176: 3D model manjeg valjka

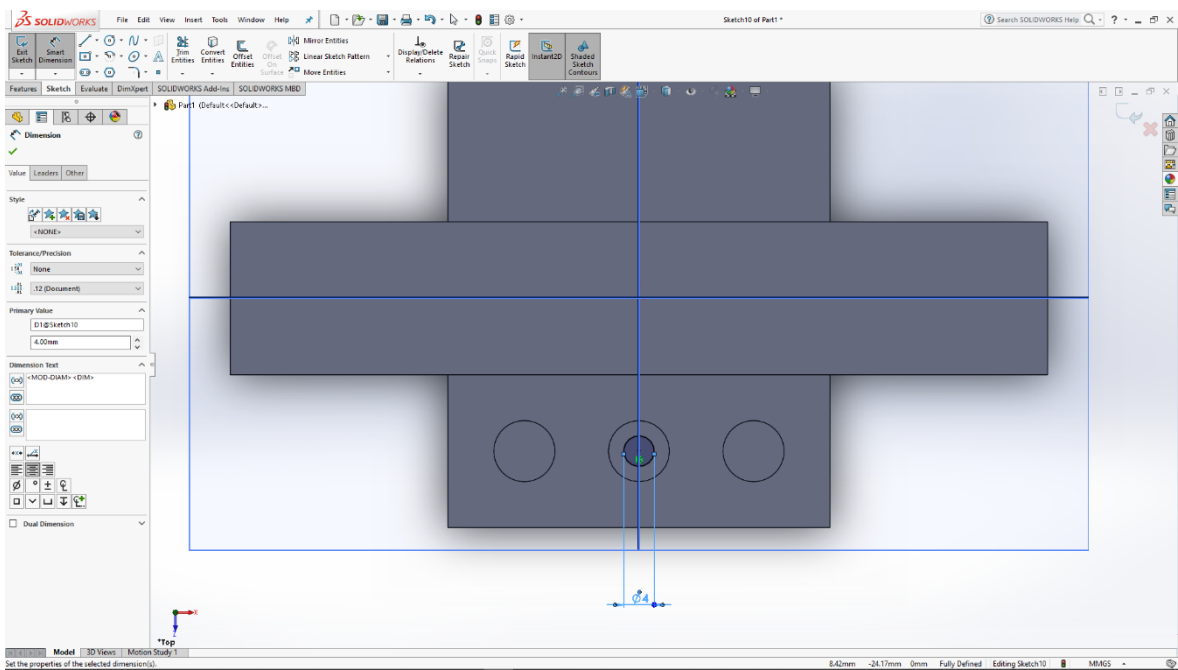
Na vrhu manjeg valjka skiciramo veću kružnicu koju naredbom Extrude izvlačimo u tanjurasti oblik 3D modela, te na vrhu modela skiciramo kružnicu s kojom pomoću naredbe Cut izrađujemo utor kroz napravljene modele.



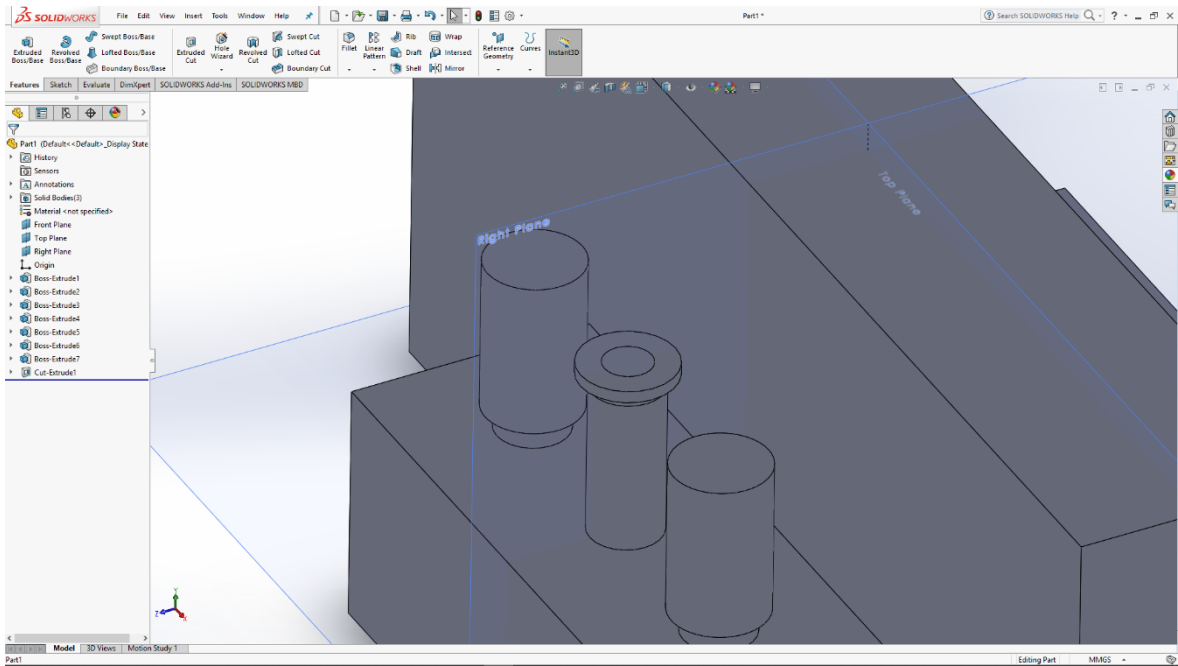
Slika 6.177: Skica kružnice



Slika 6.178: 3D model tanjurastog oblika

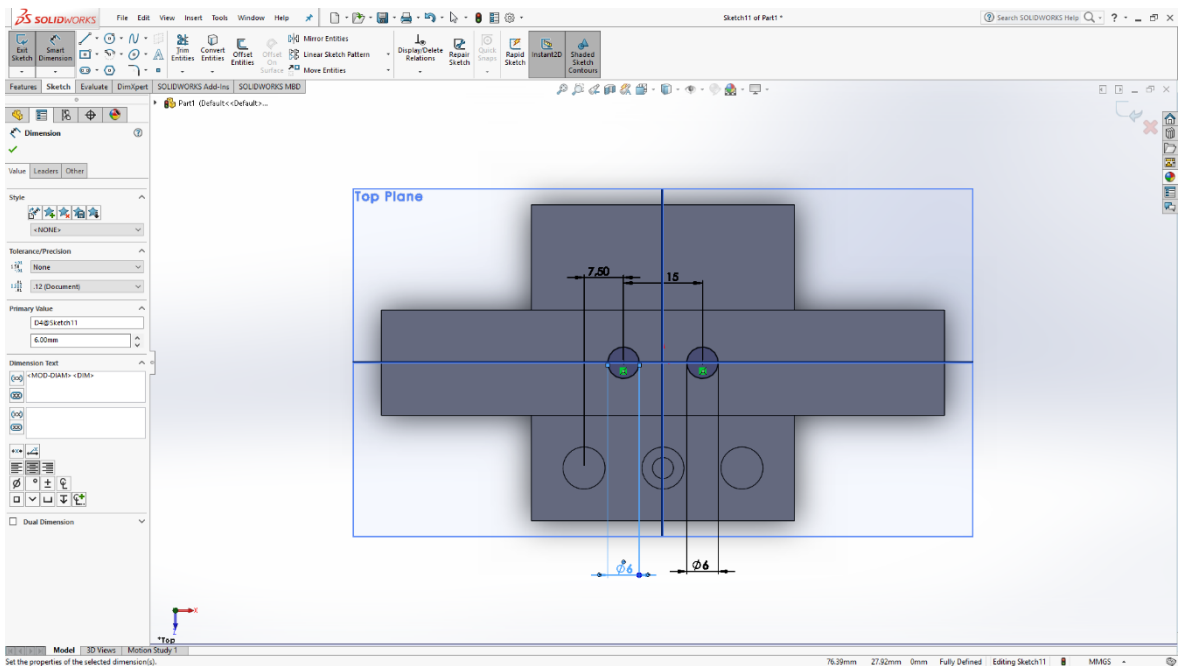


Slika 6.179: Skica kružnice

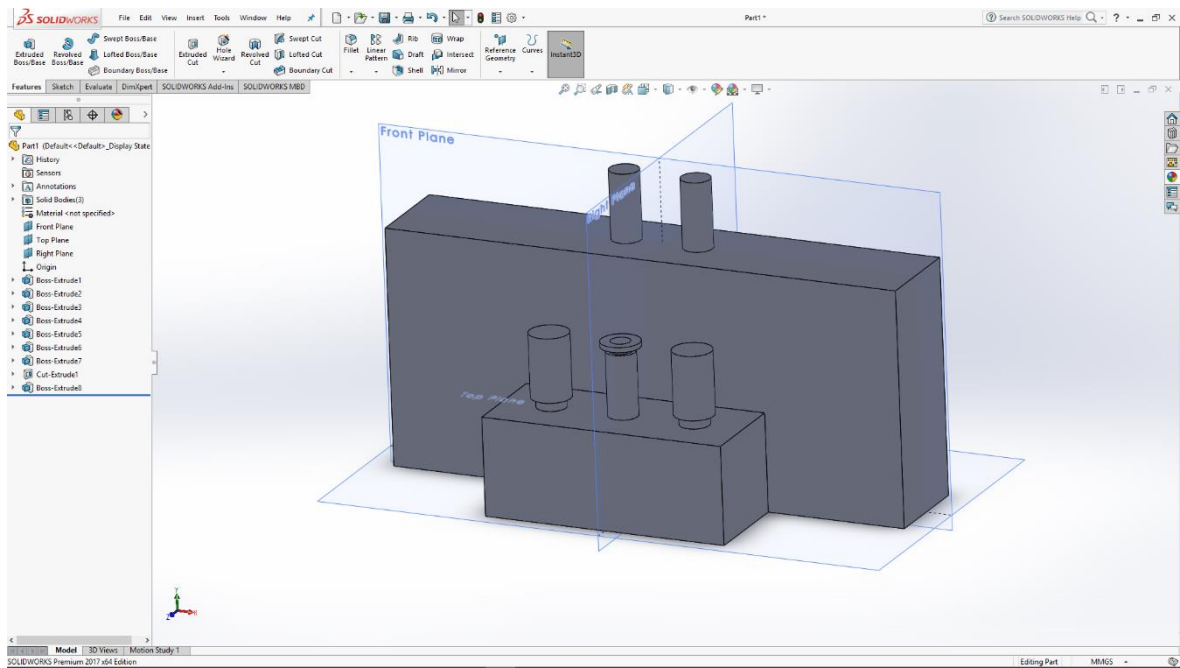


Slika 6.180: Utor u modelu

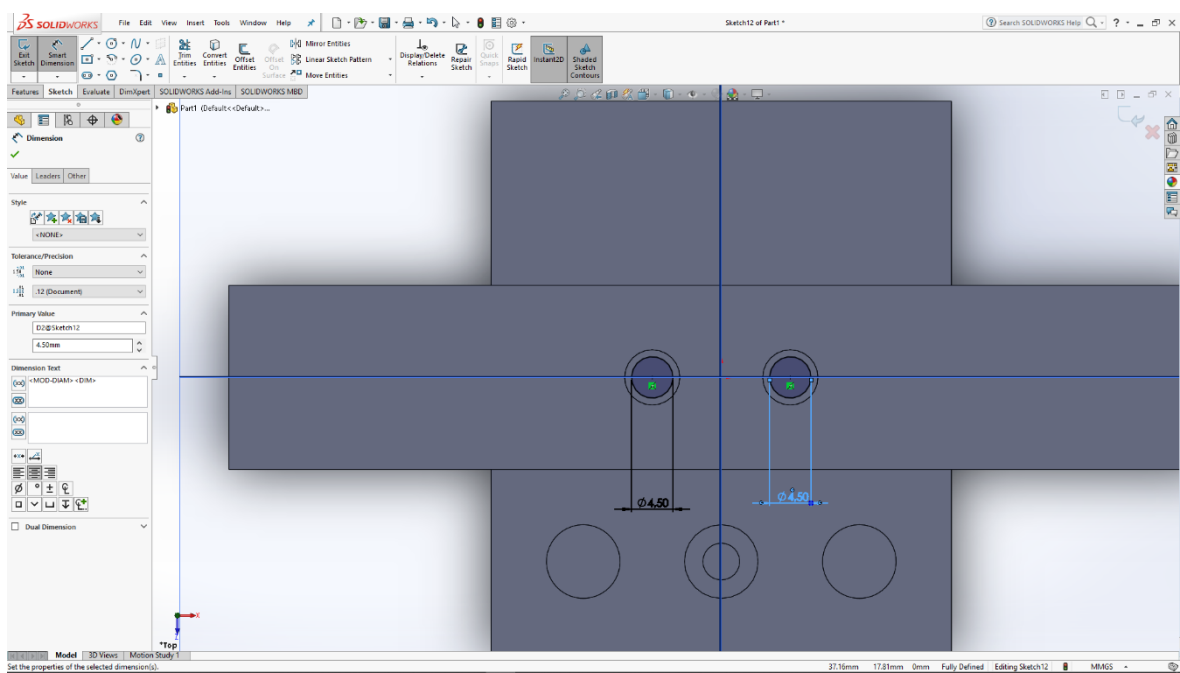
U gornjoj ravnini skiciramo kružnice koje naredbom Extrude izvlačimo u 3D modele valjaka, na vrhu tih modela skiciramo manje kružnice te ih isto izvlačimo u 3D model.



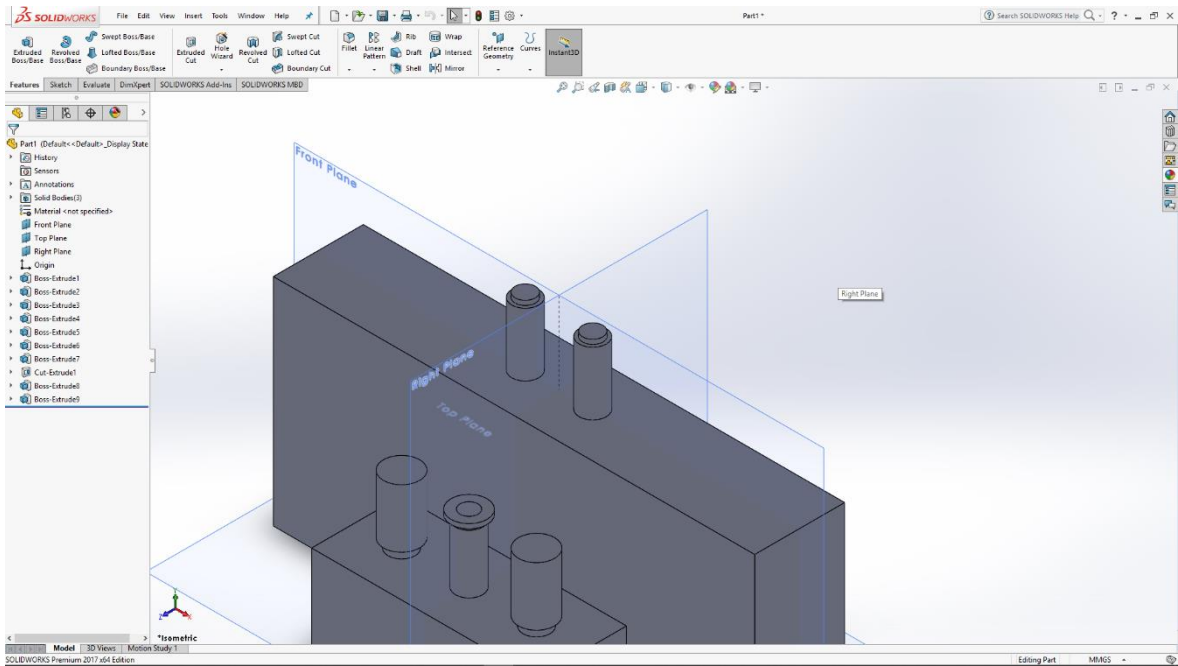
Slika 6.181: Skica kružnica



Slika 6.182: 3D model valjaka

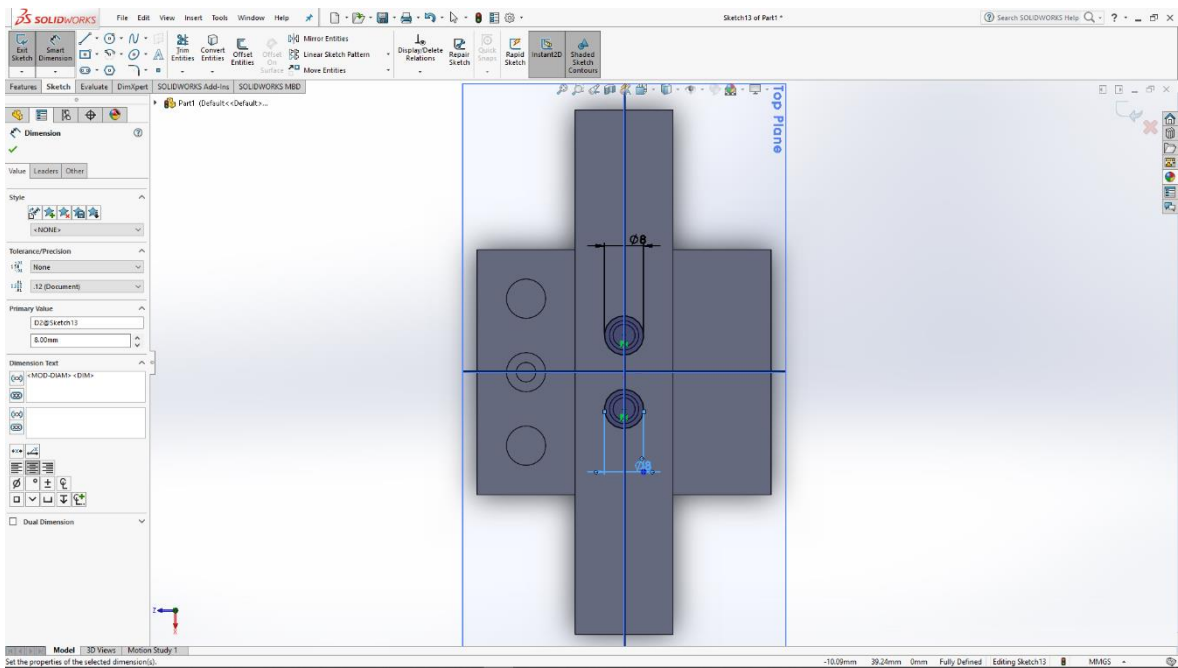


Slika 6.183: Skica manjih kružnica

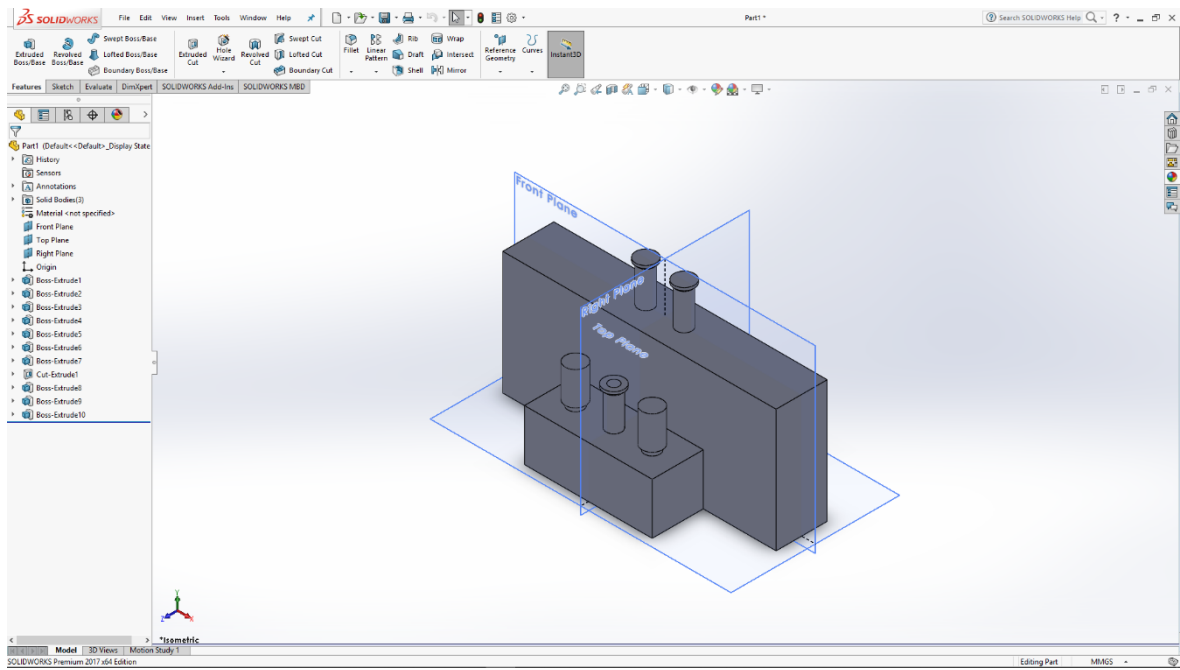


Slika 6.184: 3D modeli manjih valjaka

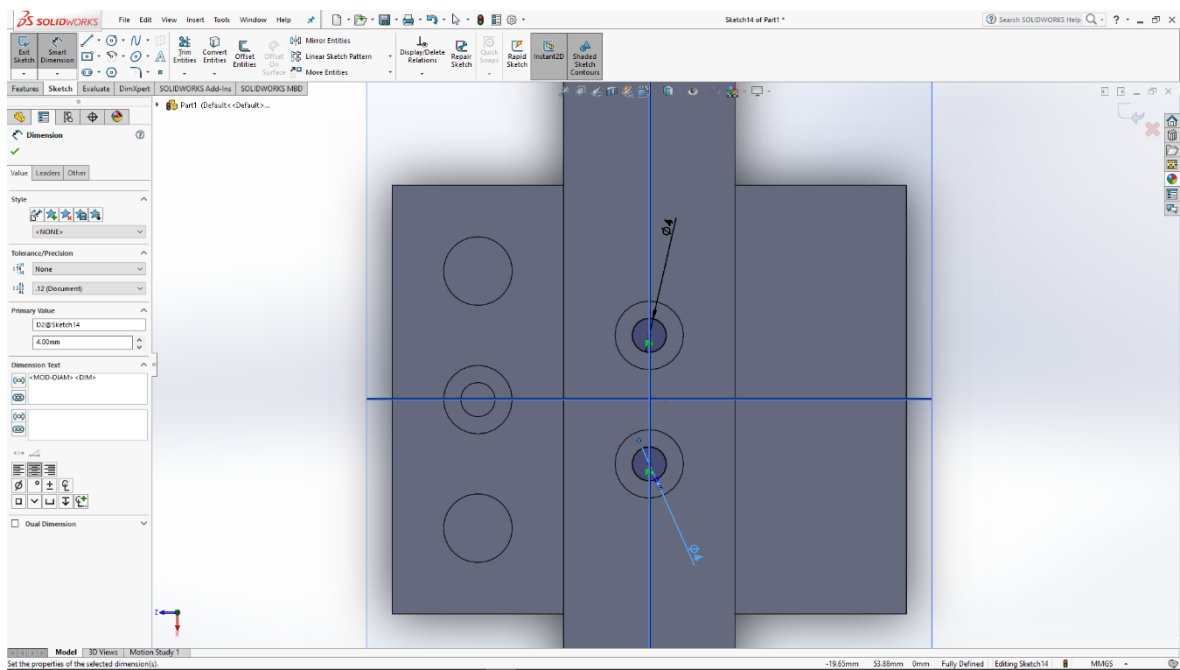
Na vrhu manjih valjaka skiciramo veće kružnice koje izvlačimo u tanjurasti oblik modela, te na tim modelima skiciramo kružnice koje naredbom Cut radimo utore u modelu.



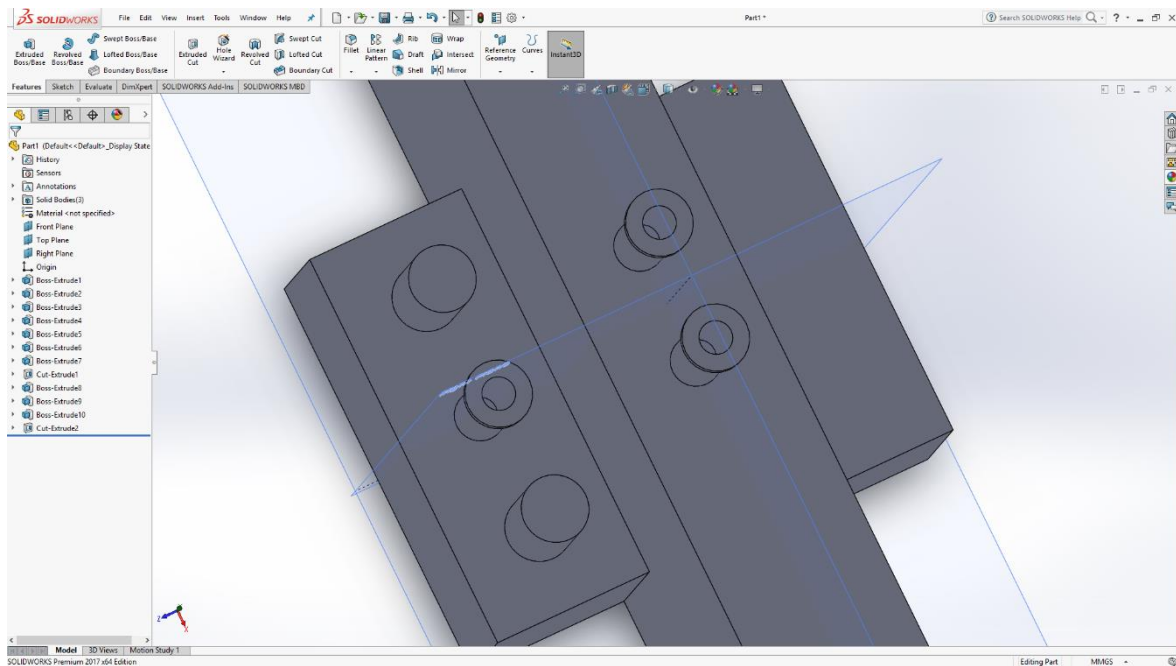
Slika 6.185: Skica kružnica



Slika 6.186: 3D modeli tanjurastog oblika



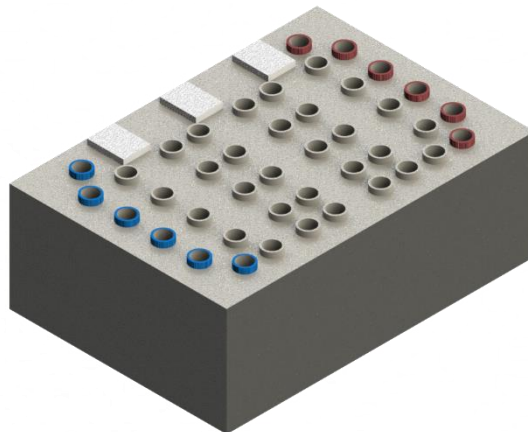
Slika 6.187: Skica kruznice



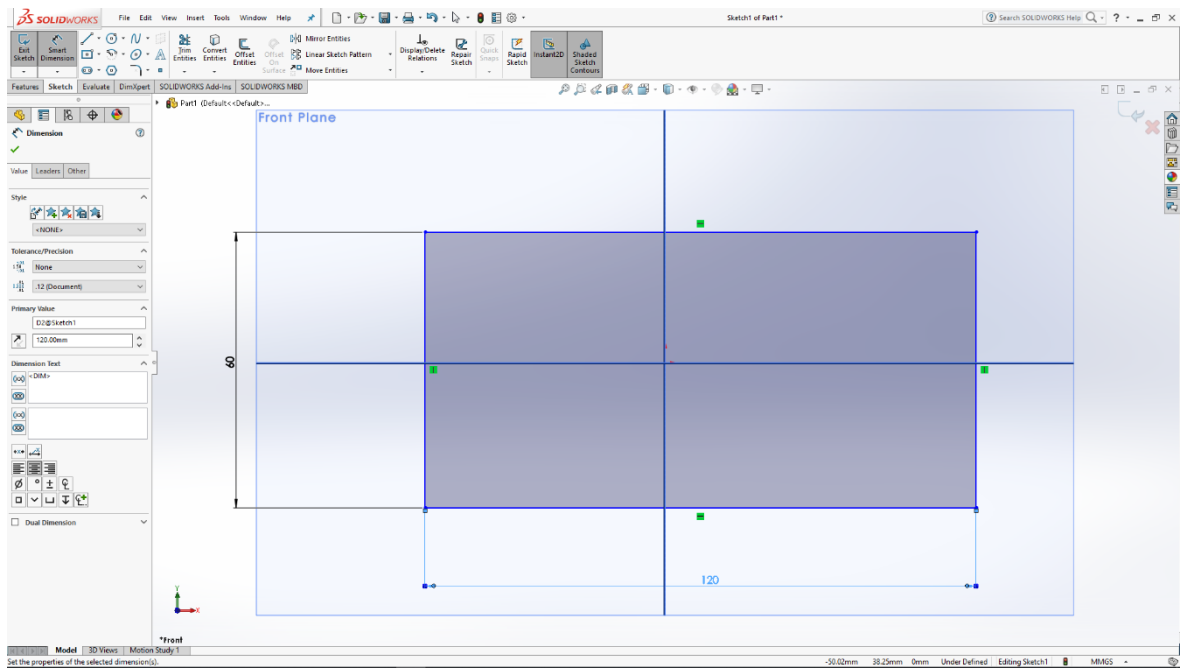
Slika 6.188: Utori u modelima

S gotovim modelom pneumatskog razvodnika potrebno je još odabrati materijal za renderiranje slike modela.

6.15 Razvodna kutija s tipkalima

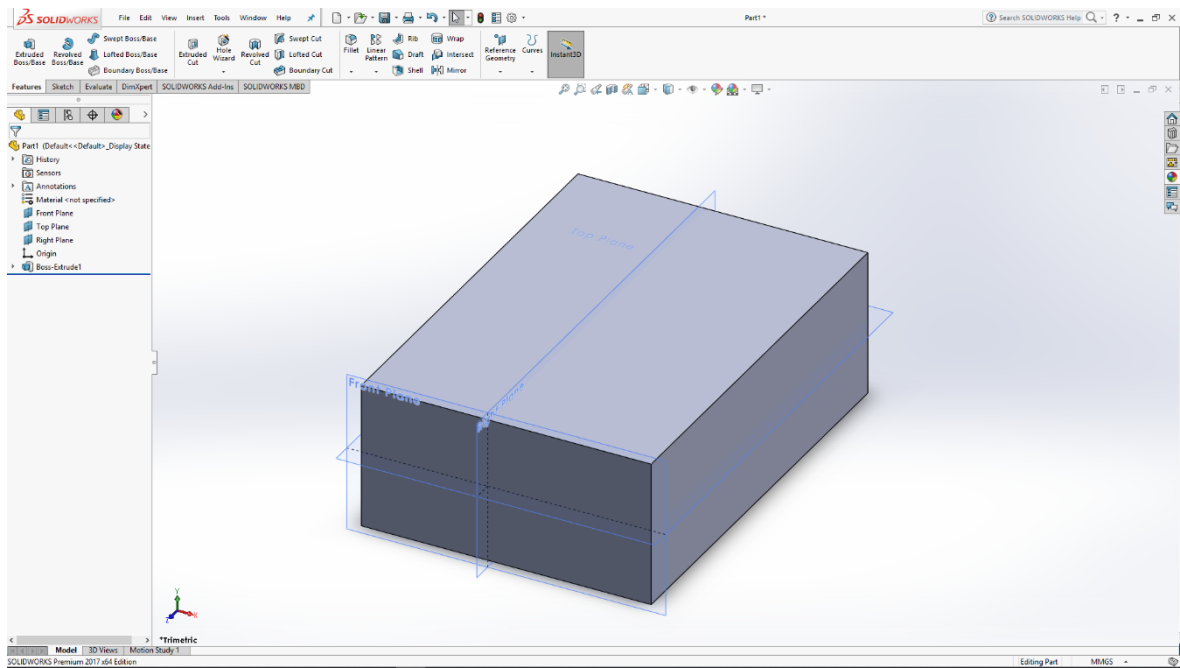


Slika 6.189: Render razvodne kutije s tipkalima

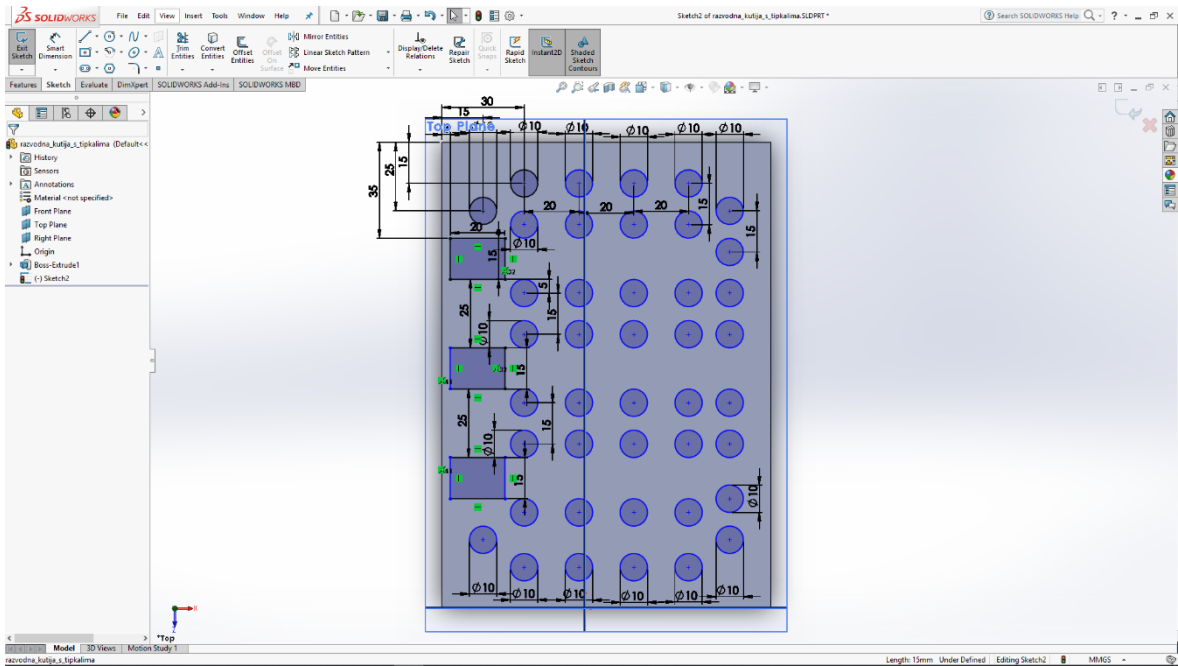


Slika 6.190: Skica pravokutnika

Izrada modela počinje u prednjoj ravnini skicom pravokutnika koju naredbom Extrude izvlačimo u 3D model pravokutnika.

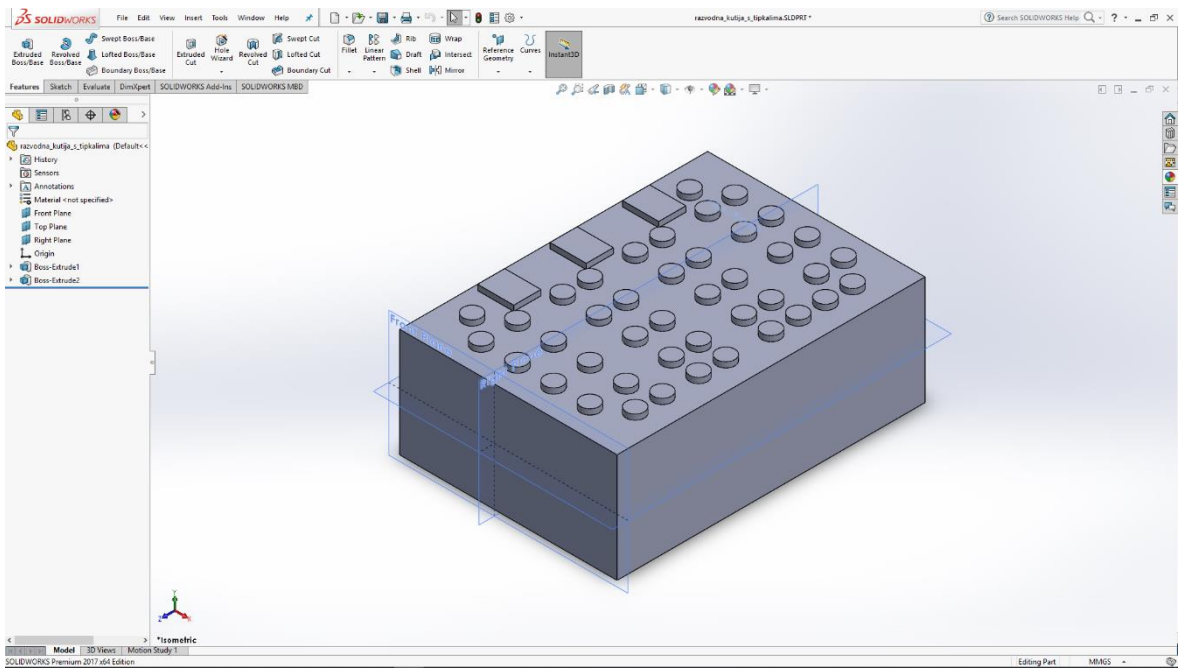


Slika 6.191: 3D model pravokutnika

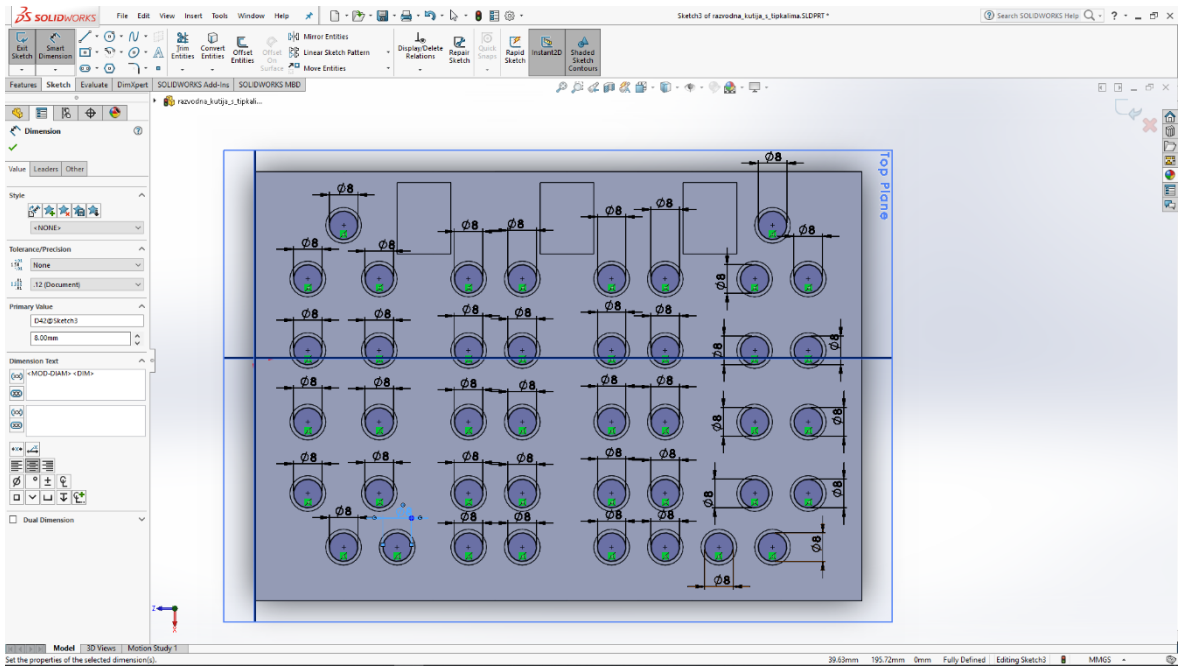


Slika 6.192: Skica kružnica i pravokutnika

Na gornjem dijelu modela skiciramo kružnice koje će služiti za utor kablova i pravokutnike koji budu služili za tipkala. Naredbom Extrude ih izvlačimo u 3D modele.

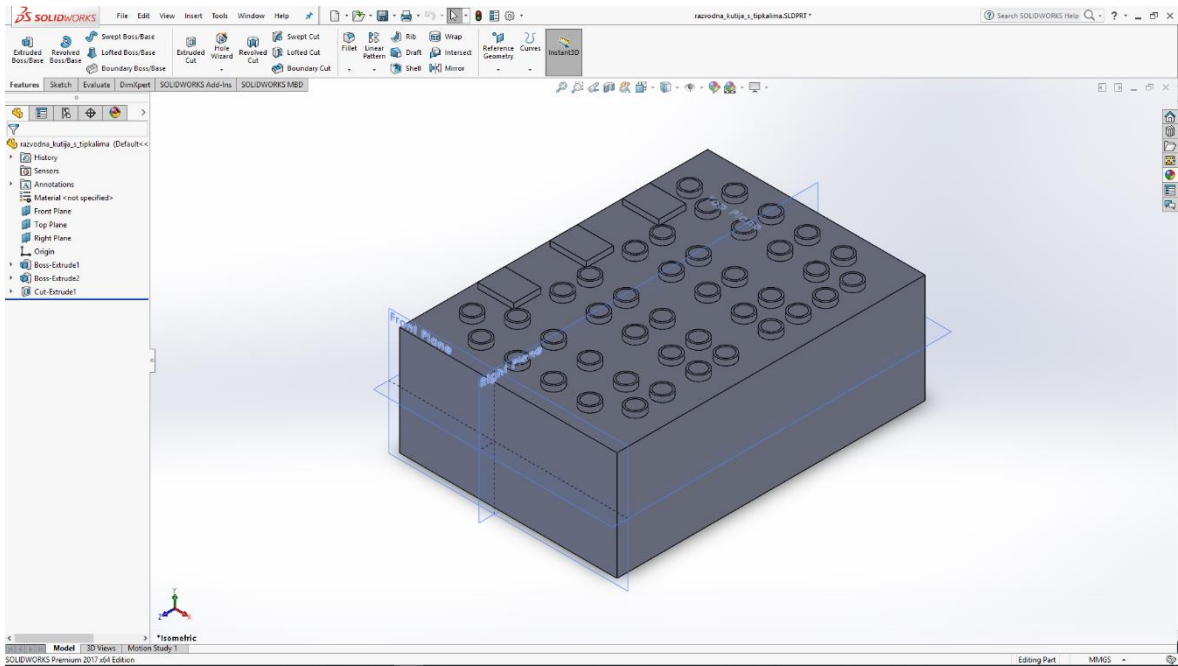


Slika 6.193: 3D modeli pravokutnika i valjaka



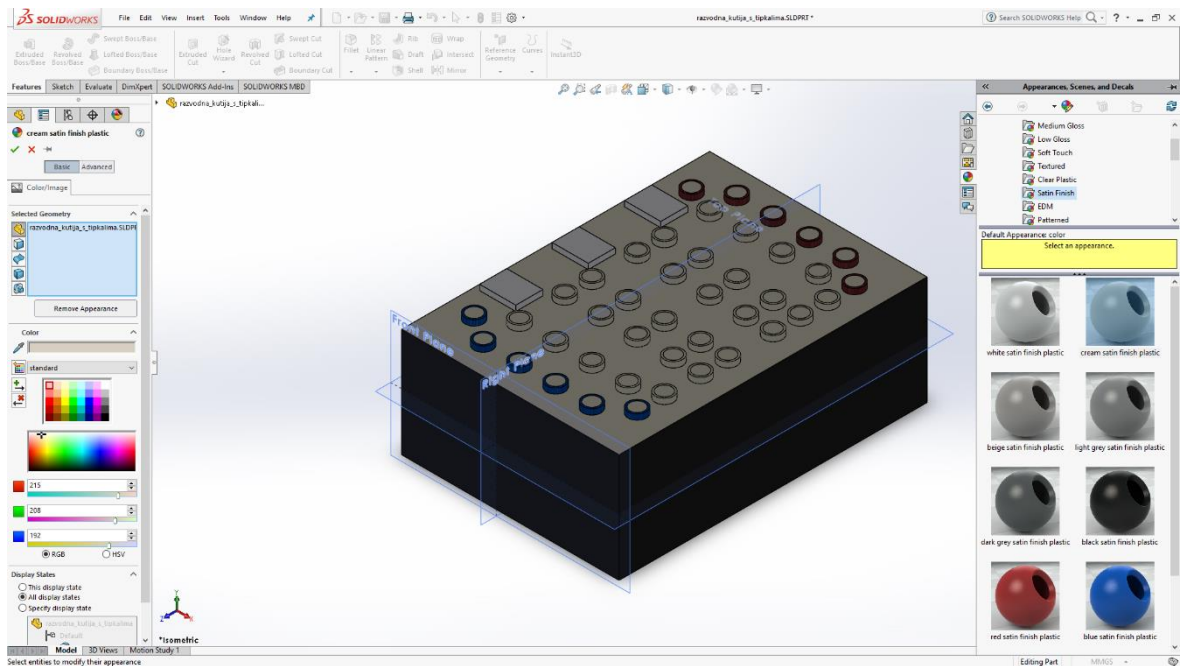
Slika 6.194: Skica kružnica

Na svim modelima valjaka skiciramo kružnice s kojima pomoću naredbe Cut izrađujemo utore za kablove.



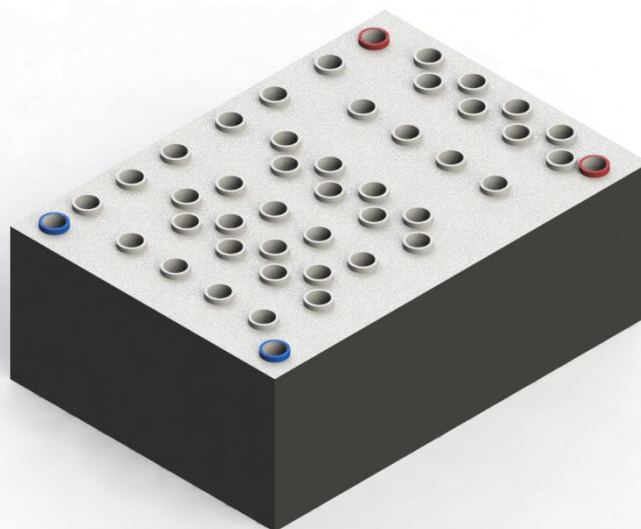
Slika 6.195: Utori u modelu

S gotovim modelom potrebno je još odabrati materijal za izradu rendera modela.

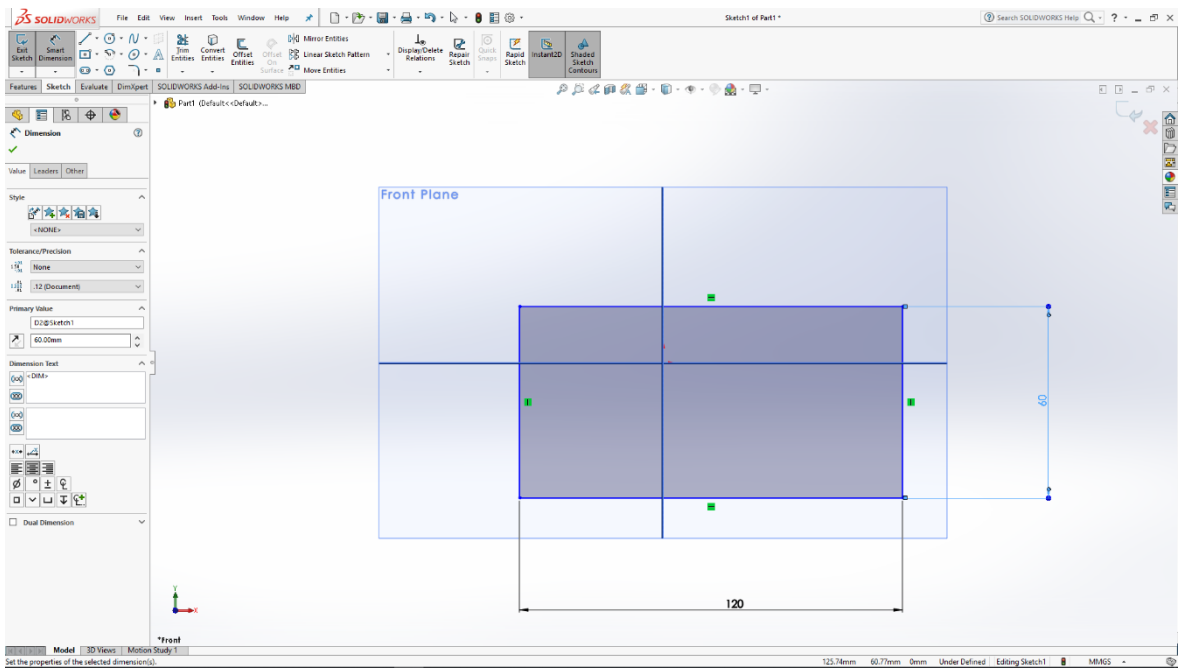


Slika 6.196: Odabir materijala

6.16 Razvodna kutija

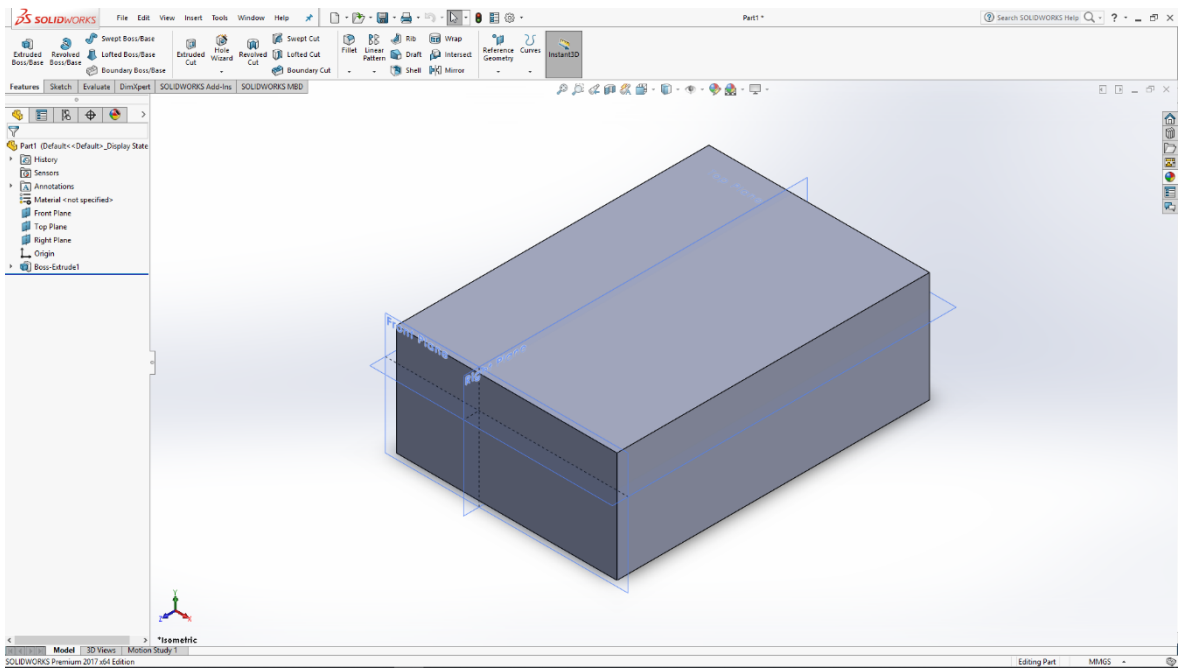


Slika 6.197: Render razvodne kutije

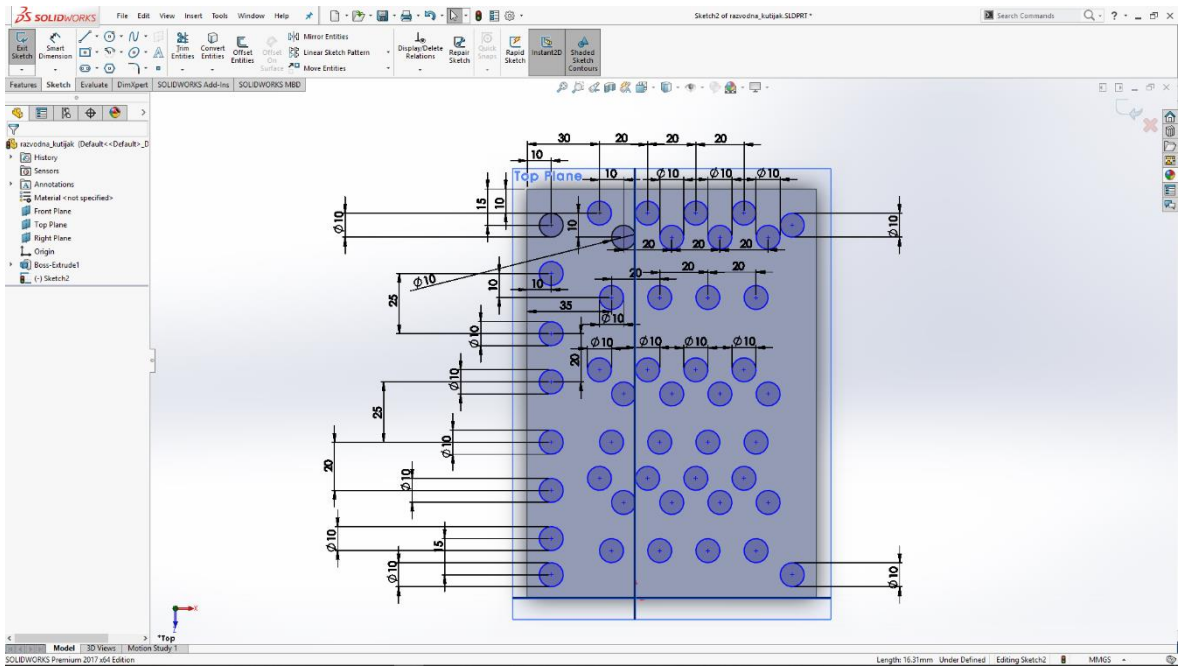


Slika 6.198: Skica pravokutnika

Izrada modela započinje skicom pravokutnika u prednjoj ravni koju naredbom Extrude izvlačimo u 3D model pravokutnika.

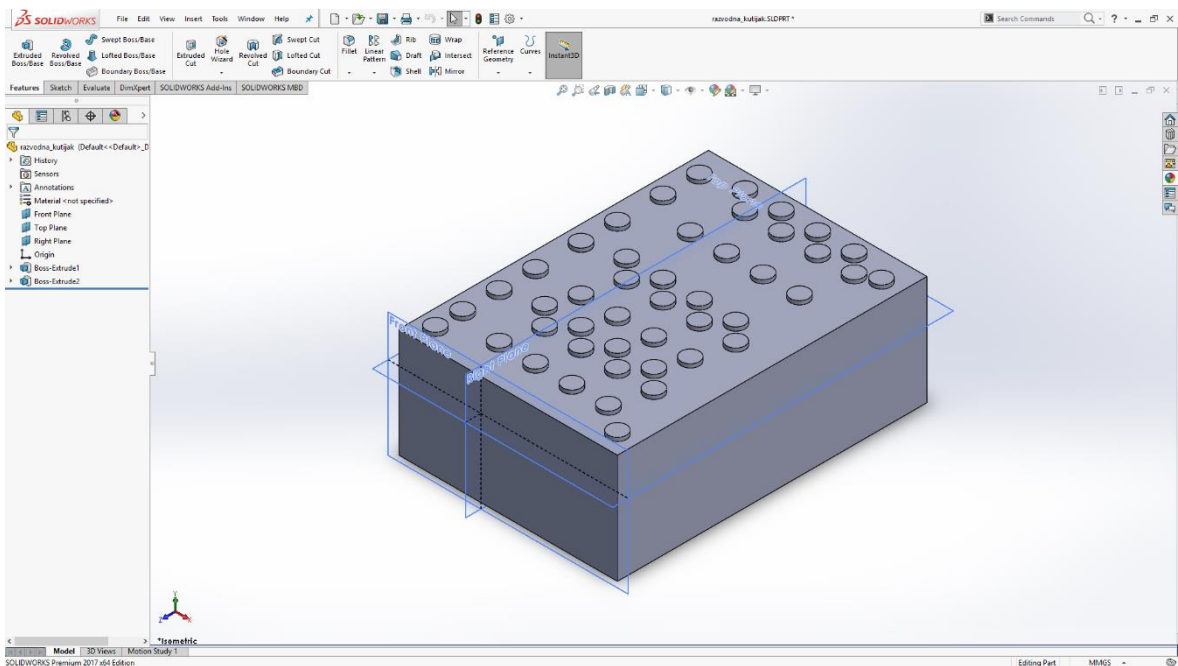


Slika 6.199: 3D model pravokutnika

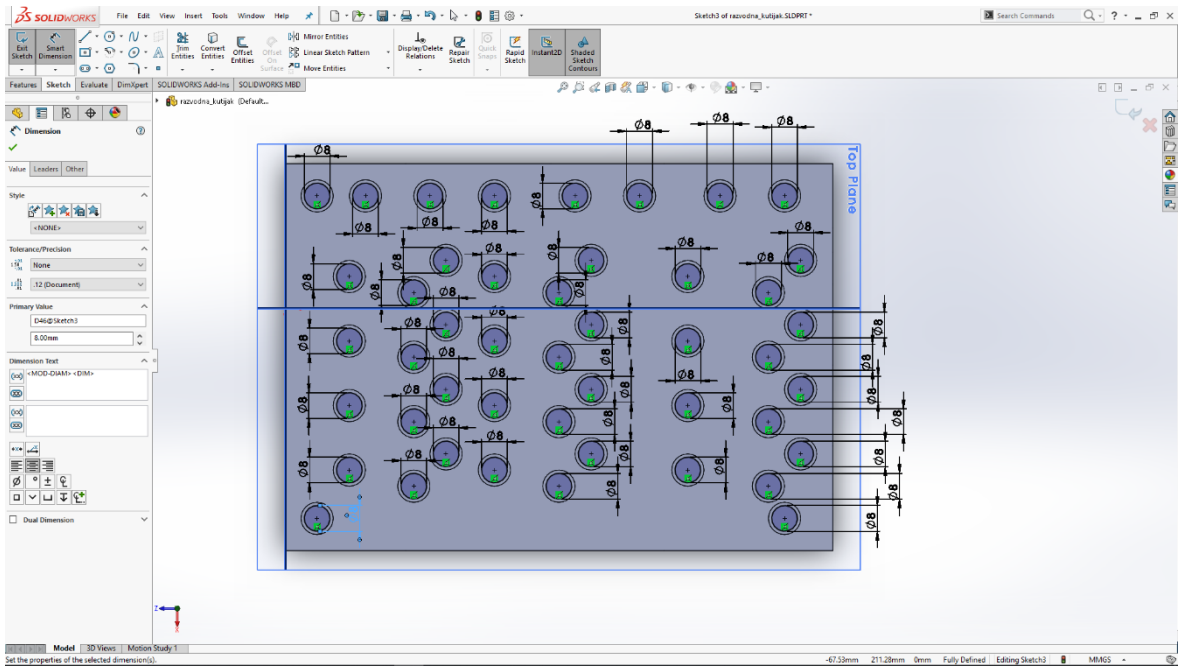


Slika 6.200: Skica kružnica

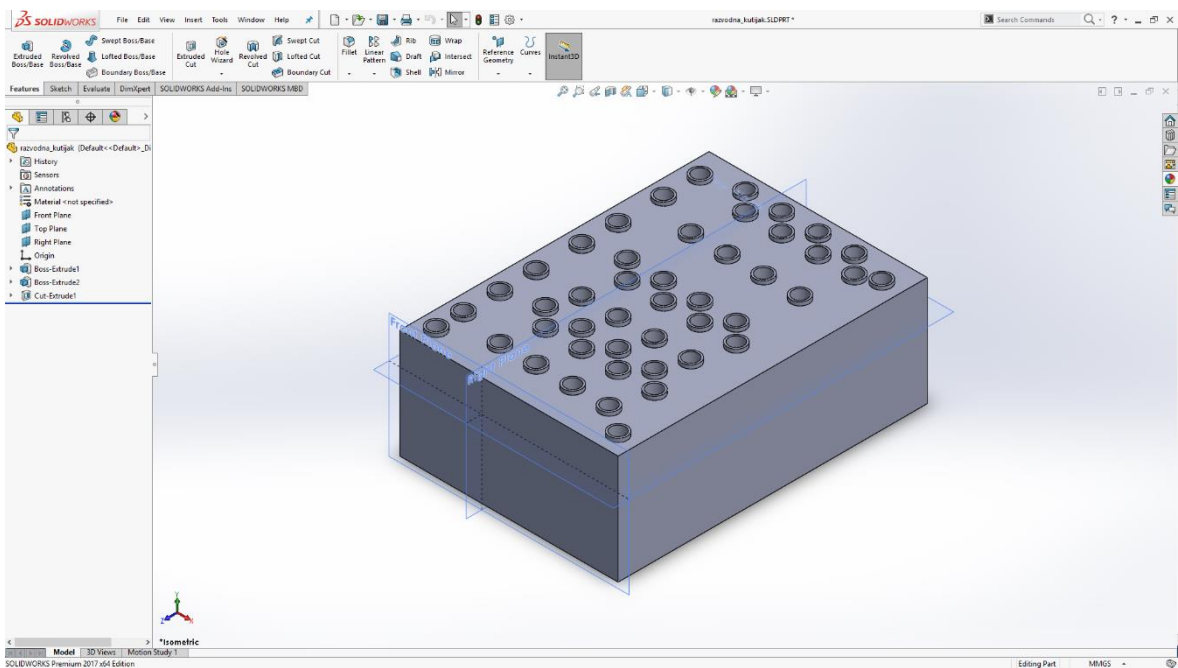
Na gornjem dijelu modela skiciramo kružnice koje naredbom Extrude izvlačimo u 3D modele, te na tim modelima skiciramo manje kružnice koje naredbom Cut izrađujemo u modelu.



Slika 6.201: 3D modeli tanjurastog oblika

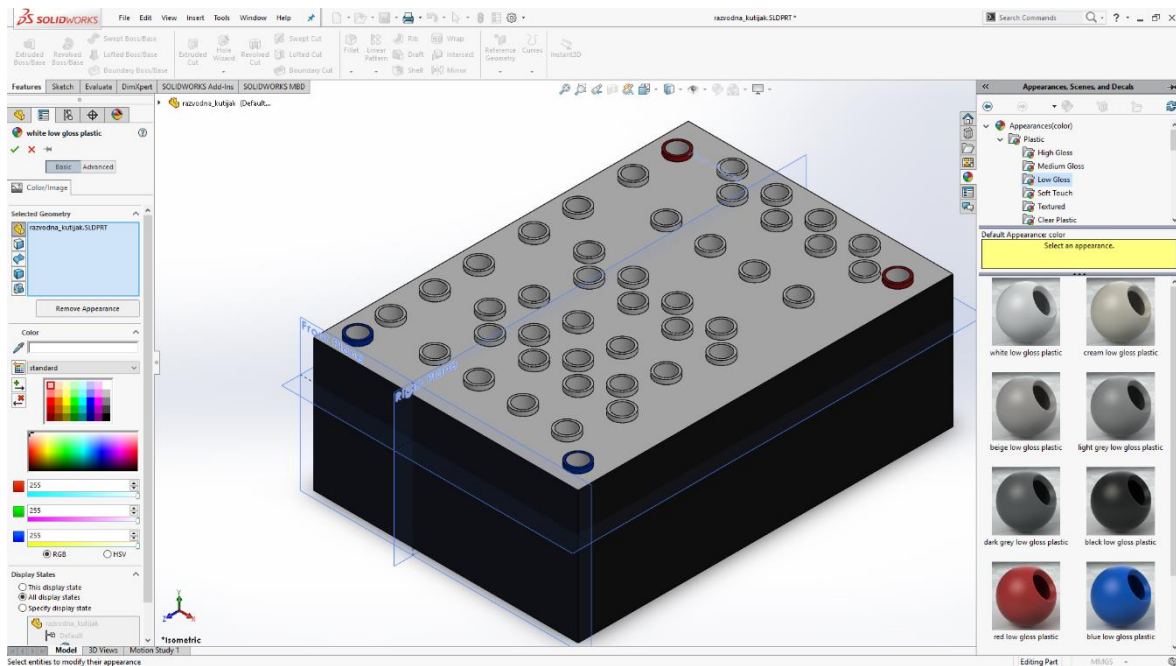


Slika 6.202: Skica kružnica



Slika 6.203: Utori u modelu

Na gotovom modelu potrebno je još odabrati materijal za renderiranje slike modela razvodne kutije.



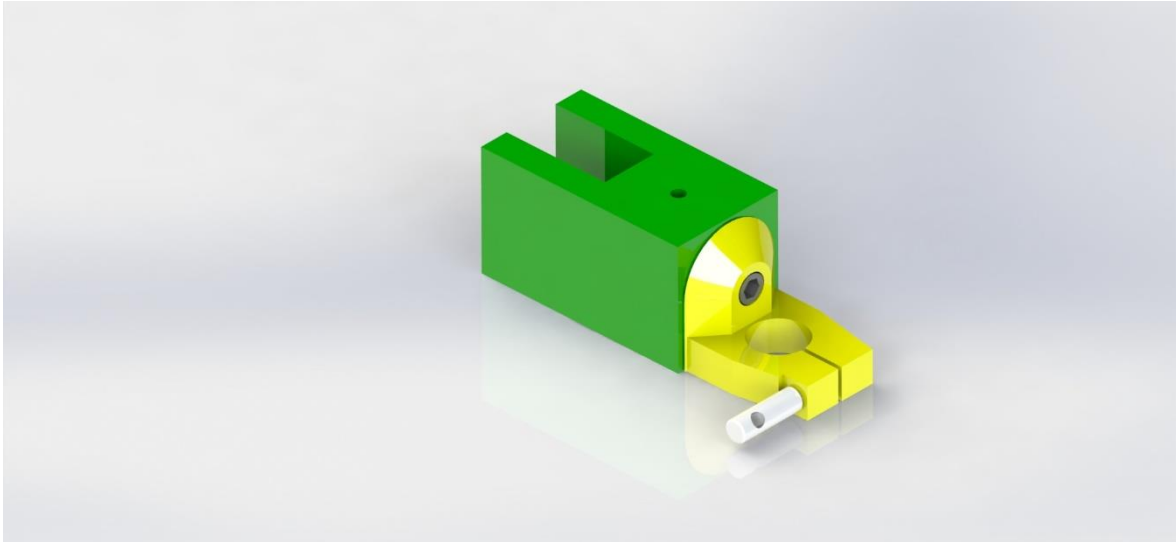
Slika 6.204: Odabir materijala za render

7. Dodatni modeli

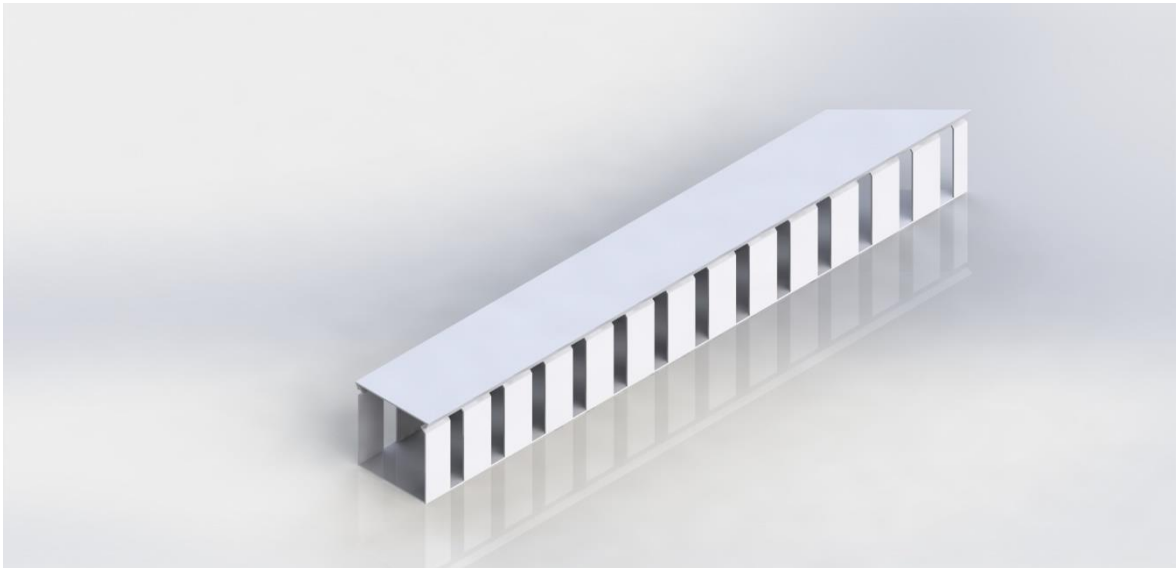
Dodatni modeli koji su korišteni u radu su već unaprijed bili napravljeni te ih se može preuzeti s interneta. Postoje stranice na internetu kao što su Grabcad [2] i Thingiverse [3] na kojima se nalaze do stotine različitih modela. Modeli koji su preuzeti su Proxon bušilica i njegov držač, kanalice za kablove, radna ploča, programabilni logički kontroler i Festovi modeli za dvoradni cilindar i pripremnu grupu zraka.



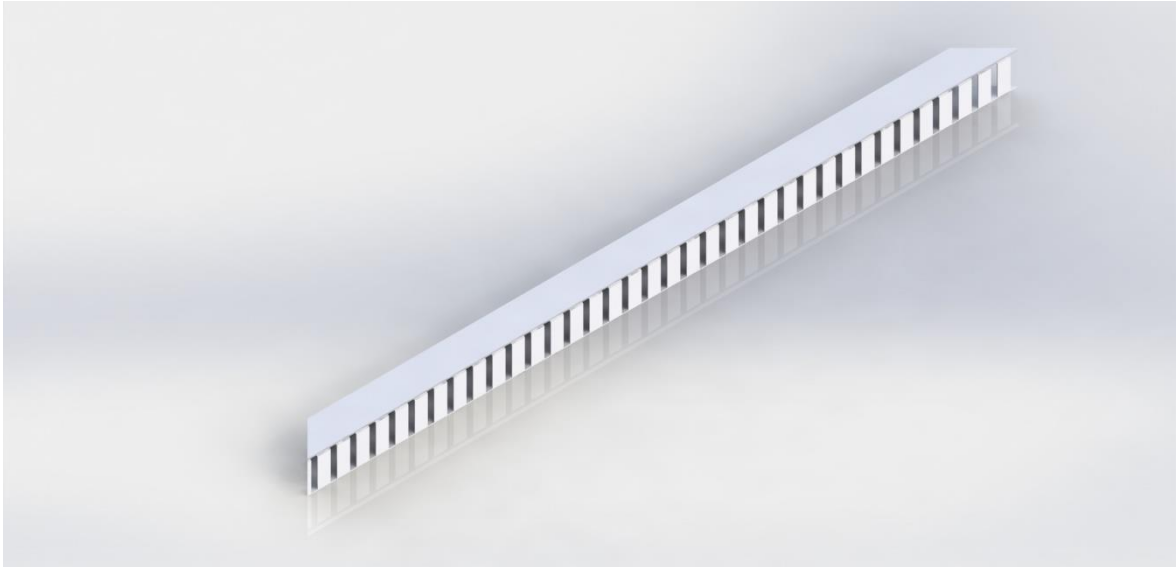
Slika 7.1: Proxon bušilica



Slika 7.2: Proxon držač



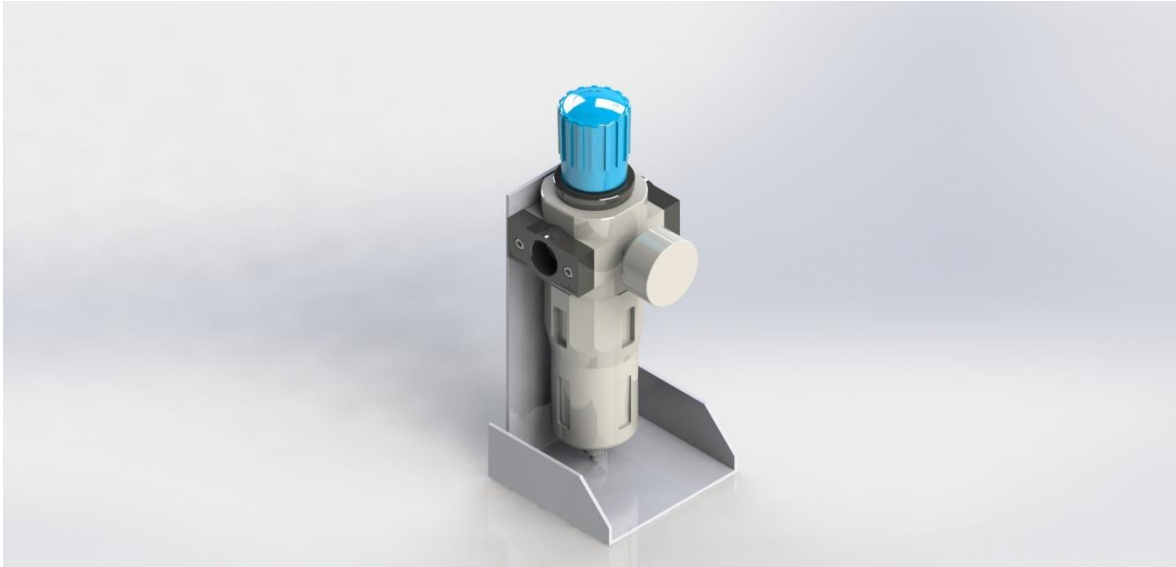
Slika 7.3: Kraća kanalica za kablove



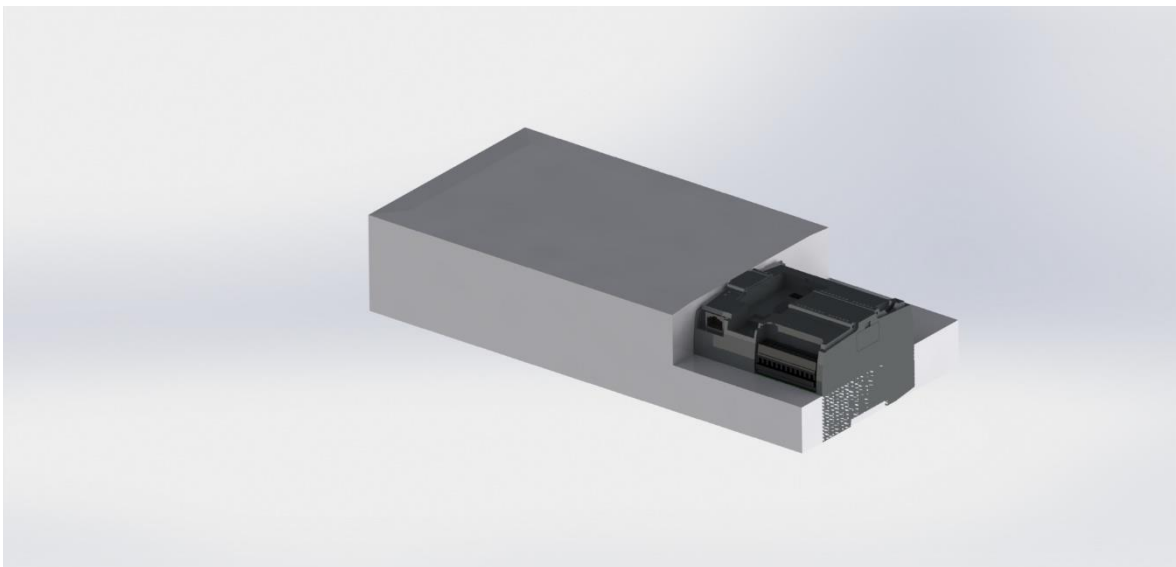
Slika 7.4: Duža kanalica za kablove



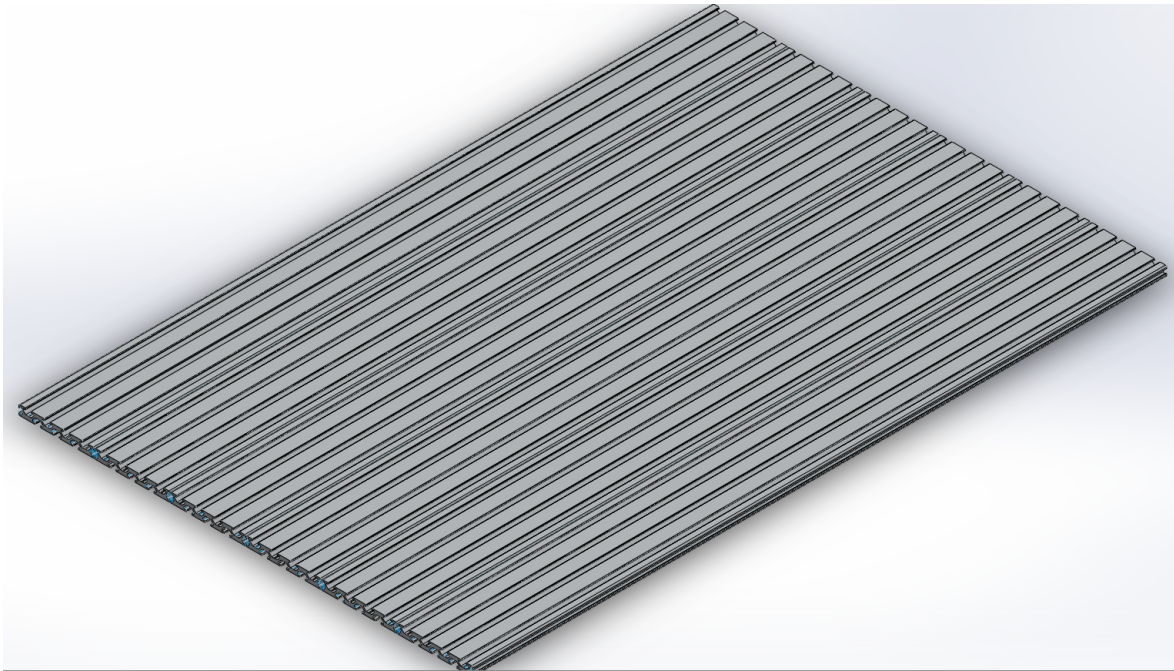
Slika 7.5: Dvoradni cilindar



Slika 7.6: Pripremna grupa zraka



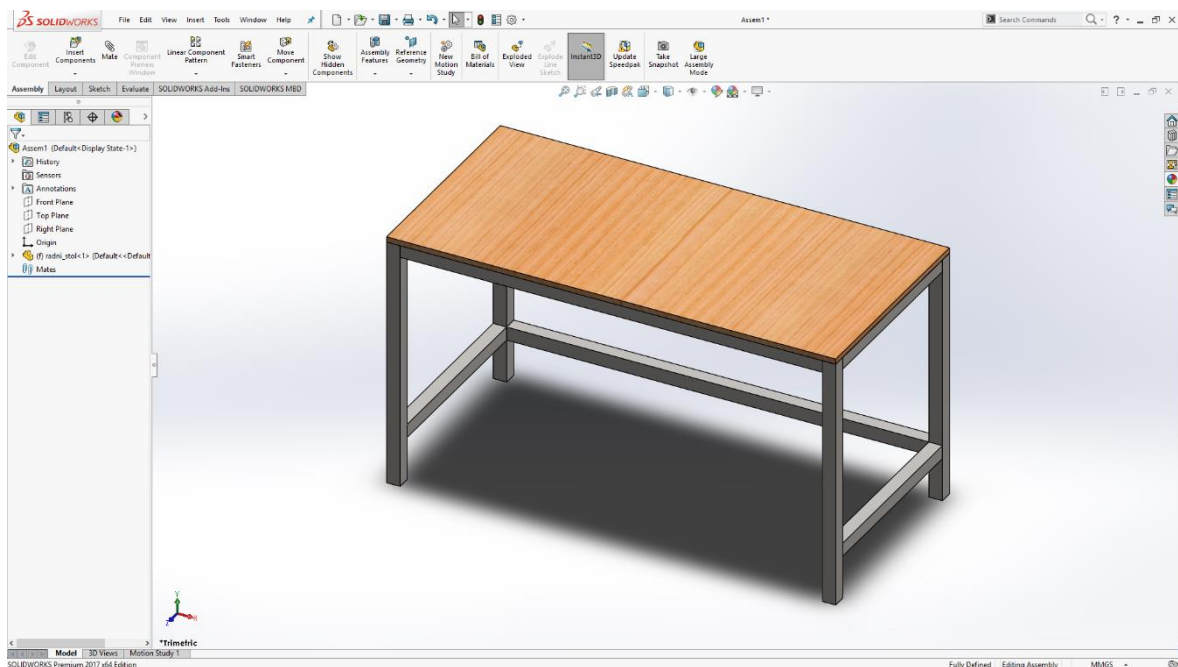
Slika 7.7: Programabilni logički kontroler



Slika 7.8: Radna ploča

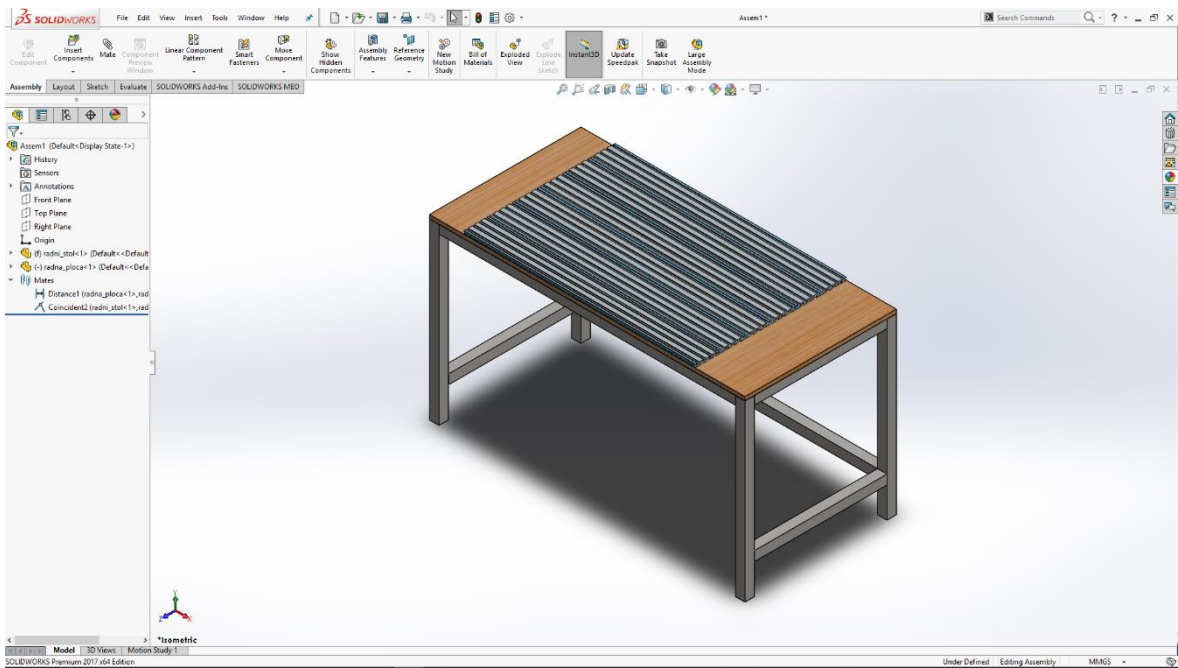
8. Assembly

Assembly je postupak slaganja pojedini modela u cjelokupni sklop pomoću posebnog sučelja koje je jako slično Part sučelju.



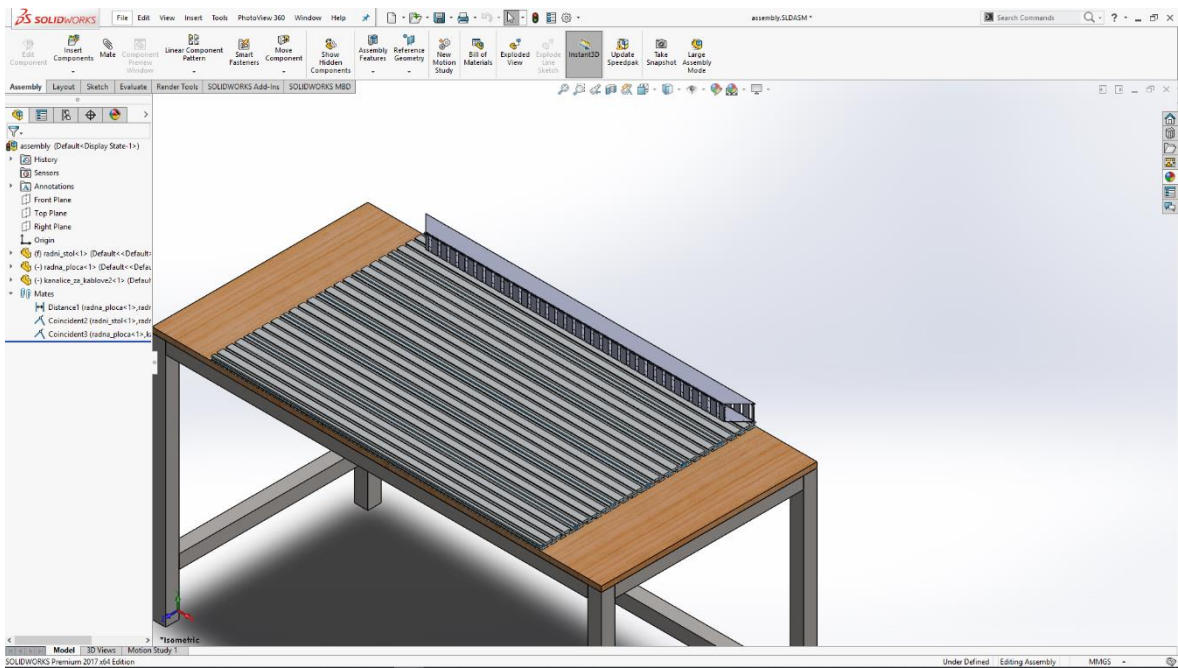
Slika 8.1: Radni stol

Sastavljanje cjelokupnog sklopa započinje s radnim stolom na kojeg stavljamo radnu ploču.

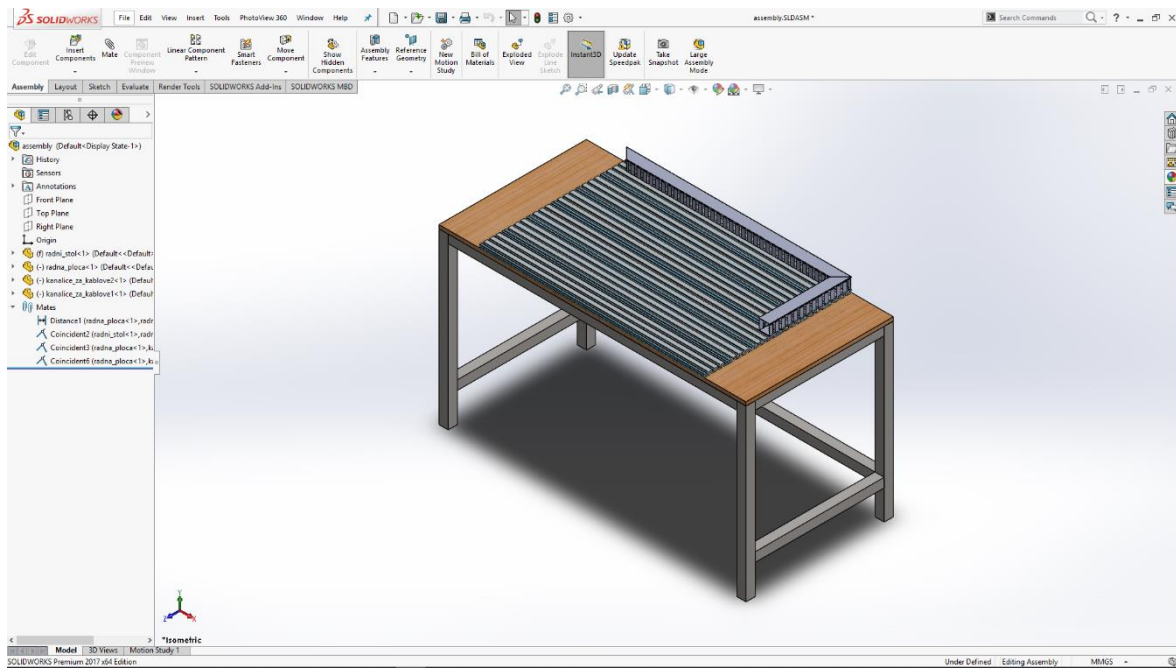


Slika 8.2: Radna ploča

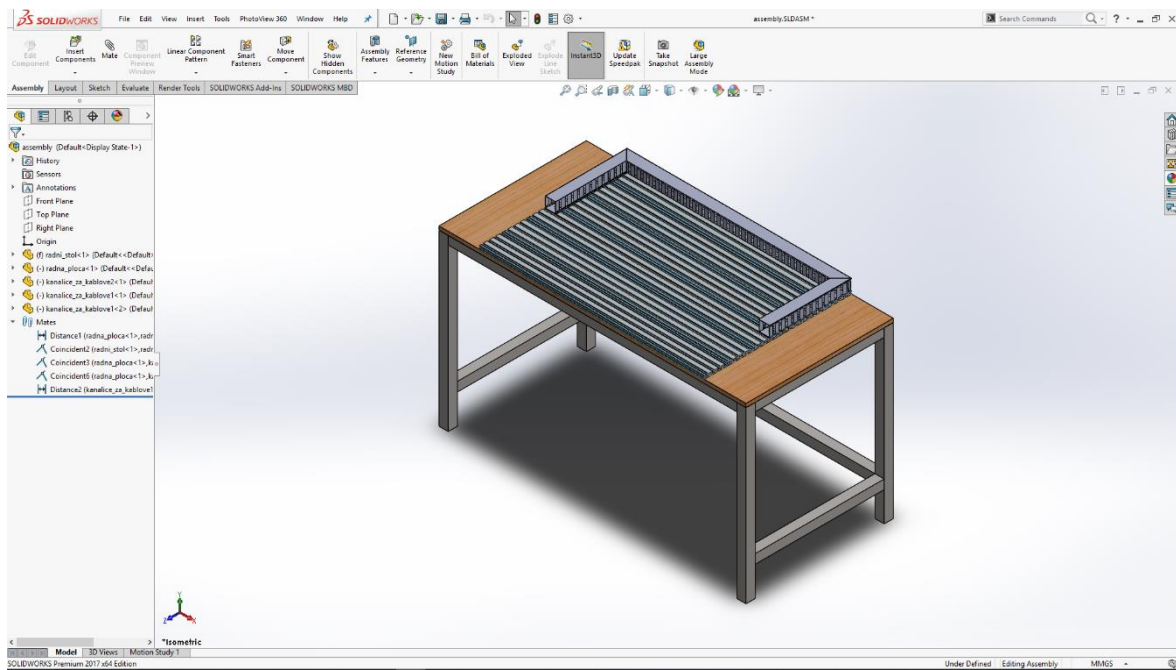
Na radnu ploču prvo stavljamo dužu kanalicu za kablove, te sa svake strane stavljamo po jednu kraću kanalicu za kablove.



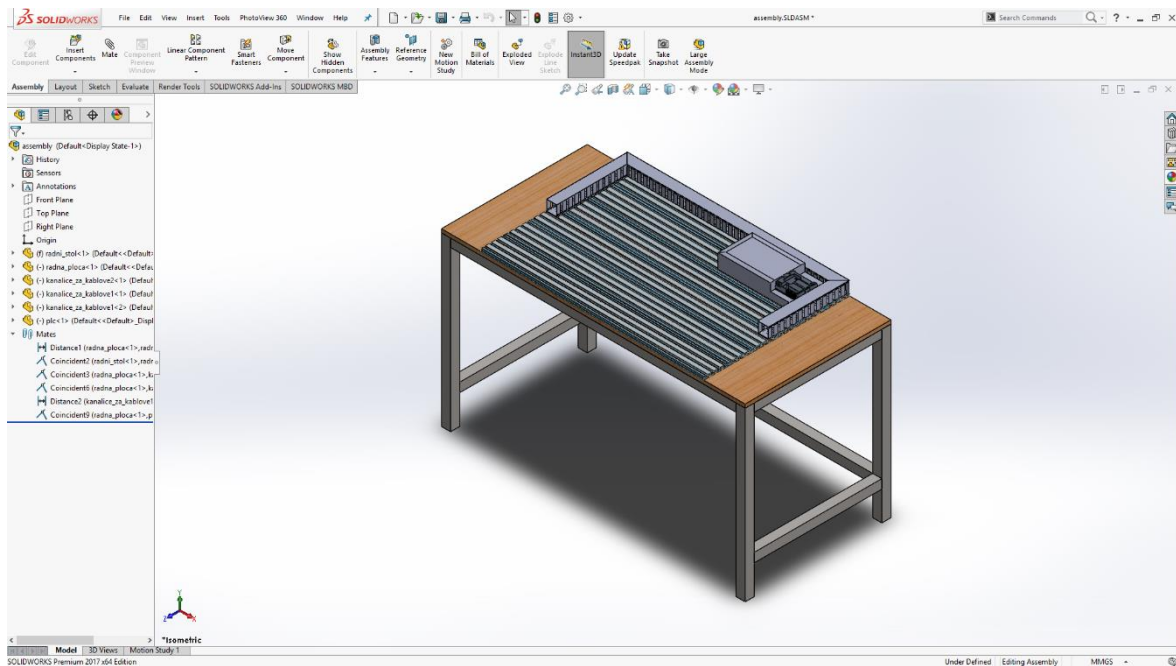
Slika 8.3: Duža kanalica za kablove



Slika 8.4: Kraća kanaliza za kablove

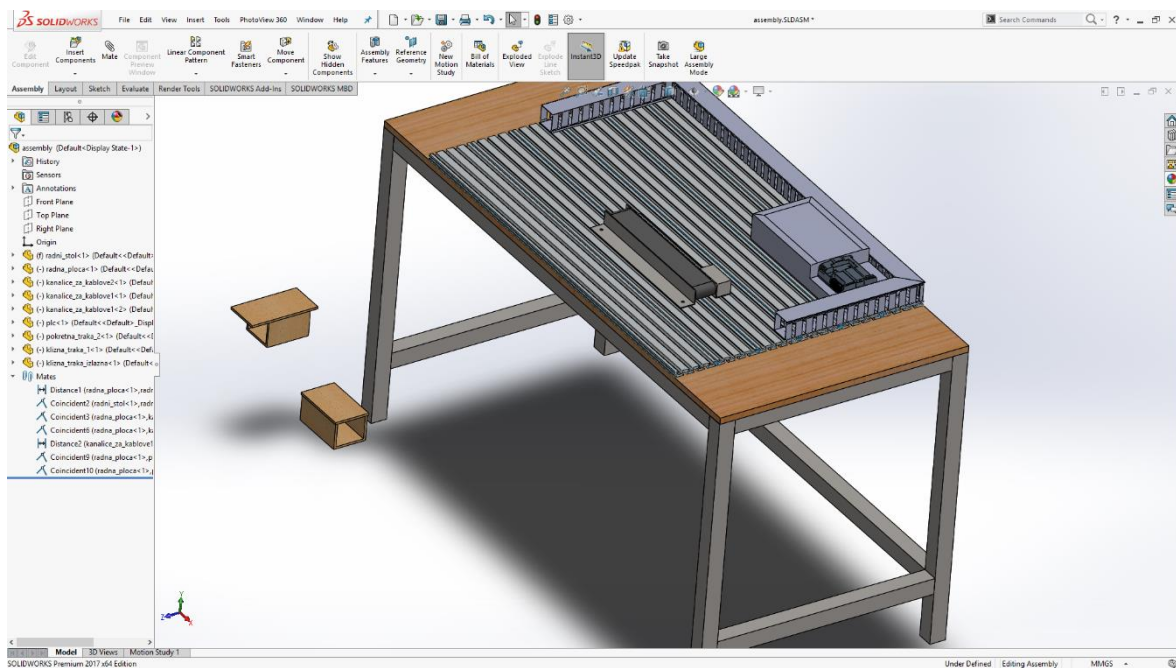


Slika 8.5: Kraća kanaliza za kablove s druge strane



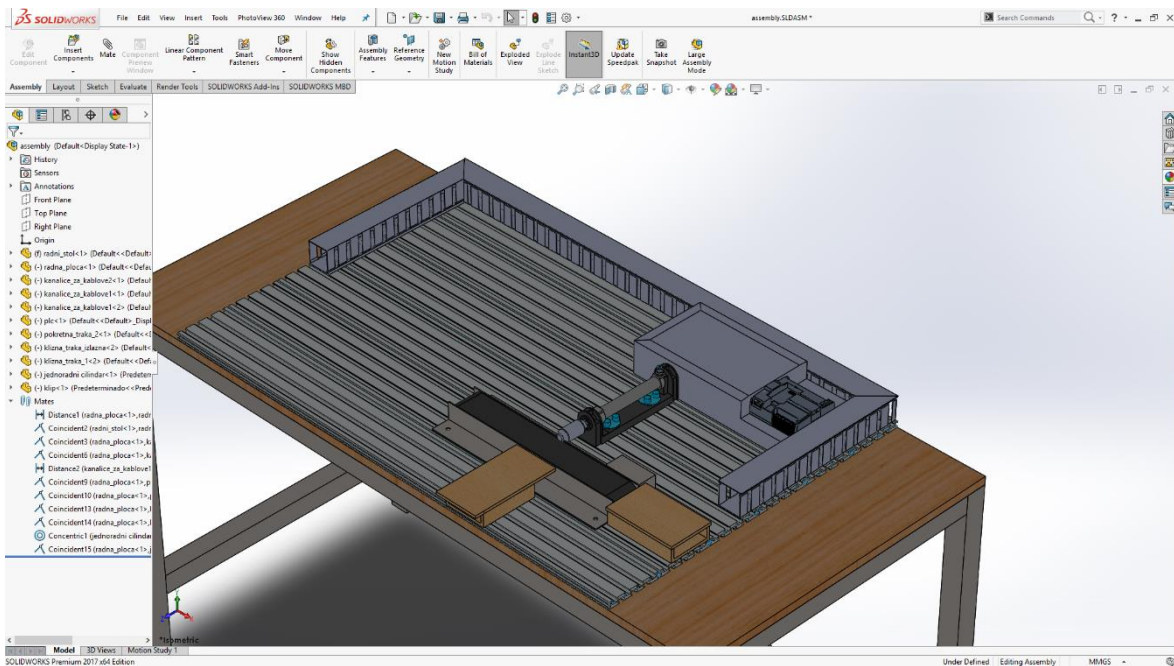
Slika 8.6: programibilni logički kontroler

Sljedeći model koji stavljamo je programibilni logički kontroler te ga pomoću naredbe Mate smještamo u kut kanalice.



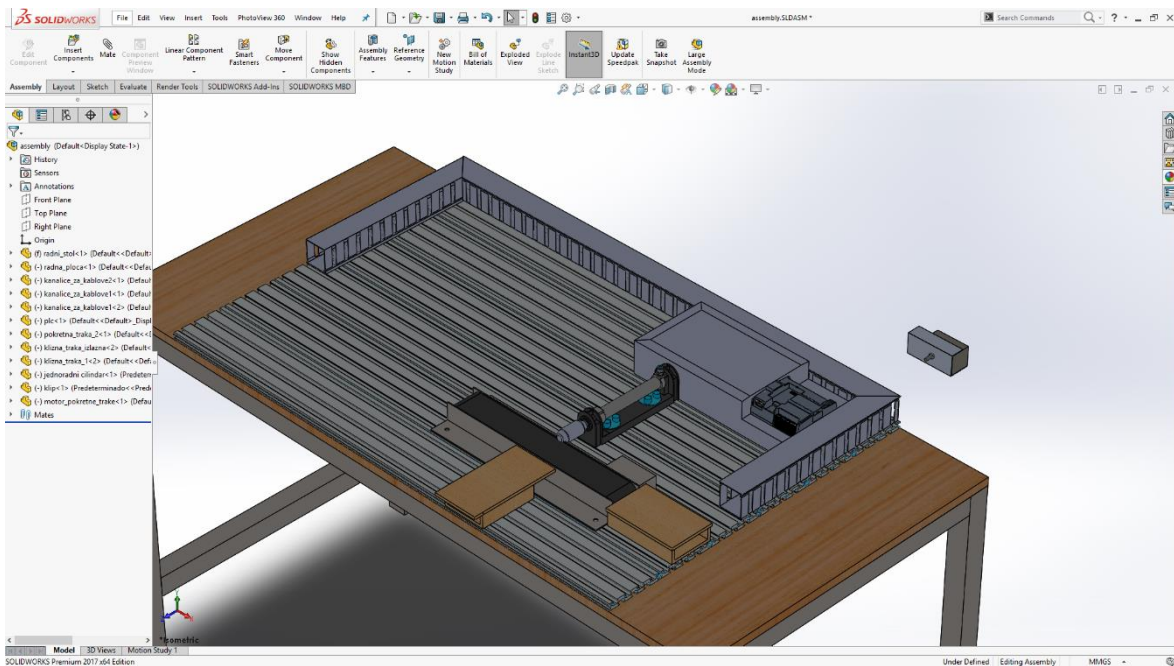
Slika 8.7: pokretna traka s remenom i izlazne trake

U Assembly umećemo pokretnu traku s remenom i dvije izlazne trake.



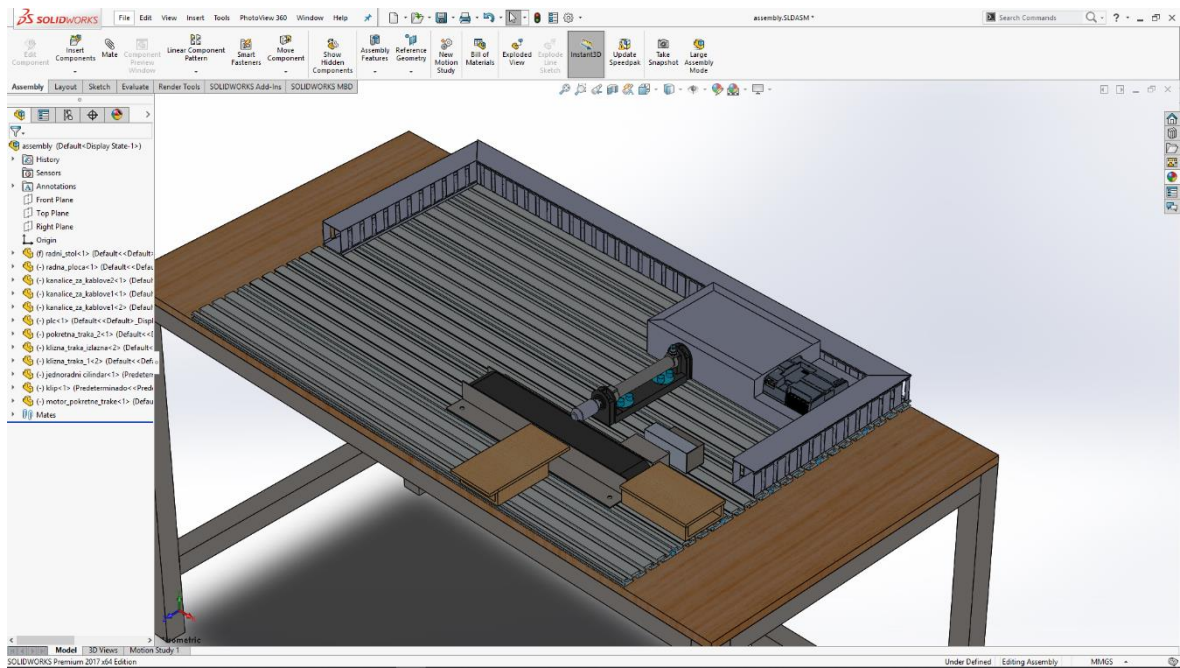
Slika 8.8: Pneumatski cilindar

Bočno od pokretne trake s remenom stavljamo pneumatski cilindar koji služi za potiskivanje određenog radnog materijala.



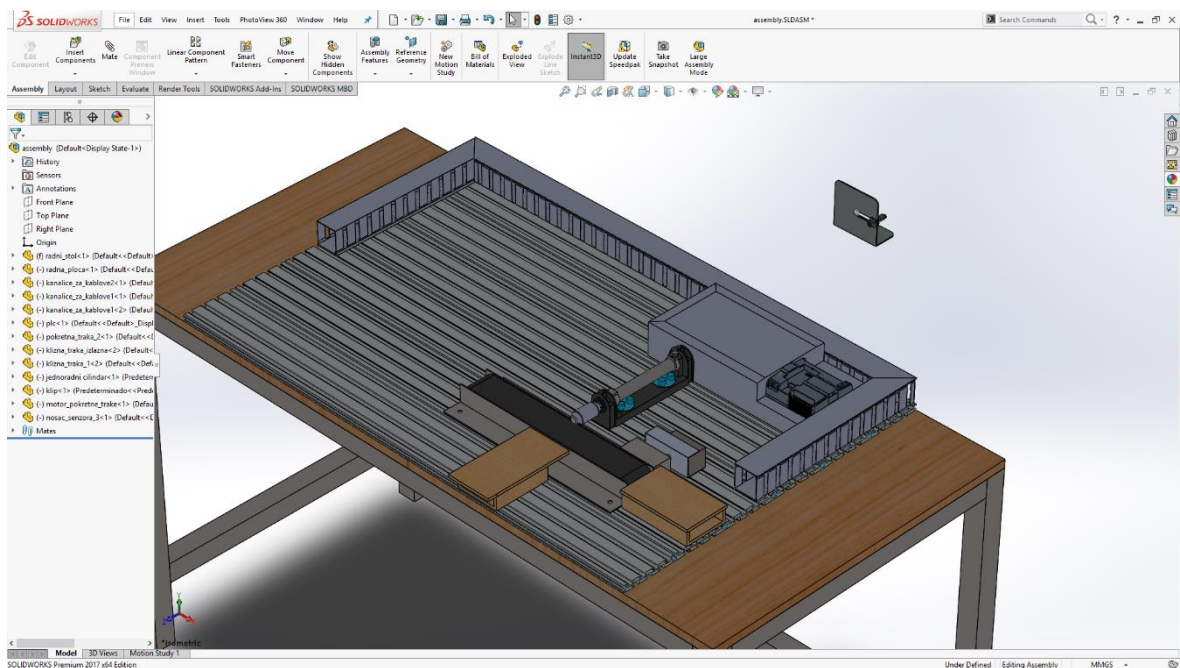
Slika 8.9: Motor pokretne trake

Kako bi pokretna traka s remenom radila potrebno je postaviti motor i spojiti ga s pokretnom trakom. Naredbama Mate i Move component se služimo kako bismo to omogućili.

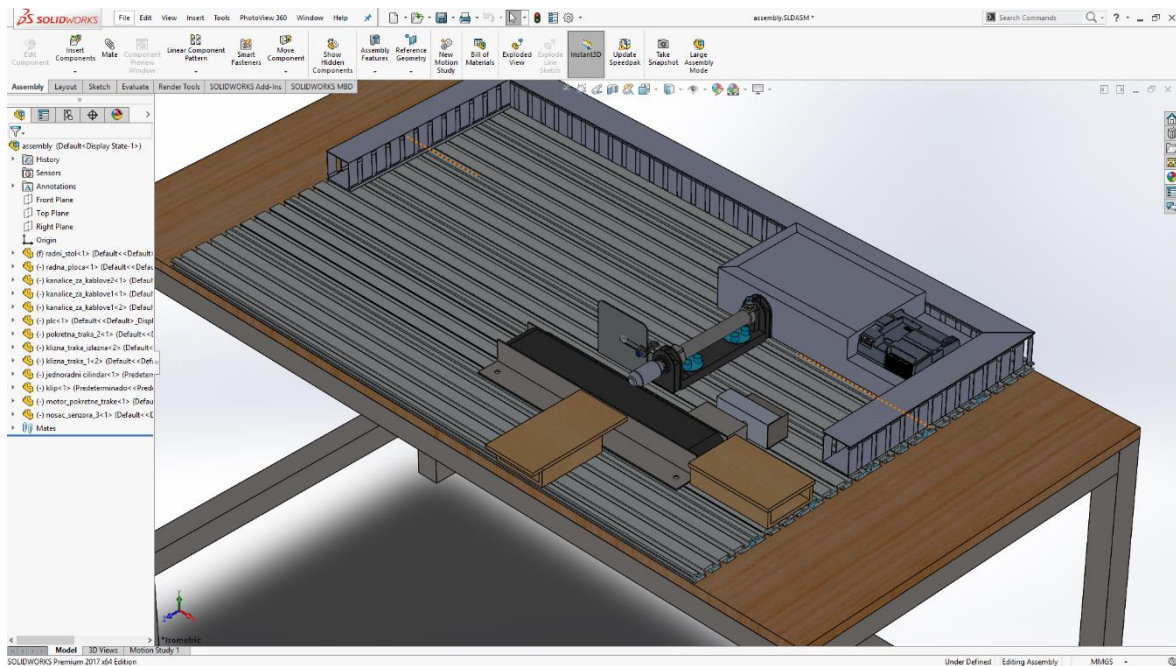


Slika 8.10: motor spojen na pokretnu traku s remenom

Nakon toga, bočno na pokretnu traku s remenom umećemo senzor i njegov držač.

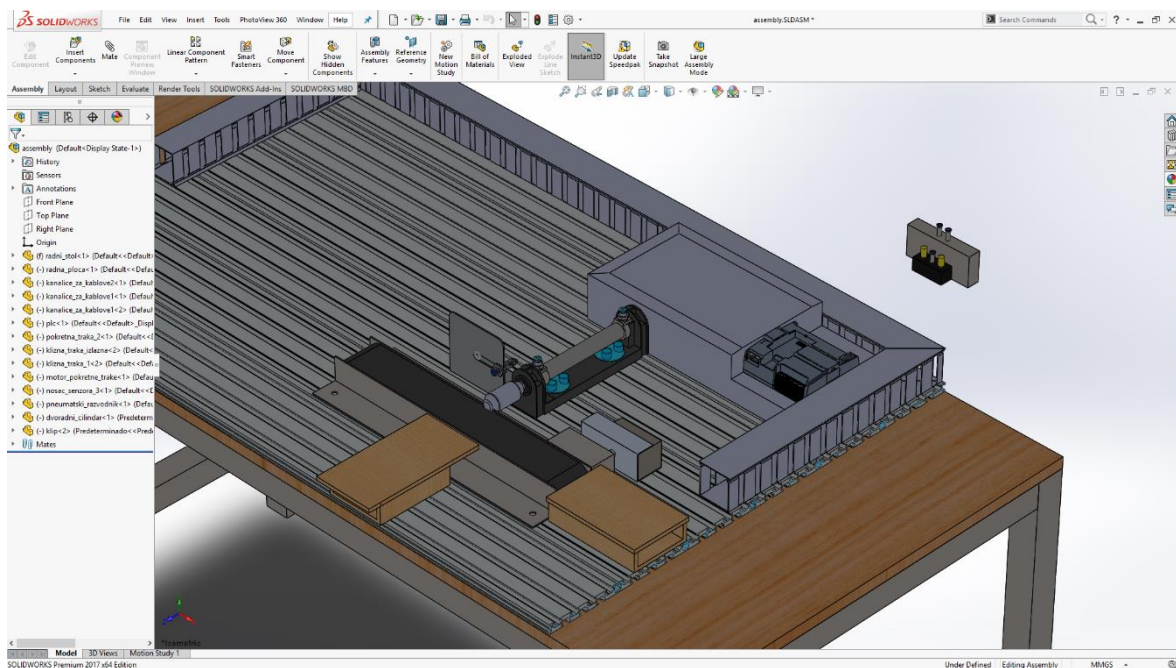


Slika 8.11: Držač senzora s senzorom

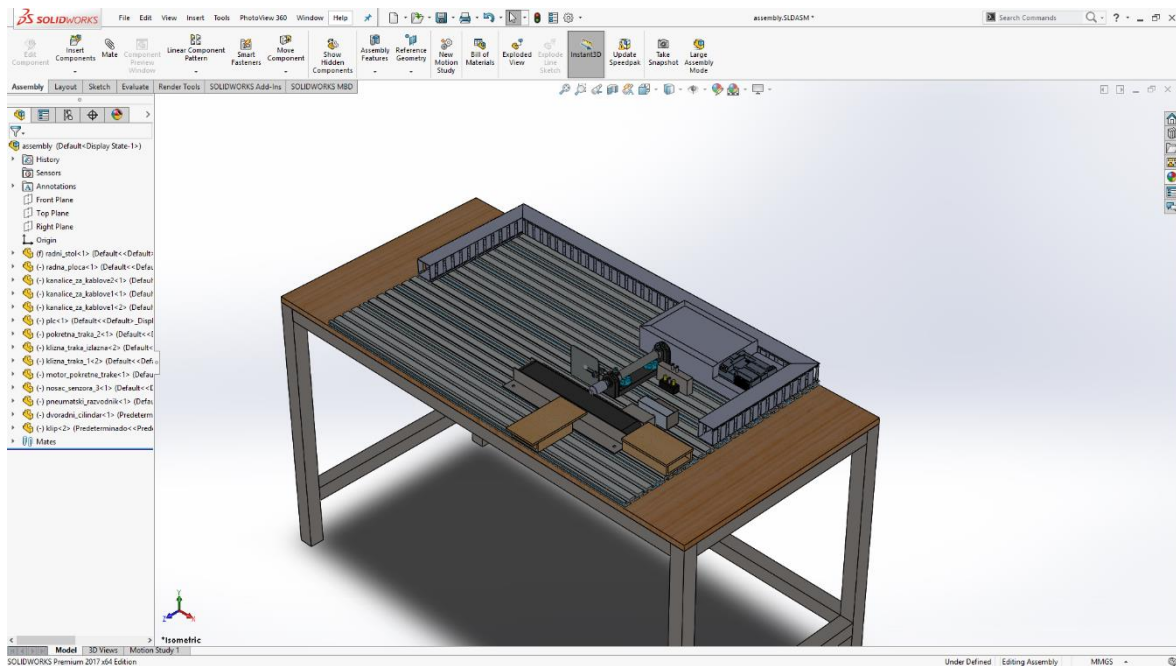


Slika 8.12: Senzor stavljen bočno od pokretne trake

Za pneumatski cilindar je potreban pneumatski razvodnik te njega stavljamo sljedećeg.

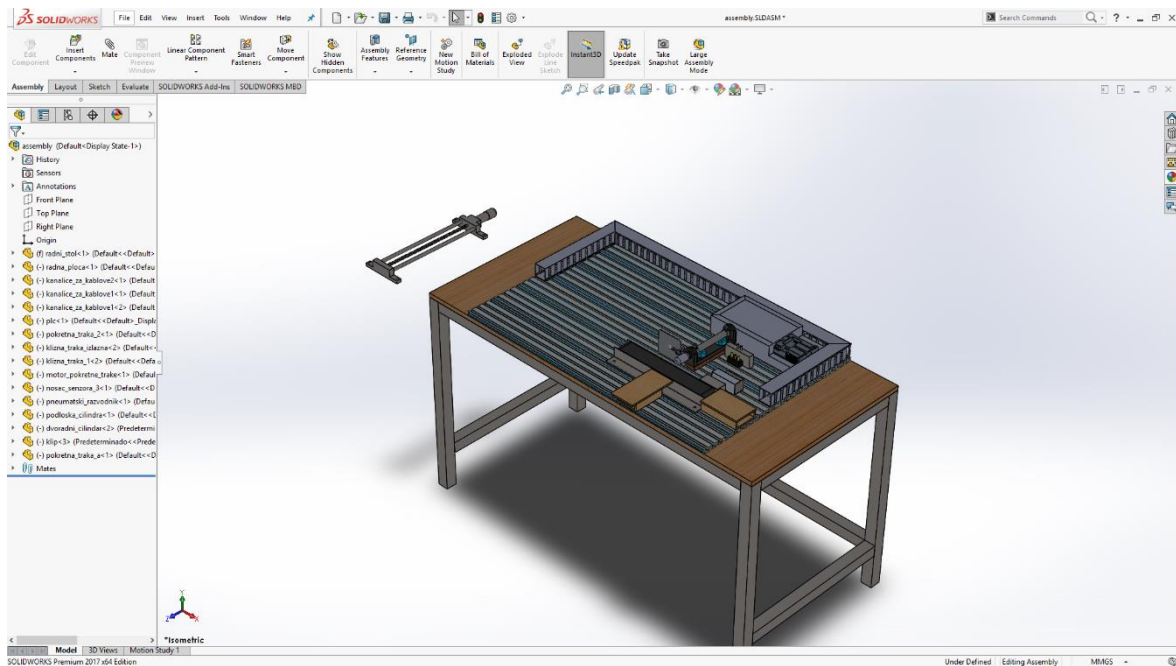


Slika 8.13: Pneumatski razvodnik

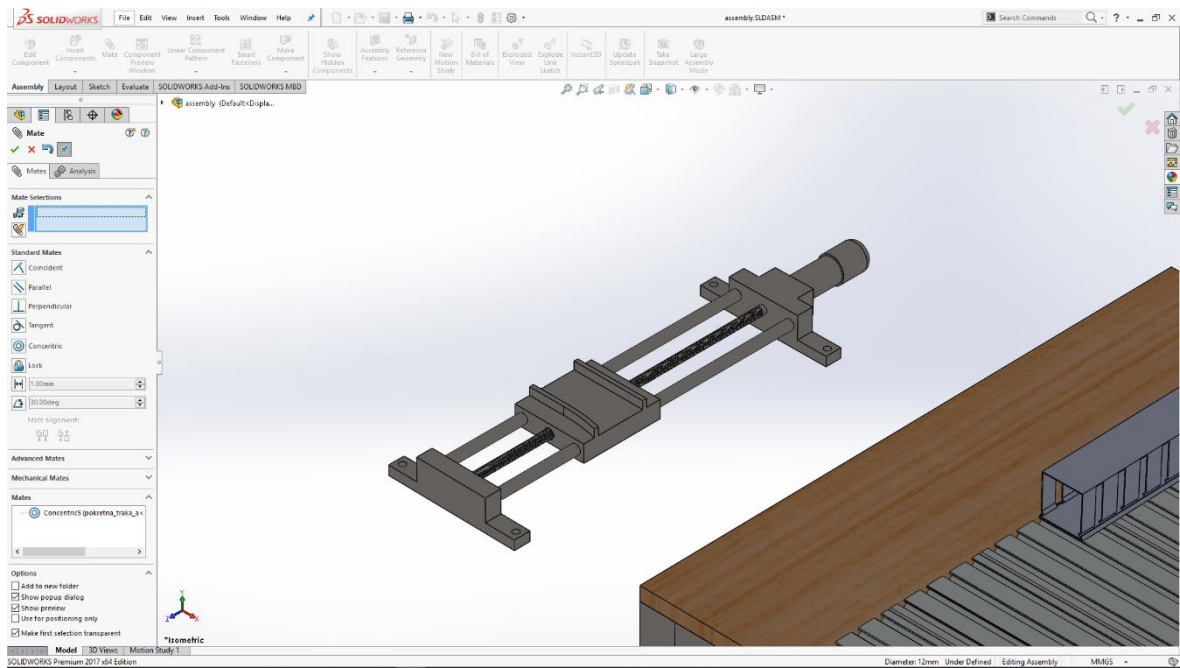


Slika 8.14: Pneumatski razvodnik stavljen bočno od cilindra

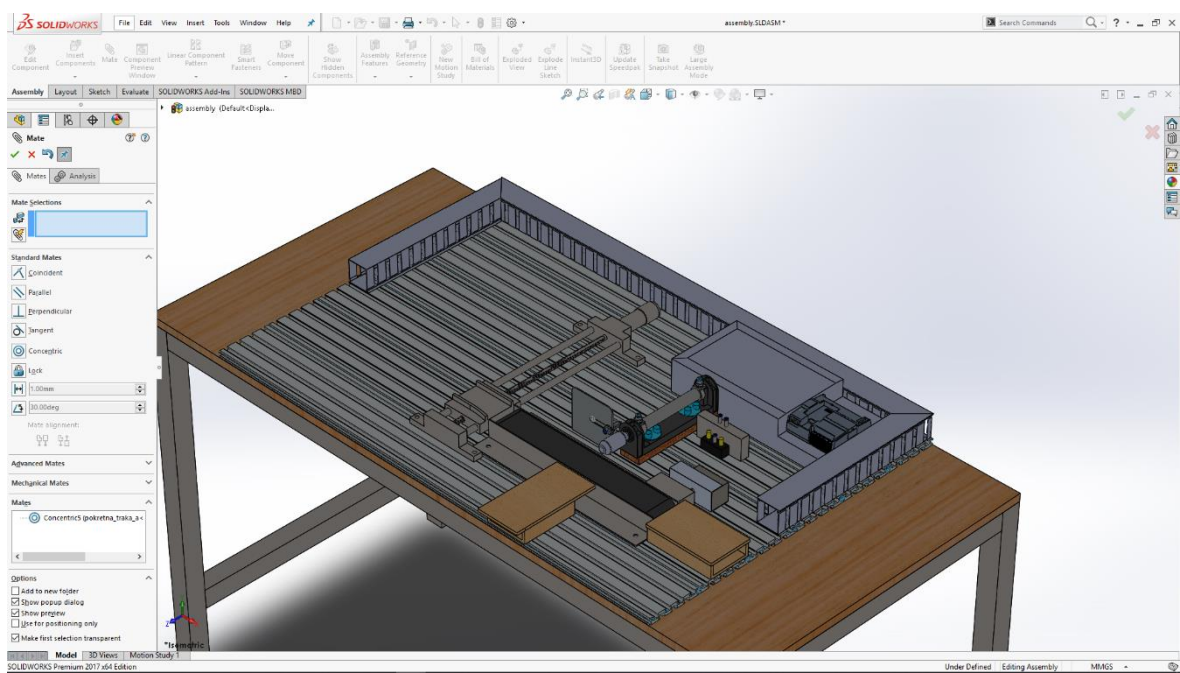
Za sljedeći model stavljamo pokretnu traku na koju najprije stavljamo nosač radnog materijala, te tu pokretnu traku smještamo okomito na pokretnu traku s remenom.



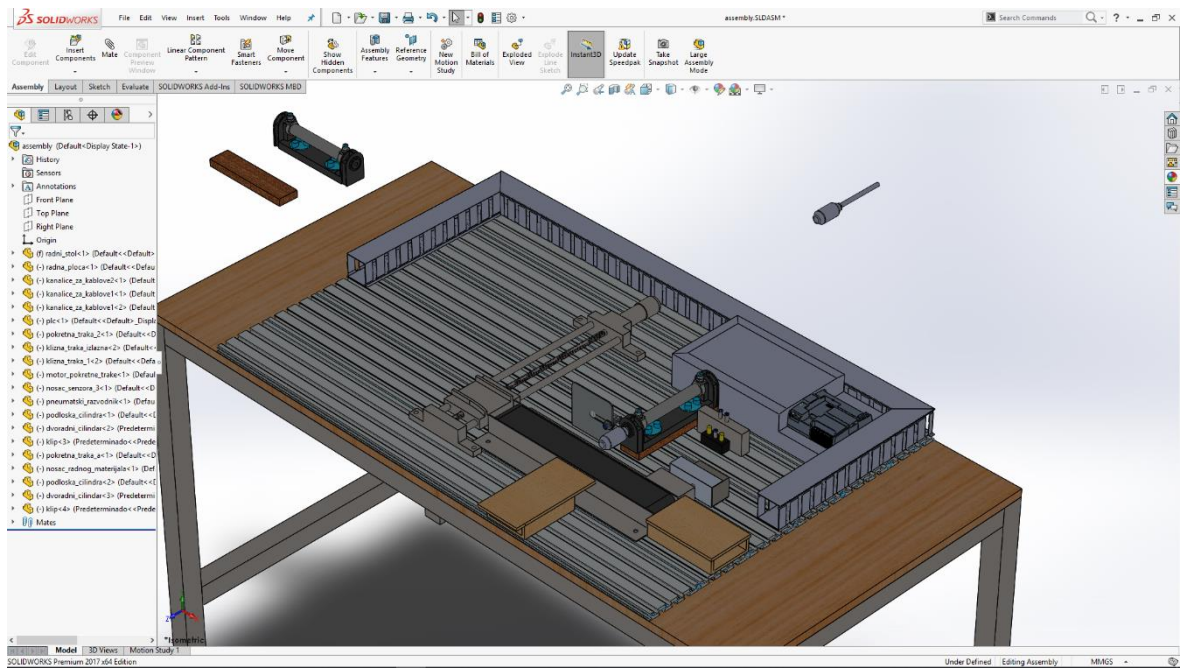
Slika 8.15: Pokretna traka



Slika 8.16: Nosač radnog materijala na pokretnoj traci

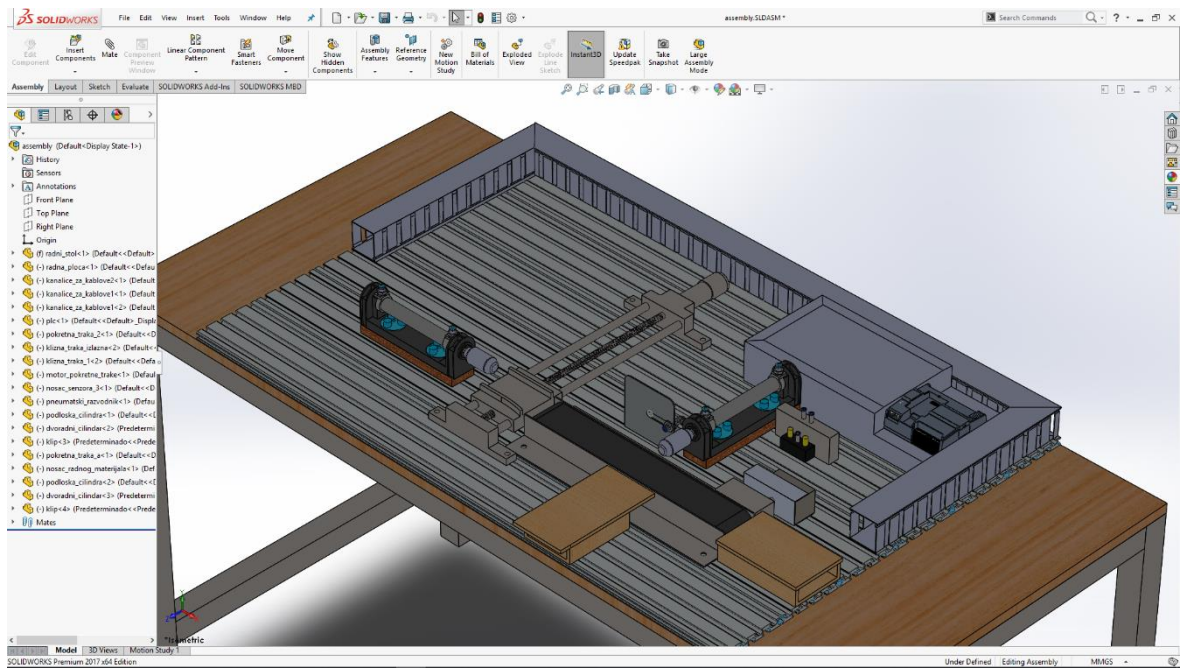


Slika 8.17: Pokretna traka smještena okomito od trake s remenom

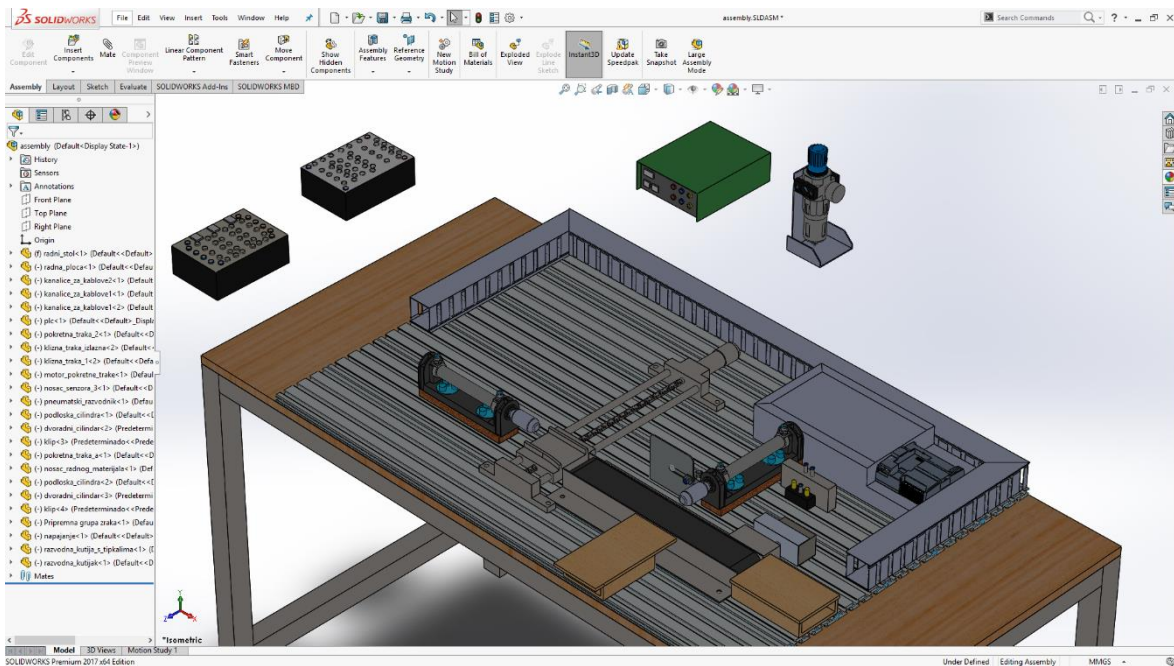


Slika 8.18: Pneumatski cilindar

Potreban nam je pneumatski cilindar kako bismo potisnuli radni materijal s jedne pokretne trake na drugu.

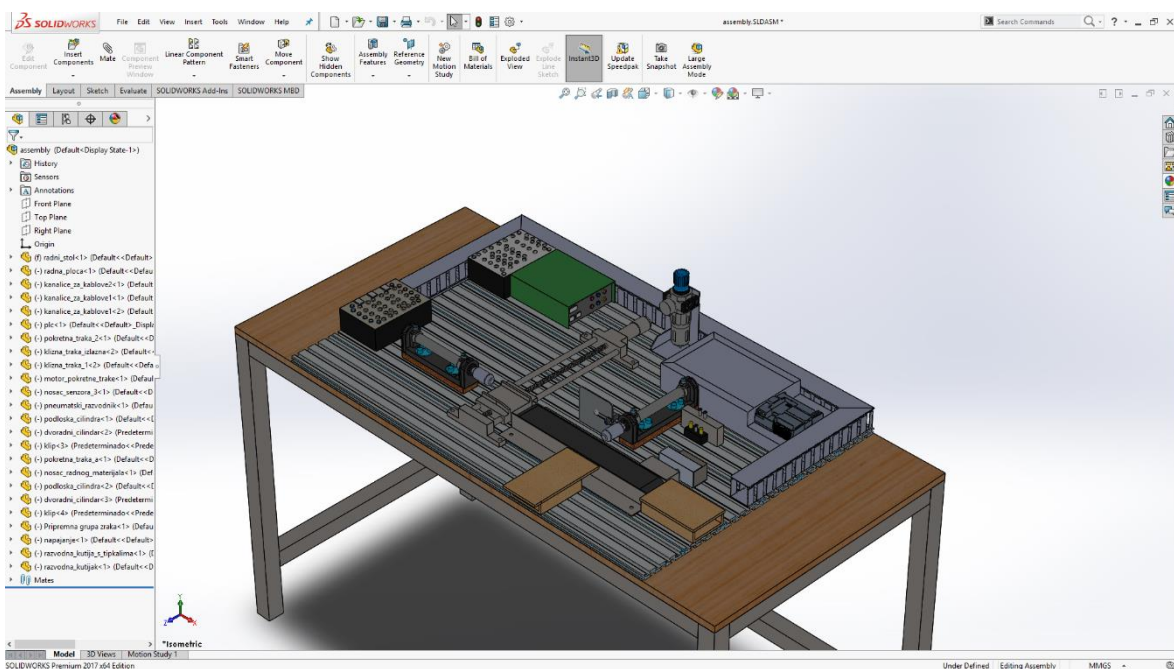


Slika 8.19: Postavljen pneumatski cilindar

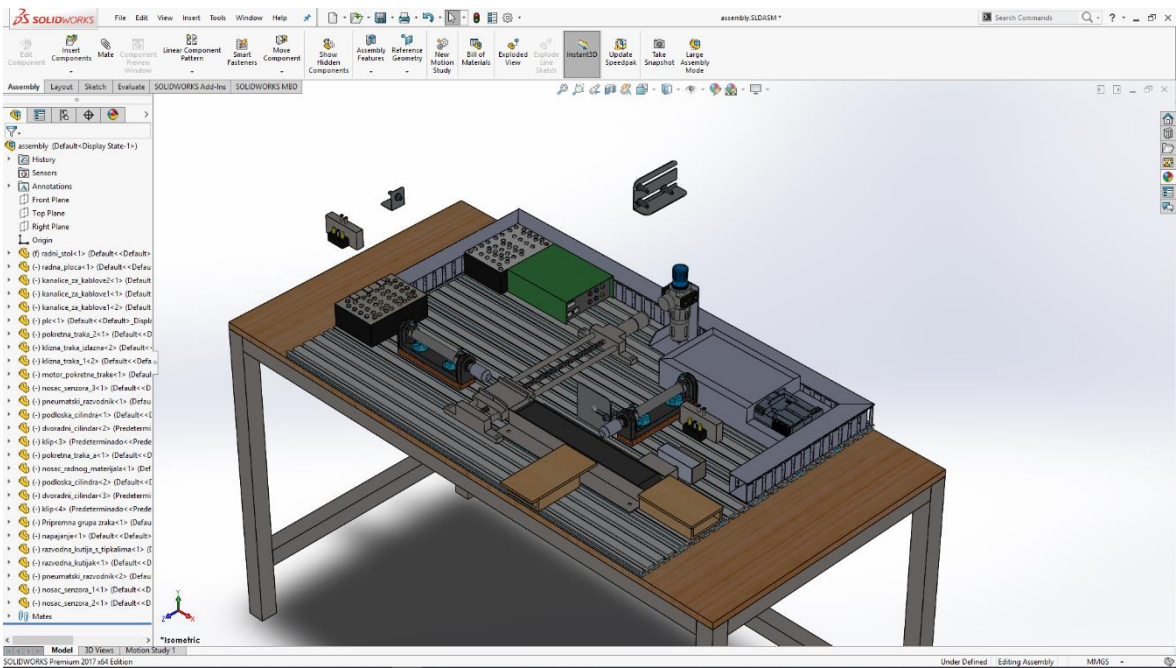


Slika 8.20: Napajanje i festo-vi elementi

U kutu kanalice za kablove stavljamo razvodnu kutiju i napajanje, nasuprot njih stavljamo pripremnu grupu zraka. Nasuprot drugog pneumatskog cilindra stavljamo razvodnu kutiju s tipkalima.

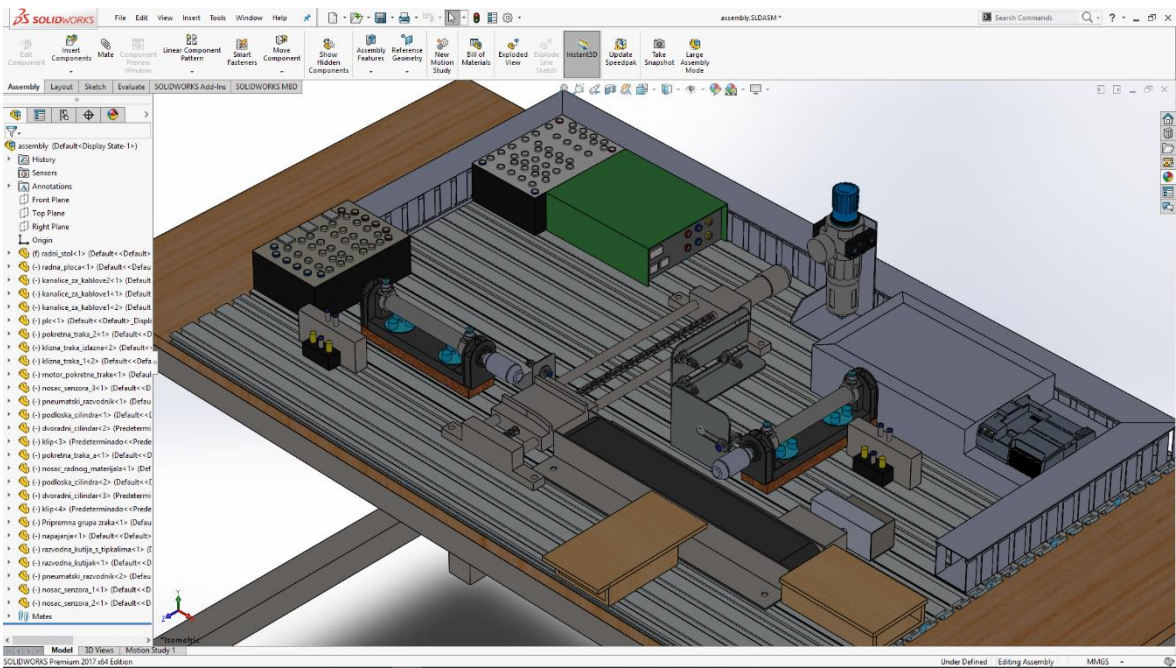


Slika 8.21: Posloženi festo-vi elementi i napajanje

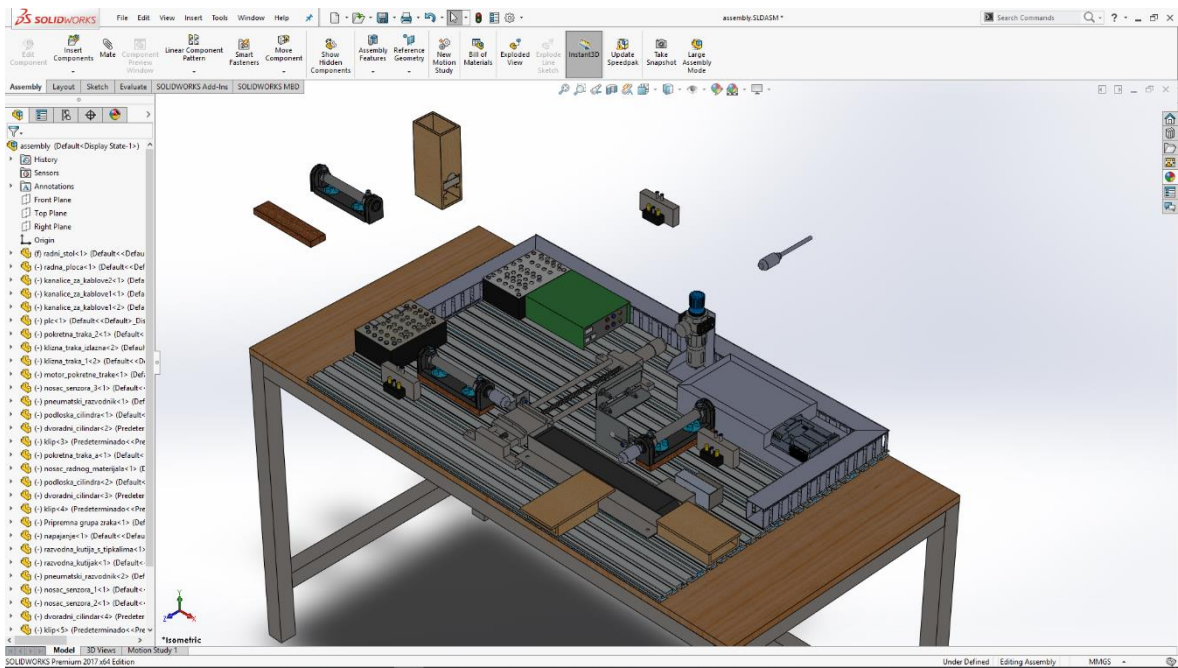


Slika 8.22: Pneumatski razvodnik i senzori

Za drugi cilindar nam je potreban pneumatski razvodnik, te također stavljamo još dodatne senzore u Assembly.

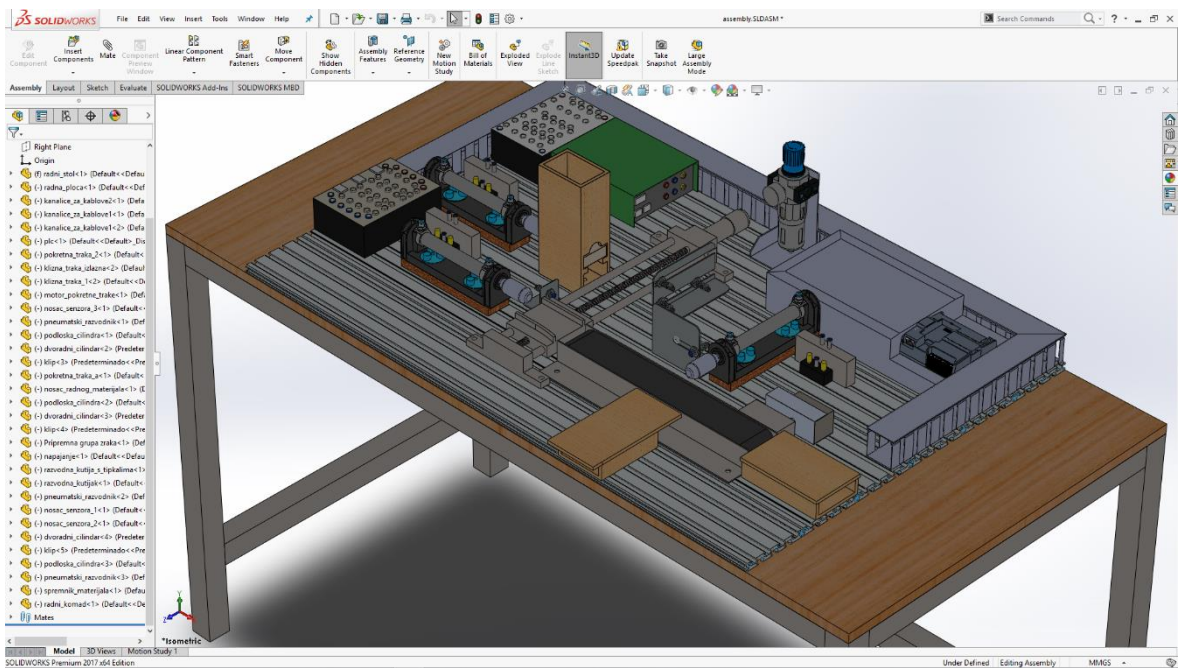


Slika 8.23: Posloženi pneumatski razvodnik i senzori

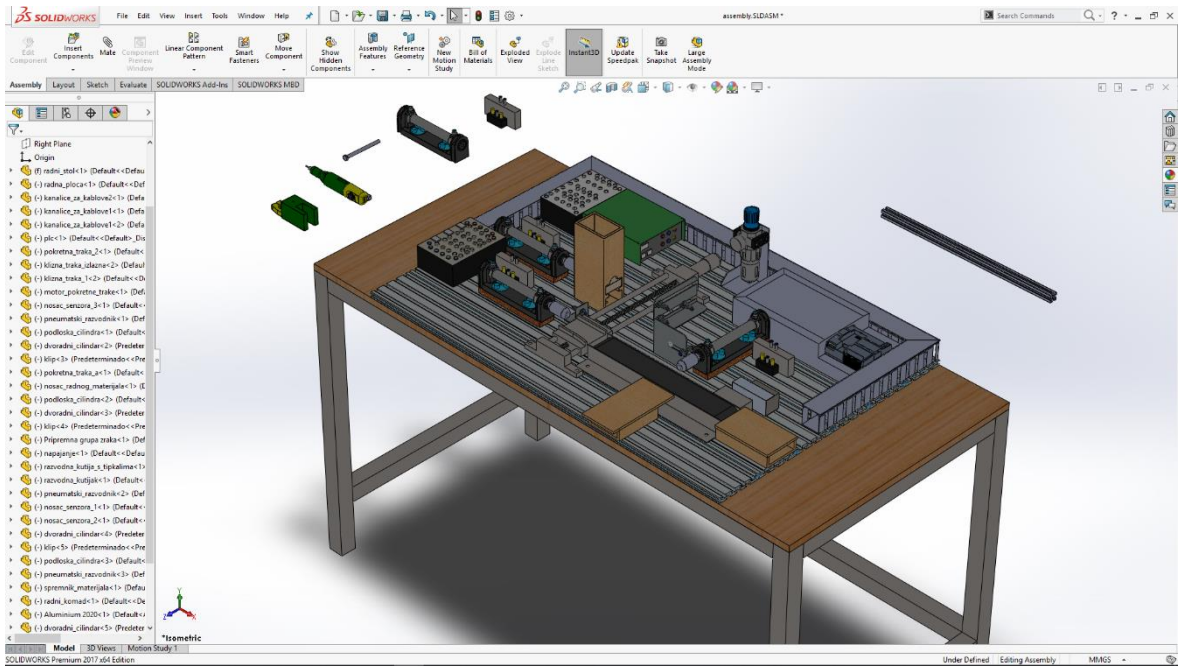


Slika 8.24: Spremnik materijala s radnim materijalom

Bočno od pokretne trake stavljamo spremnik materijala s radnim materijalom, te stavljamo pneumatski cilindar kako bismo potisnuli radni materijal iz spremnika materijala na pokretnu traku.

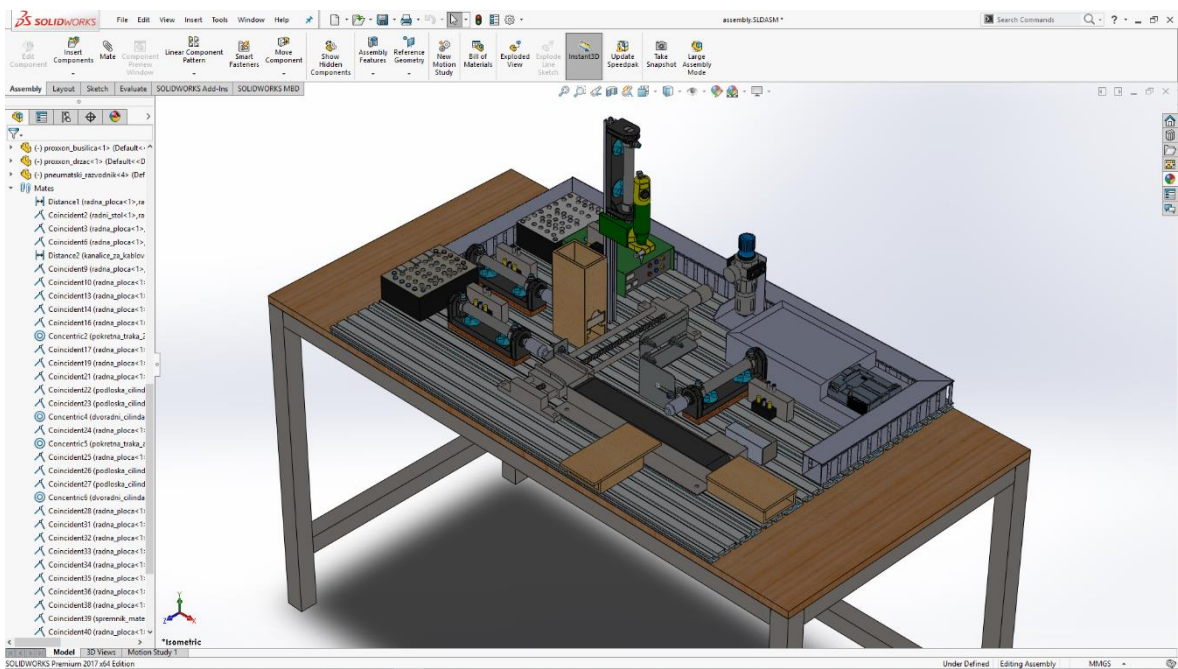


Slika 8.25: Postavljen spremnik materijala s radnim materijalom



Slika 8.26: Proxon bušilica

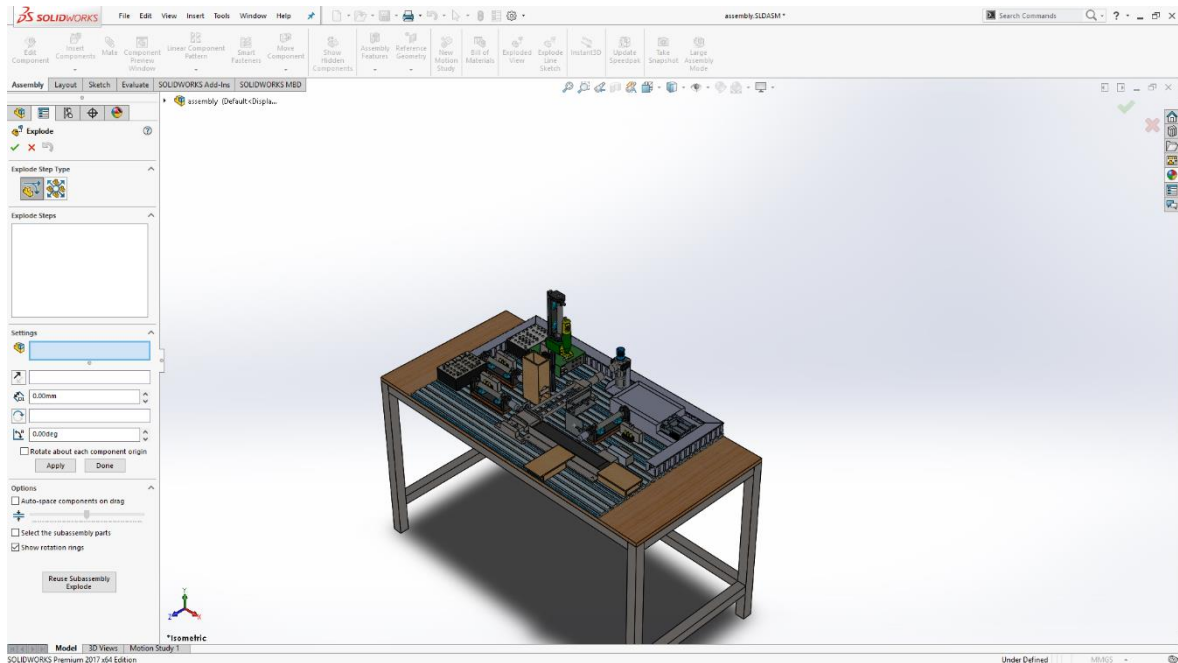
Metalnu šipku stavljamo okomito na pokretnu traku na kojoj stavljamo pneumatski cilindar s pričvršćenim držačem za Proxon bušilicu.



Slika 8.27: Postavljena proxon bušilica

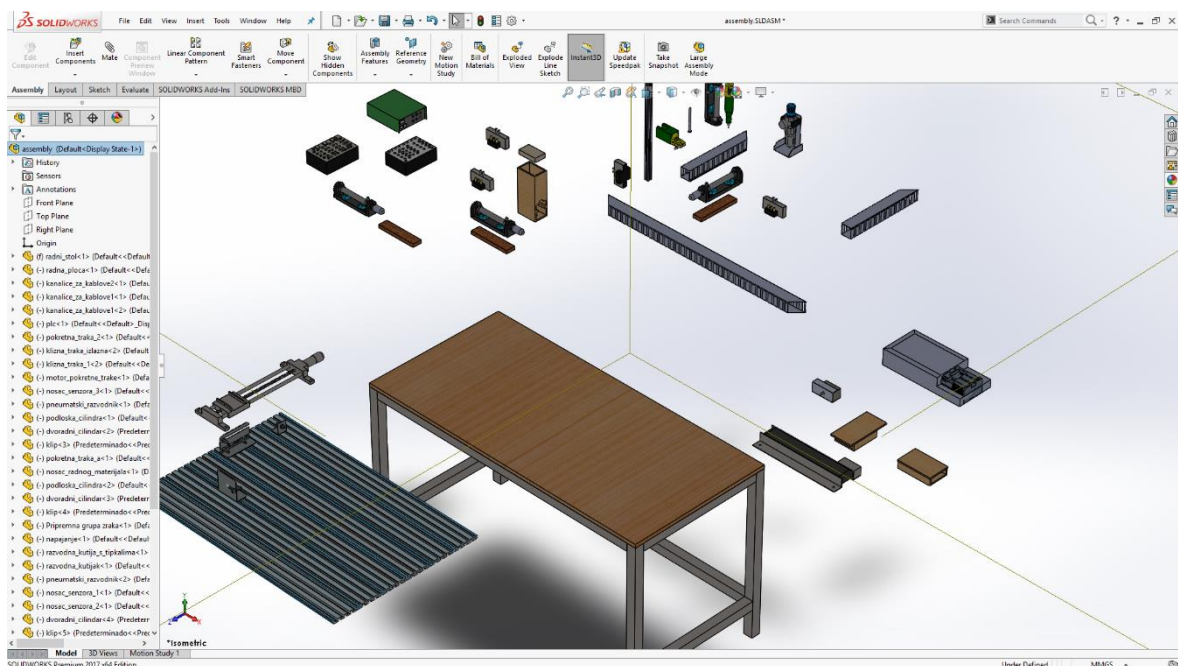
9. Exploded animacija

Exploded animacija je programsko rješenje u SolidWorksu. Služi za izradu animacije kojom prikazujemo pojedine modele i njihovo sastavljanje u pozicije u cjelokupnom sklopu.

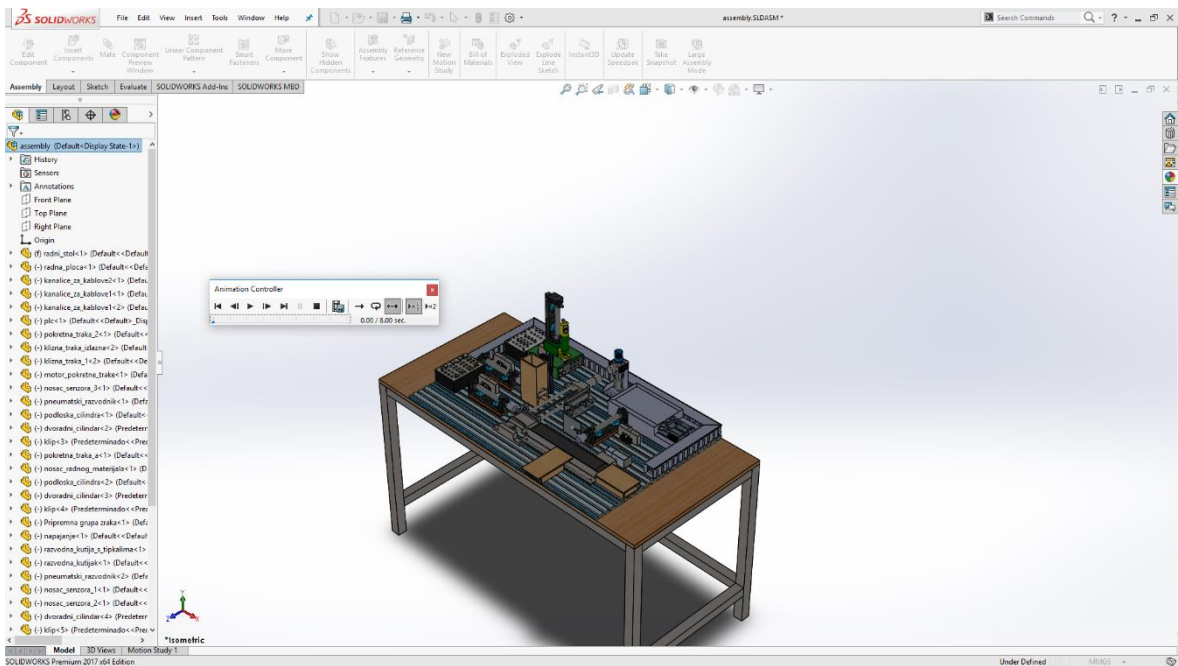


Slika 9.1: Naredba Explode

U programskoj traci nalazi se naredba Exploded View. Uključivanjem te naredbe otvara se posebno sučelje. Na tom sučelju prikazuje se svaki korak pomicanja modela. [4]

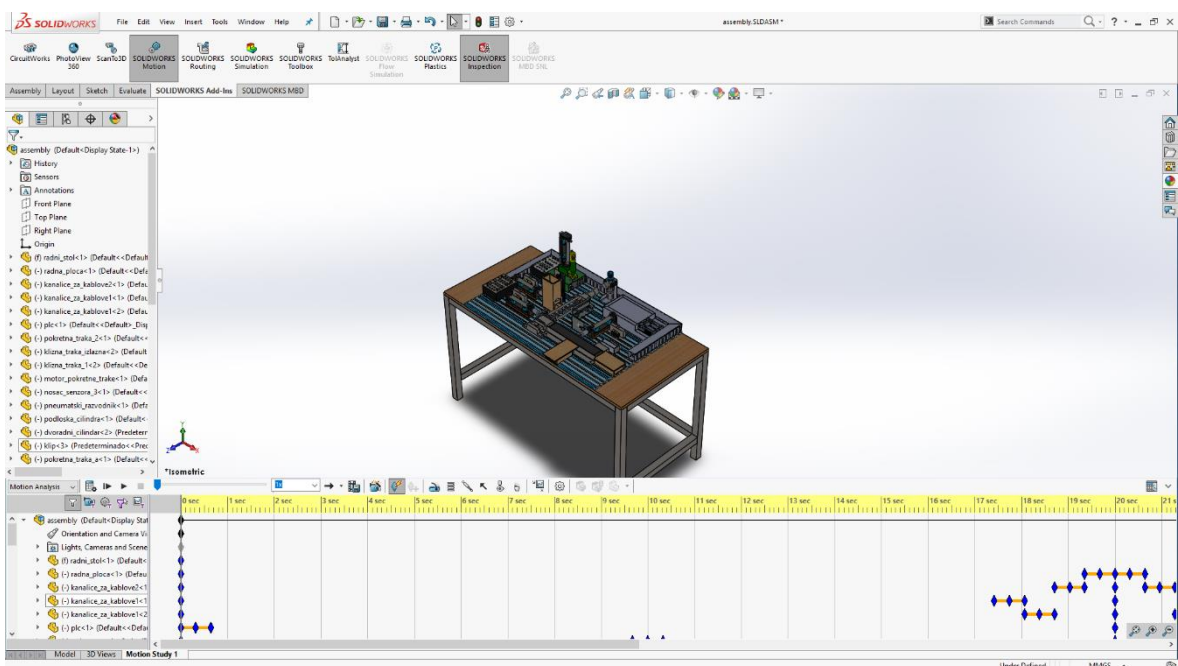


Slika 9.2: Pomaknuti modeli



Slika 9.3: Test animacije

Prije izrade finalne animacije prvo je potrebno testirati animaciju explode. Sa zadovoljnom animacijom otvaramo MotionManager te u njemu koristimo naredbu AnimationWizard kako bi dobili softversko generiranu animaciju. [5]



Slika 9.4: Finalna animacija u MotionManager-u

10. ZAKLJUČAK

Možemo zaključiti da SolidWorks program veoma olakšava proces izrade željenog cjelokupnog sklopa, a u navedenom radu uzet je za primjer model stanice za sortiranje i distribuciju. Program sam po sebi dolazi s već integriranim programskim rješenjima koja nam omogućuju brzu, preciznu i relativno jednostavnu izradu segmenata za svaki pojedini model u koje spada izrada cjelokupnog sklopa, njegovih rendera, animacije sastavljanja i simulacije rada sustava te izradu popratne tehničke dokumentacije poput tehničkog crteža za svaki model i cjelokupni sklop.

11. LITERATURA

[1] Student: Horvat Josip; Nastavnik: mag. ing. mech. Tomislav Pavlic: „seminarski rad: Mehatronički didaktički stol“, Veleučilište u Bjelovaru

[2] CAD baza „GrabCAD“

<https://grabcad.com>

(dostupno: 9.10.2019.)

[3] CAD baza „Thingiverse“

<https://www.thingiverse.com>

(dostupno: 9.10.2019.)

[4] SolidWorks HELP Creating Basic Animations

http://help.solidworks.com/2018/english/SolidWorks/motionstudies/t_creating_basic_animations_motion.htm?id=7200d63f07884bbf96b1f5dc78864b9e#Pg0

(dostupno: 9.10.2019.)

[5] SolidWorks HELP Exploding and Collapsing Using Animation Wizard

http://help.solidworks.com/2018/english/SolidWorks/motionstudies/t_exploding_collapsing_anim_wizard.htm?id=31d8013096f64d10ac20e6157e8cb887#Pg0

(dostupno: 9.10.2019.)

12. SAŽETAK

Naslov: Razvoj funkcionalnog 3D modela stanice za sortiranje i distribuciju

U ovom radu prikazana je izrada modela i animacije stanice za sortiranje i distribuciju u programu SolidWorks. Kako bismo dobili gotov cjelokupni sklop ili Assembly potrebno je izraditi pojedinačni model svakog dijela tog cjelokupnog sklopa. Pri izradi koristimo module programa SolidWorks kao što su PhotoView360 za renderiranje foto realističnih slika modela i MotionManager za izradu animacije sastavljanja cjelokupnog sklopa i izradu simulacije rada. Svaki korak izrade pojedinog modela, cjelokupnog sklopa i animacije je popraćen tekstom i slikovnim prikazom.

Ključne riječi: SolidWorks, PhotoView360, MotionManager.

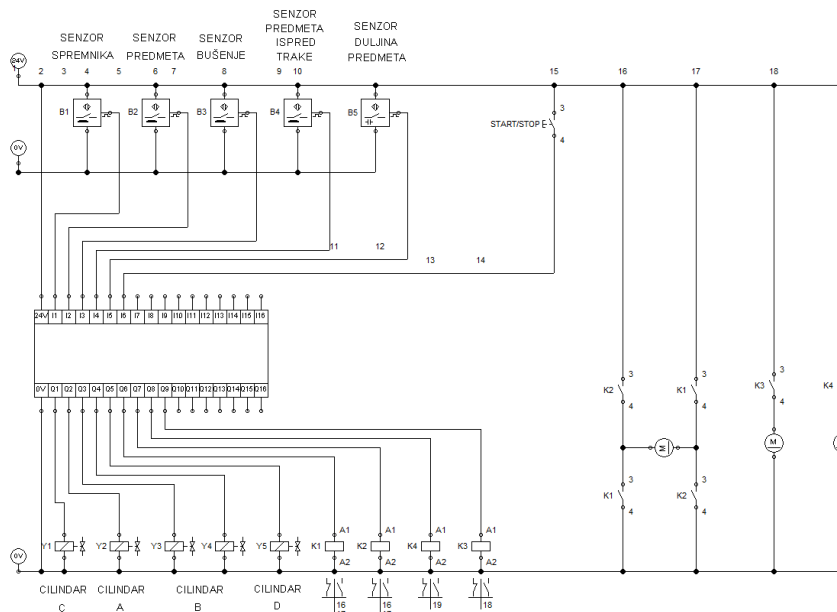
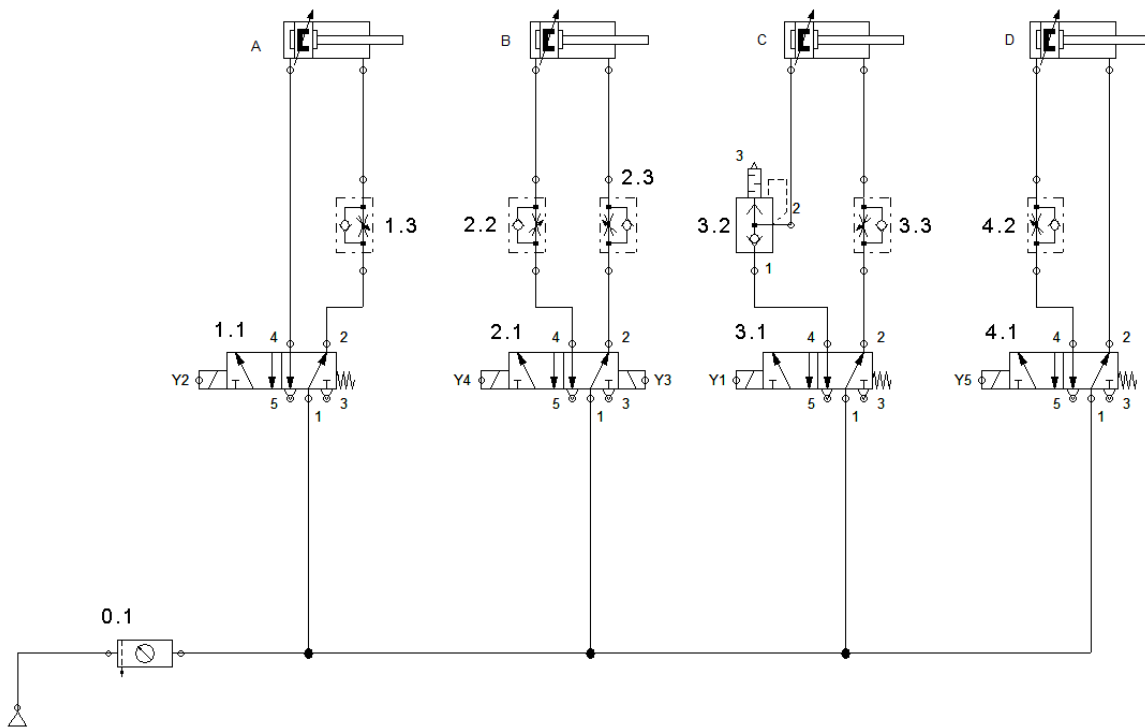
13. ABSTRACT

Title: Development of a functional 3D model station for sorting and distribution

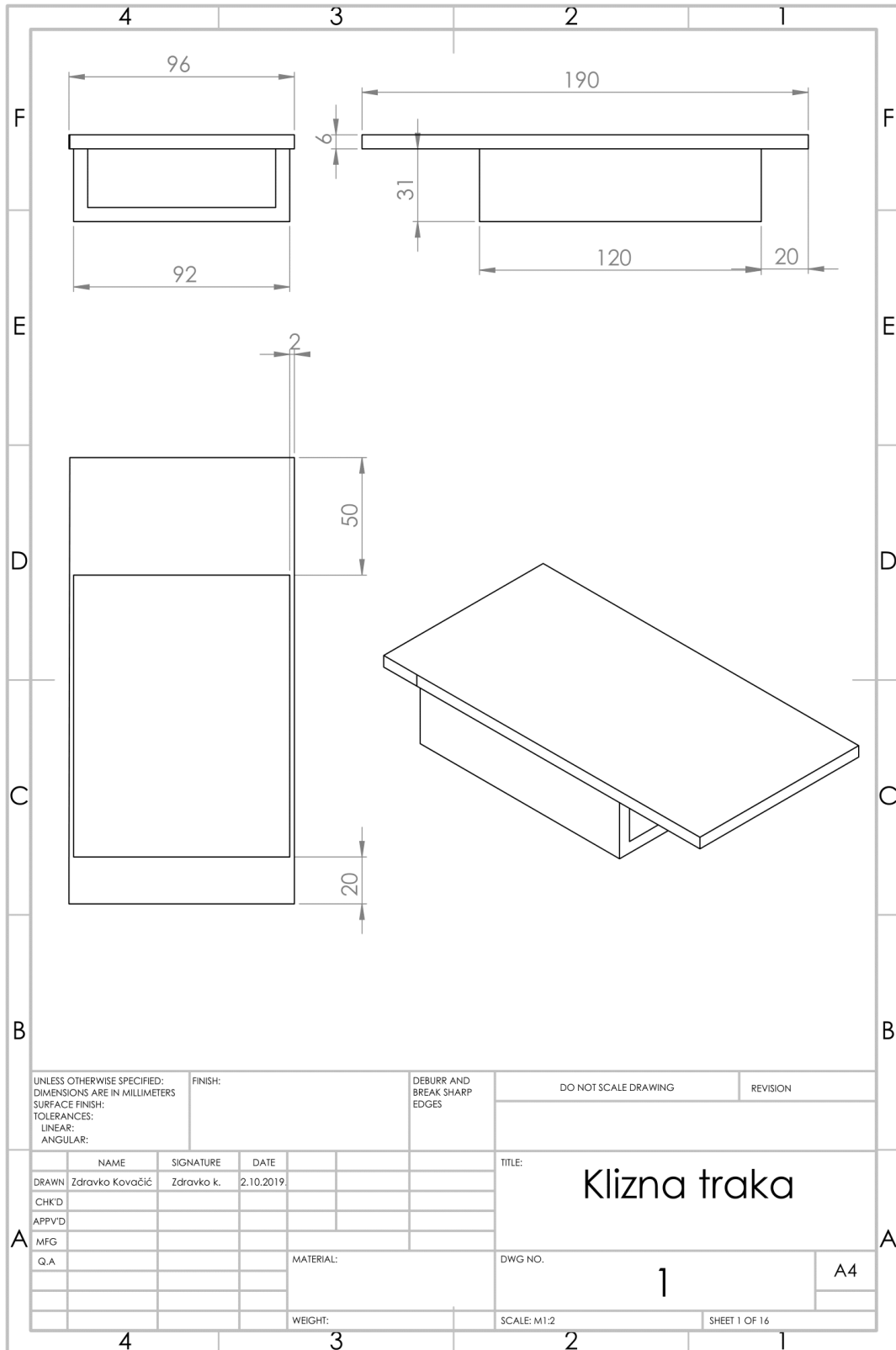
This paper shows how to create a model and an animation of a sorting and distribution station in SolidWorks. In order to get the complete assembly it is necessary to create an individual model of each part of that complete assembly. When creating, we use SolidWorks modules such as PhotoView360 to render photo realistic images of the model and MotionManager to create an animation of the assembly and to create a work simulation. Each step of creating an individual model, the entire assembly and animation is accompanied by text and a pictorial representation.

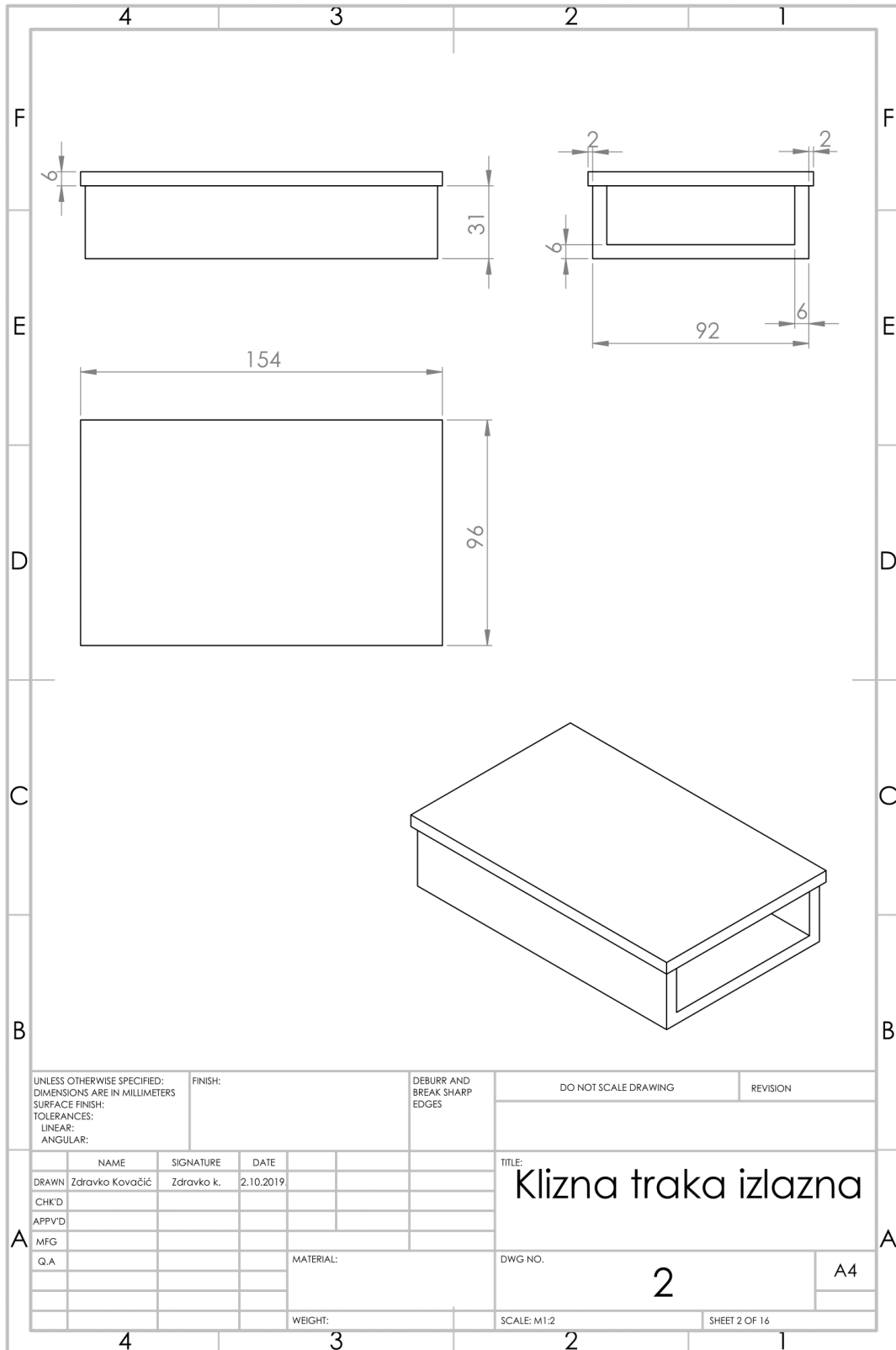
Keywords: SolidWorks, PhotoView360, MotionManager.

14. PRILOZI



Designation	Description
0.1	Air service unit, simplified representation
A	Compressed air supply
A	Double acting cylinder
1.1	S/Z racevalve
1.3	One-way flow control valve
B	Double acting cylinder
2.1	S/Z racevalve
2.3	One-way flow control valve
C	Double acting cylinder
3.1	S/Z racevalve
3.3	One-way flow control valve
3.2	Quick exhaust valve
U	Double acting cylinder
4.1	S/Z racevalve
4.2	One-way flow control valve
	Electrical connection 0V
B1	Inductive proximity switch
B2	Inductive proximity switch
B3	Inductive proximity switch
B4	Inductive proximity switch
B5	Capacitive proximity switch
	Logic module
START/STOP	Pushbutton (make)
	Electrical connection 24V
Y1	Valve solenoid
Y2	Valve solenoid
Y3	Valve solenoid
Y4	Valve solenoid
Y5	Valve solenoid
K1	Relay
K2	Relay
K3	Relay
K4	Relay
K1	Make switch
K2	Make switch
K1	Make switch
K2	Make switch
K3	Make switch
K4	Make switch
M1	DC Motor
M2	DC Motor





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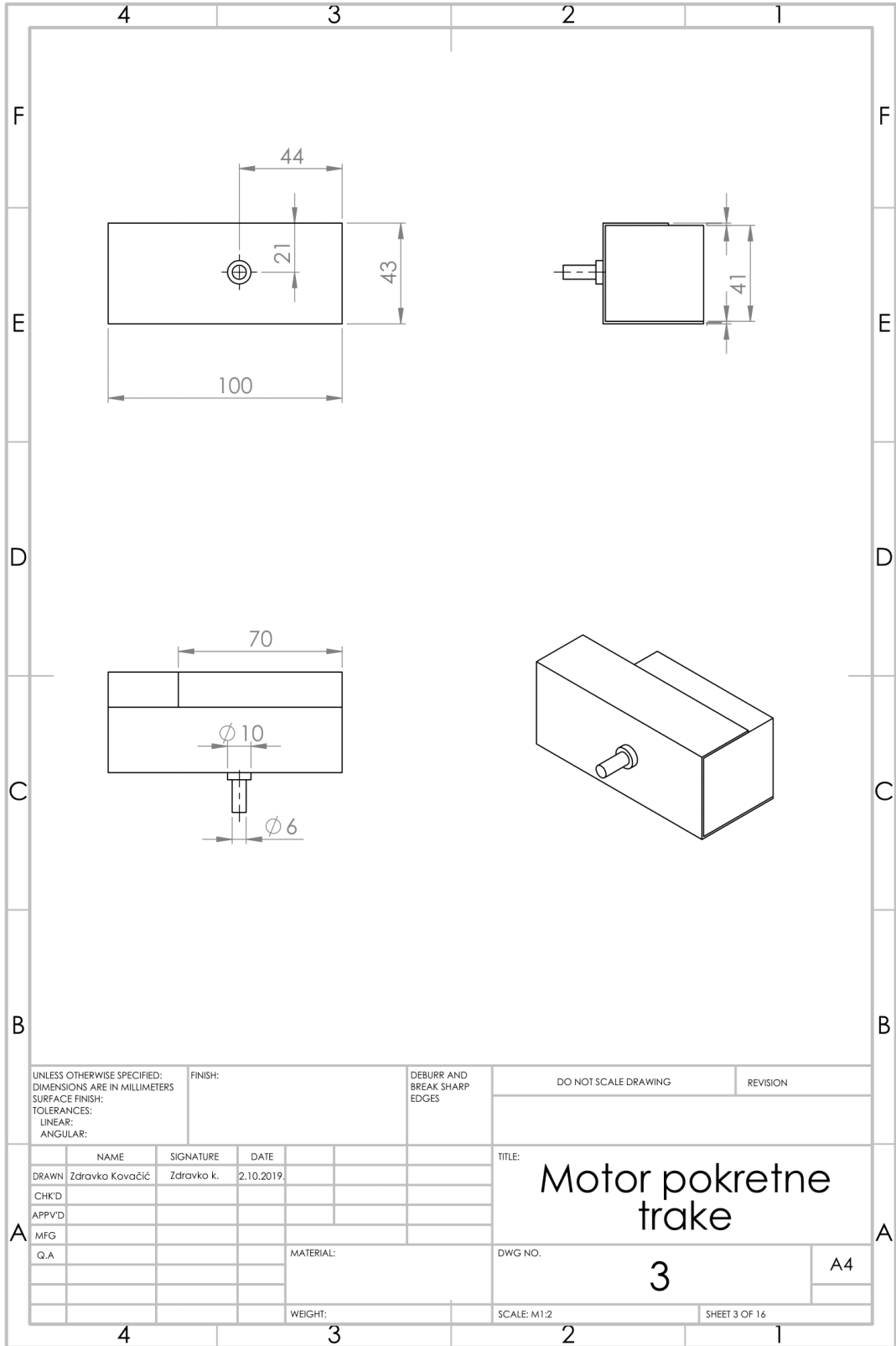
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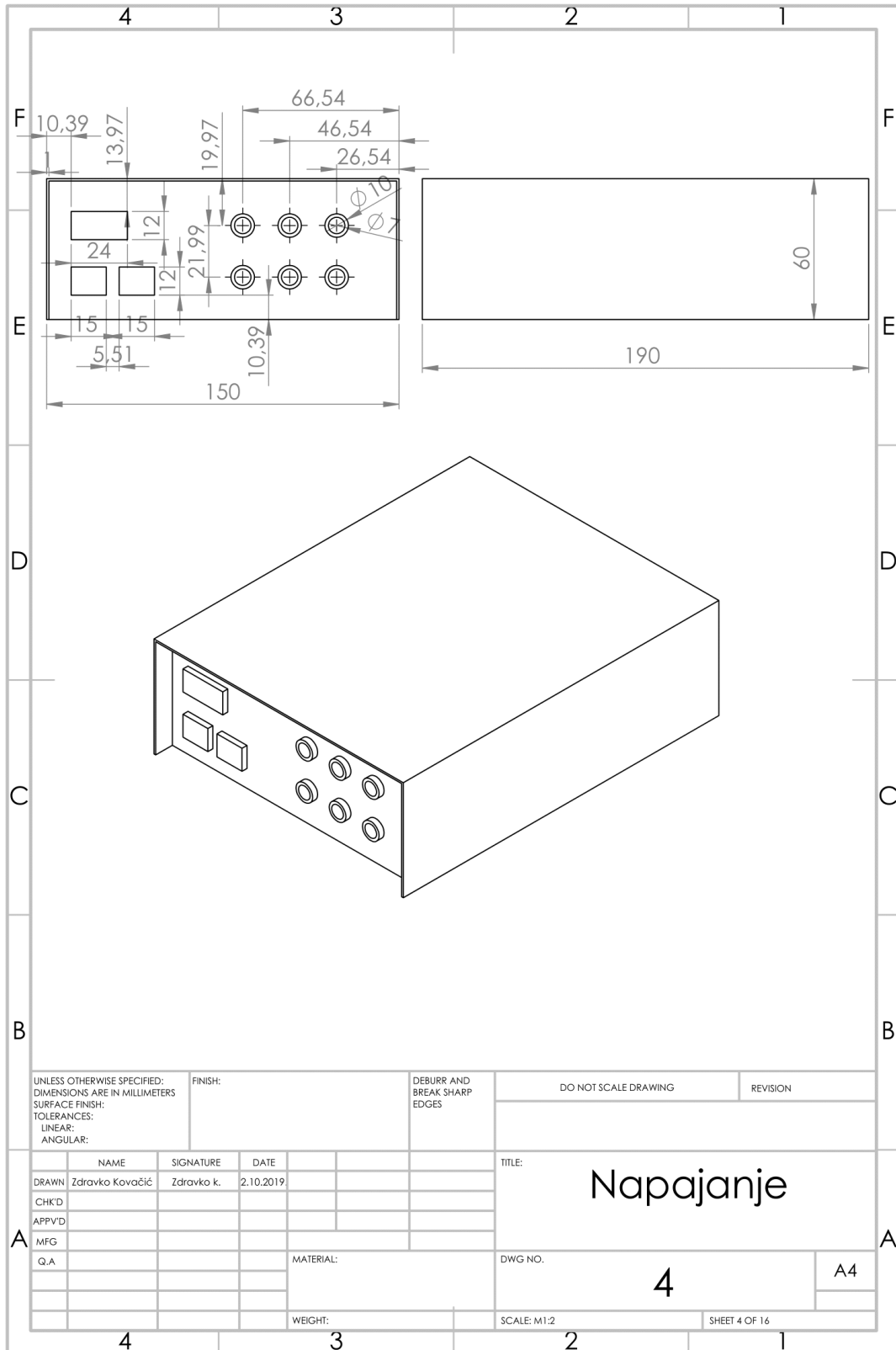
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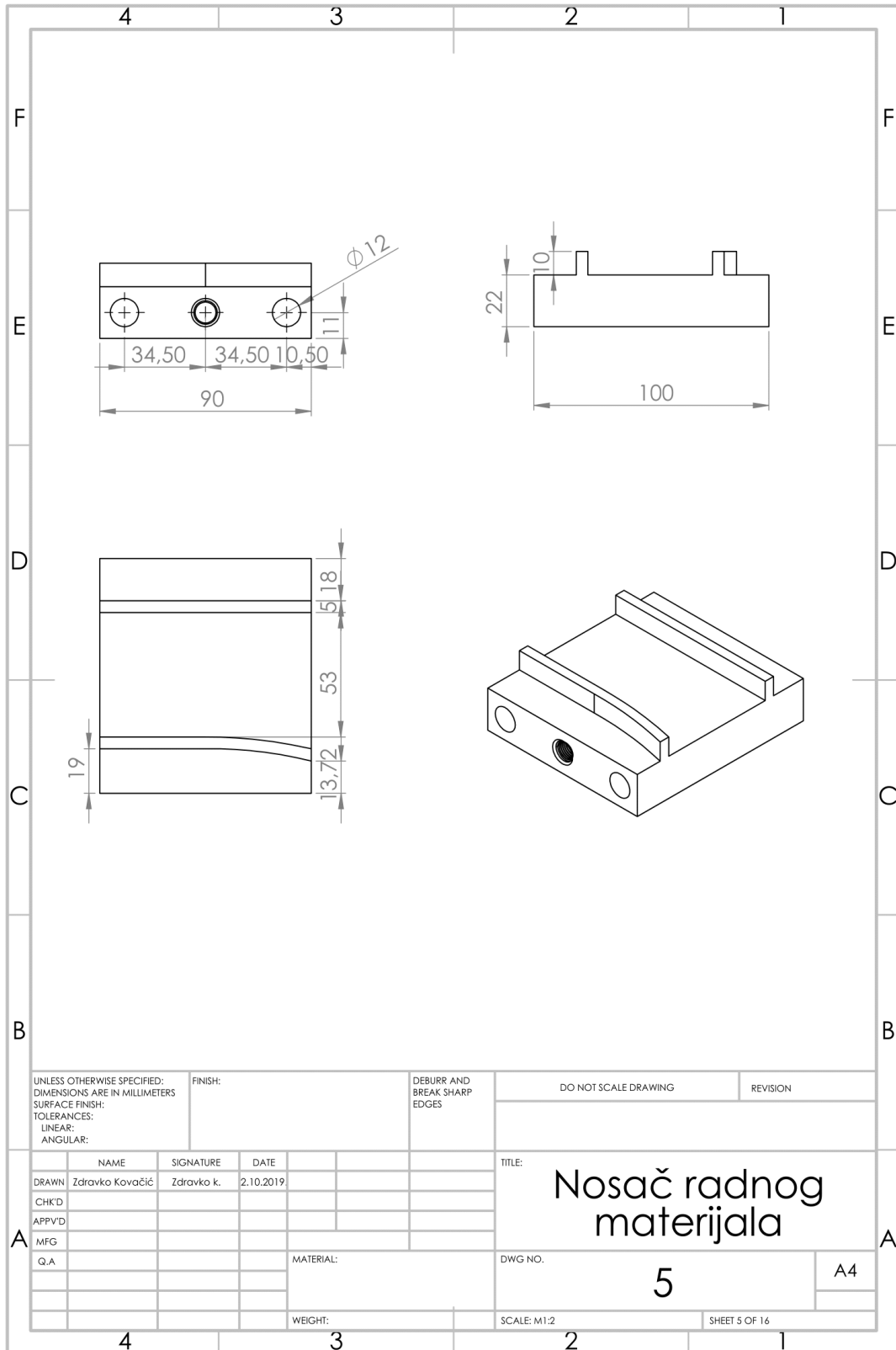
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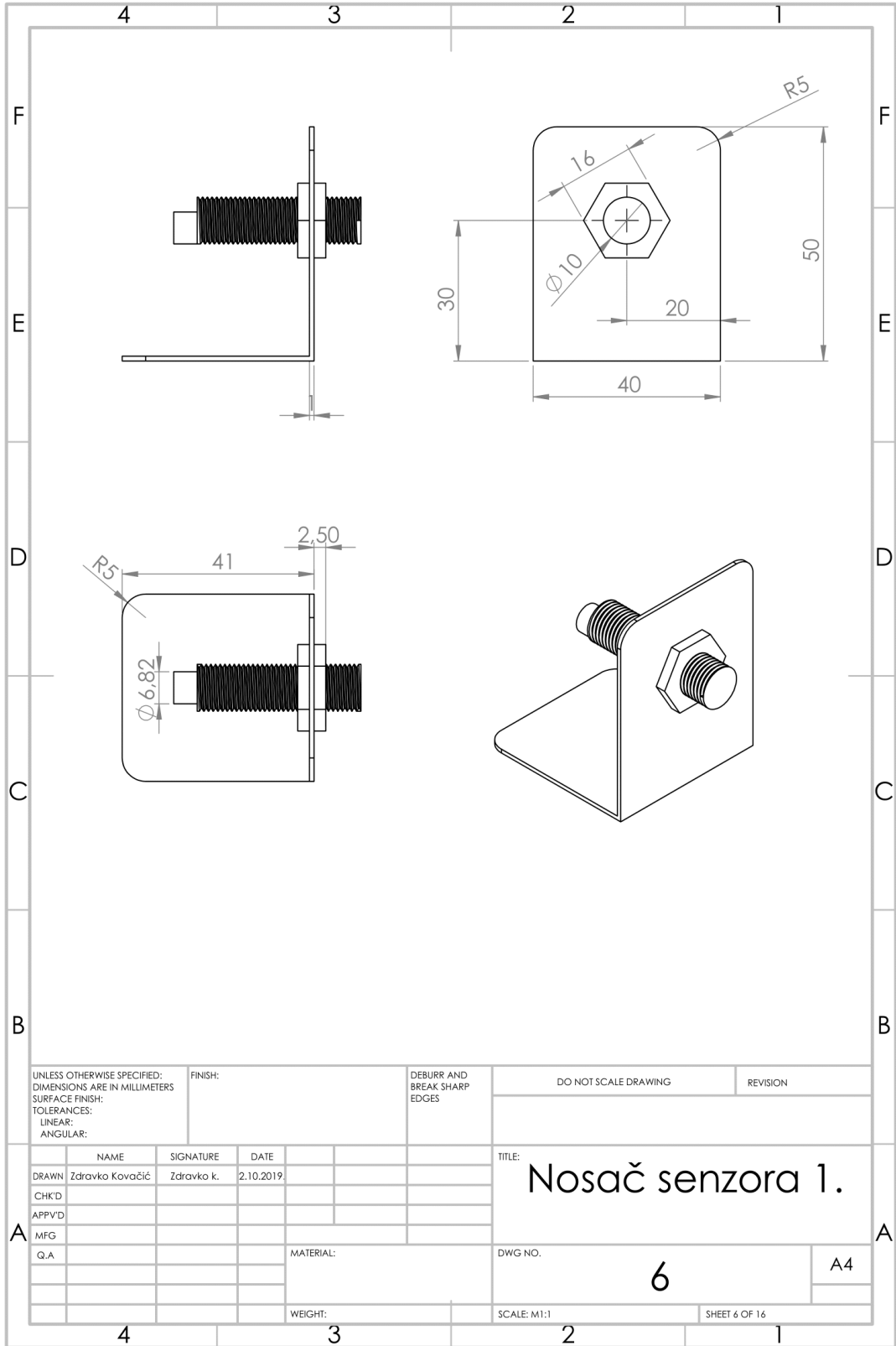


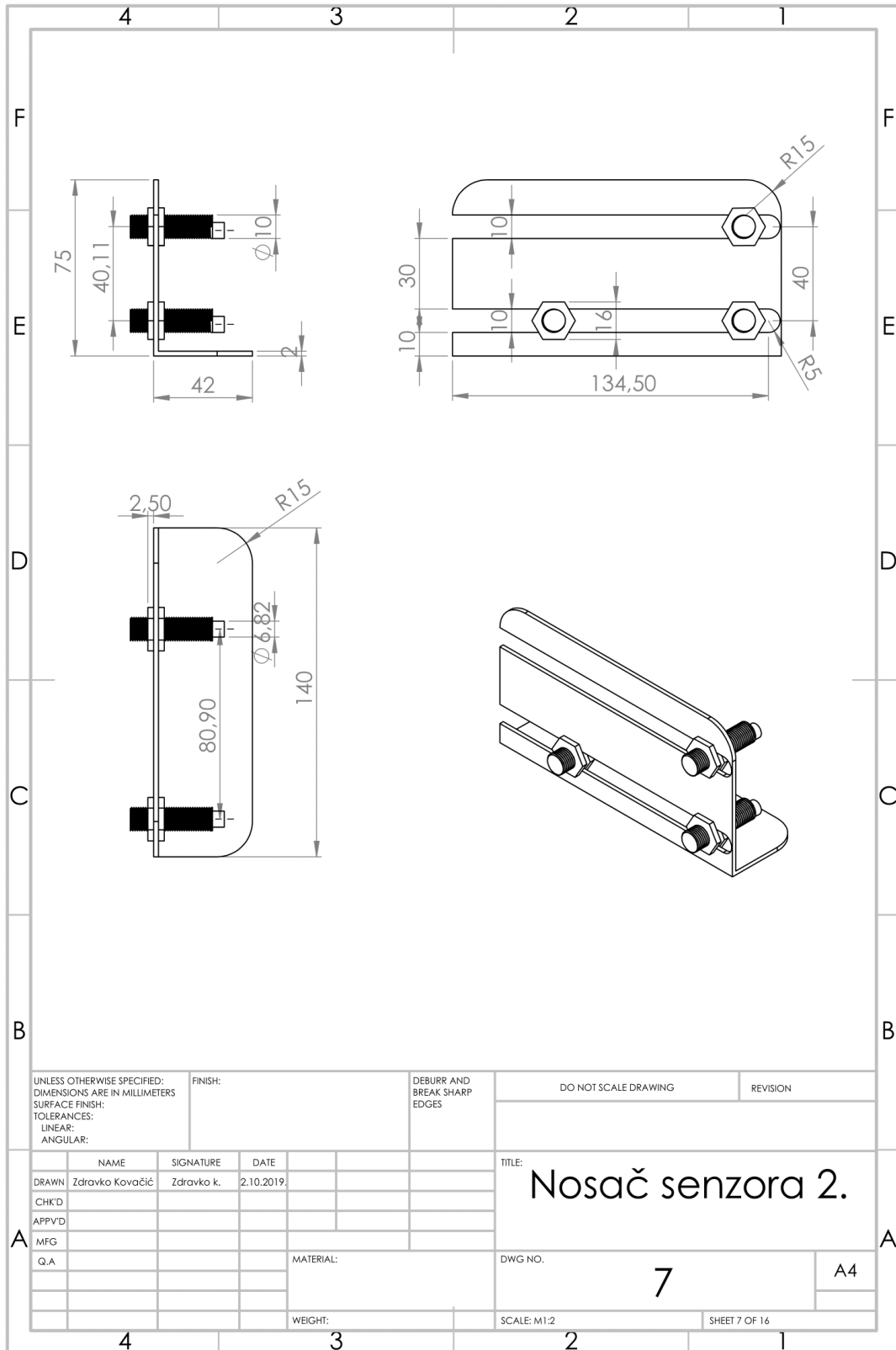
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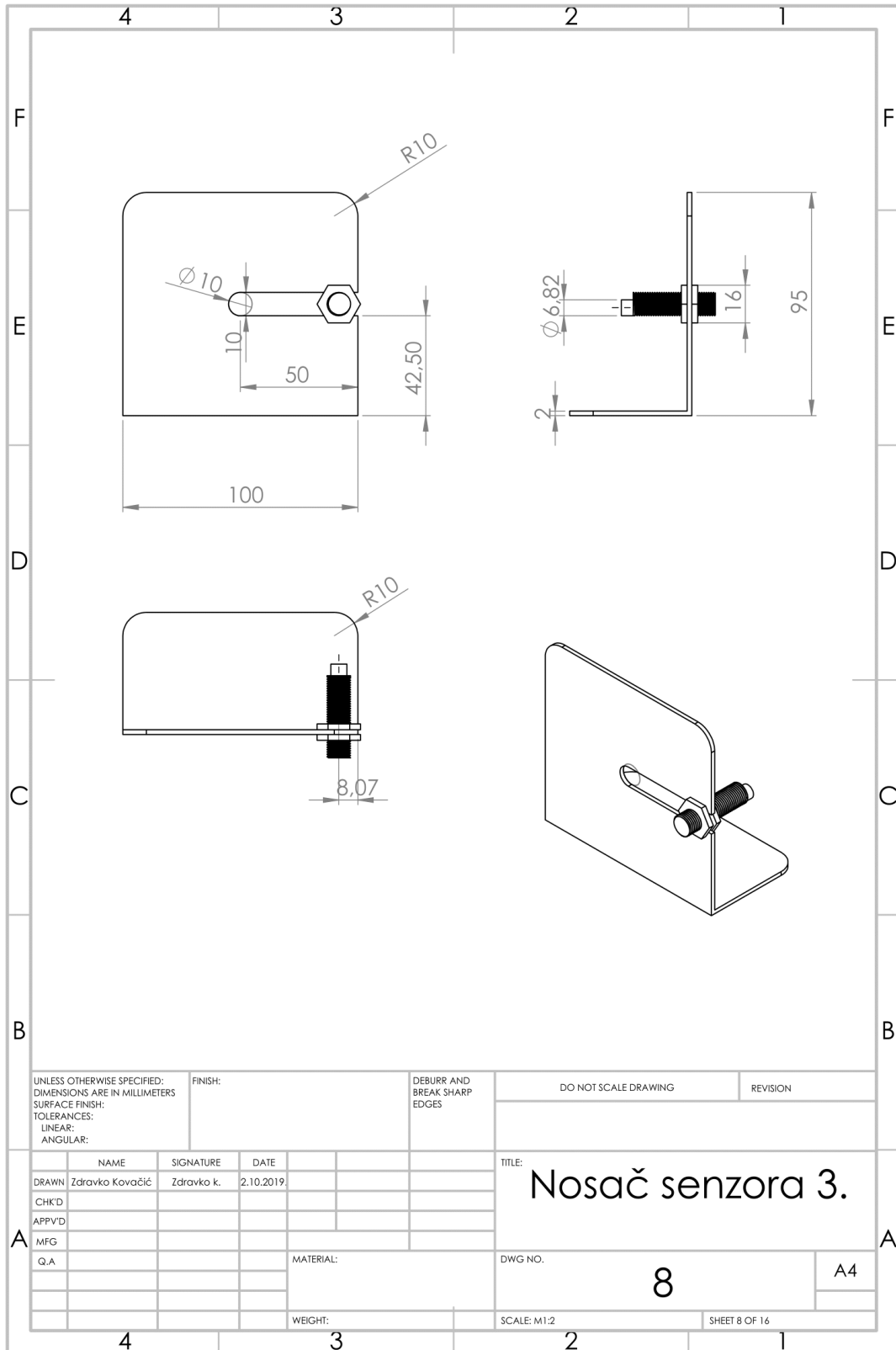


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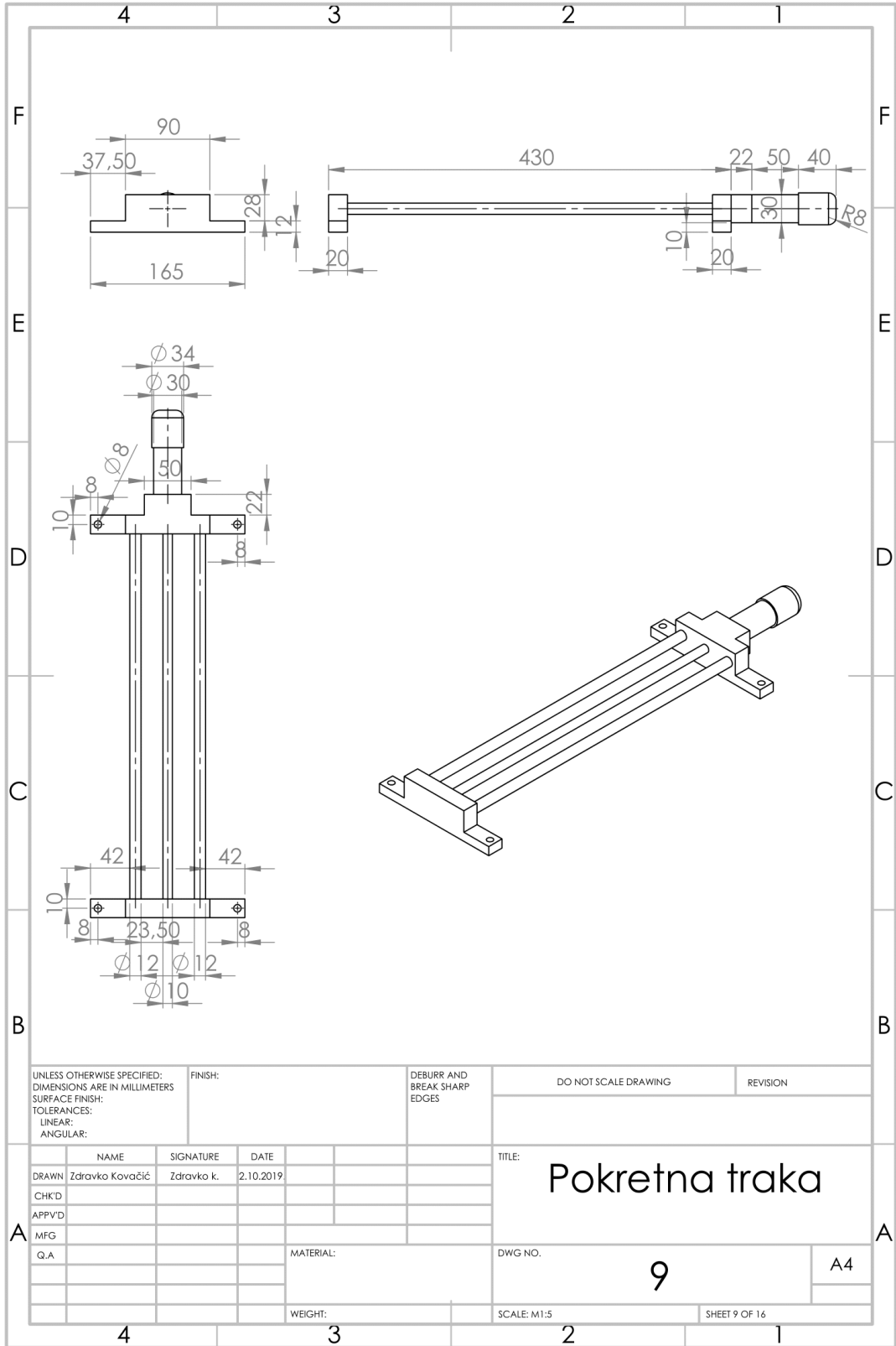


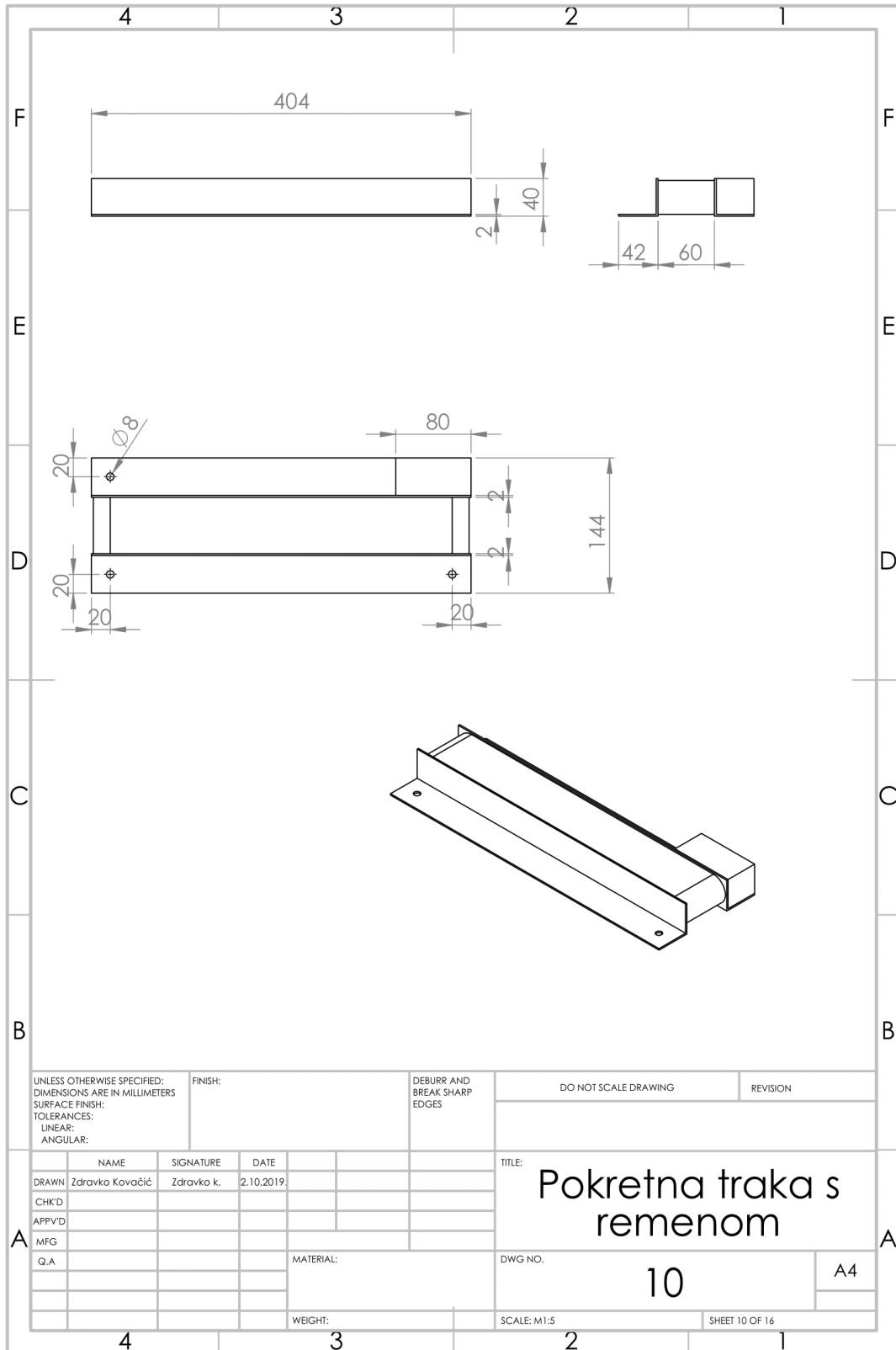




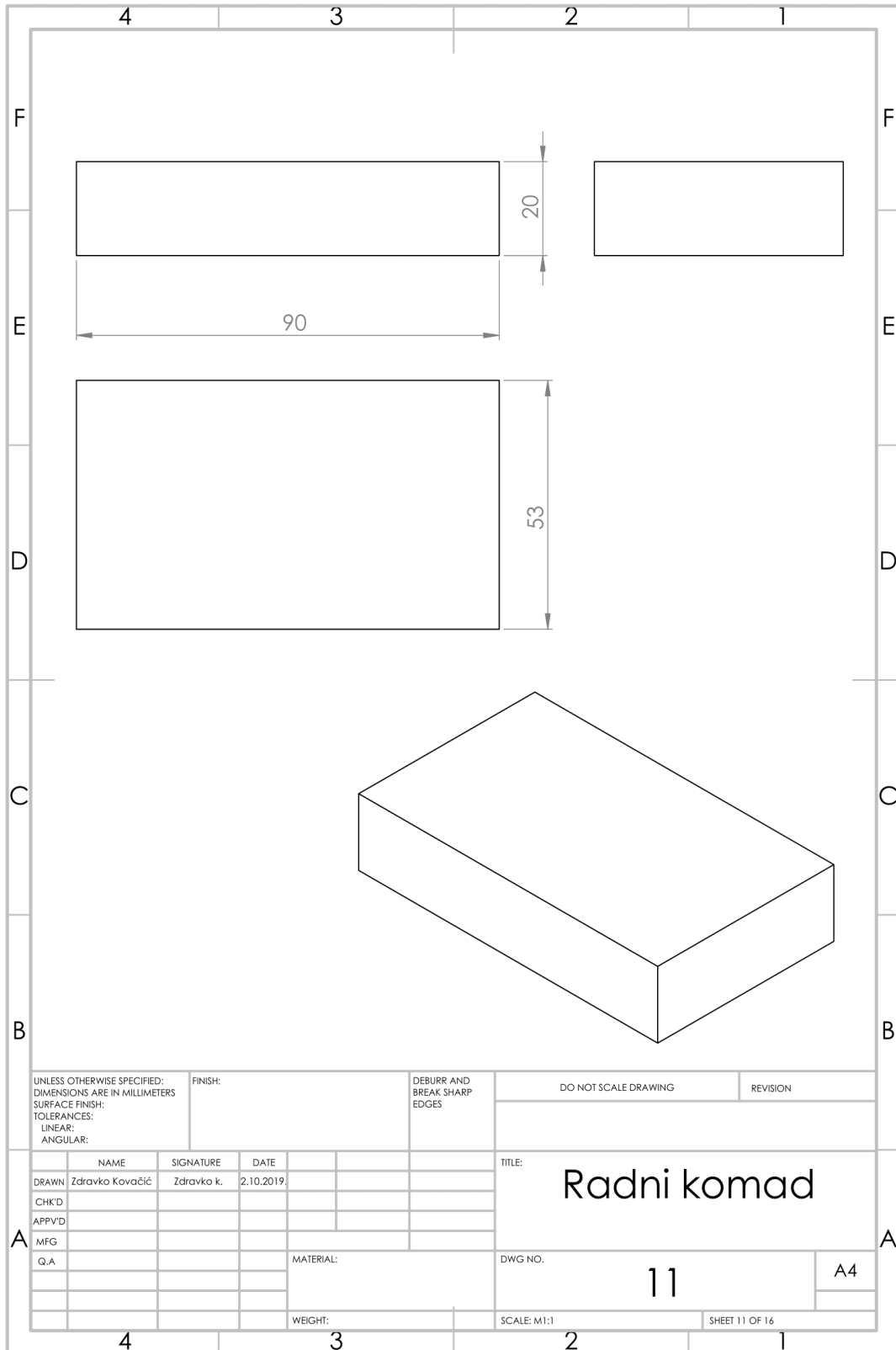


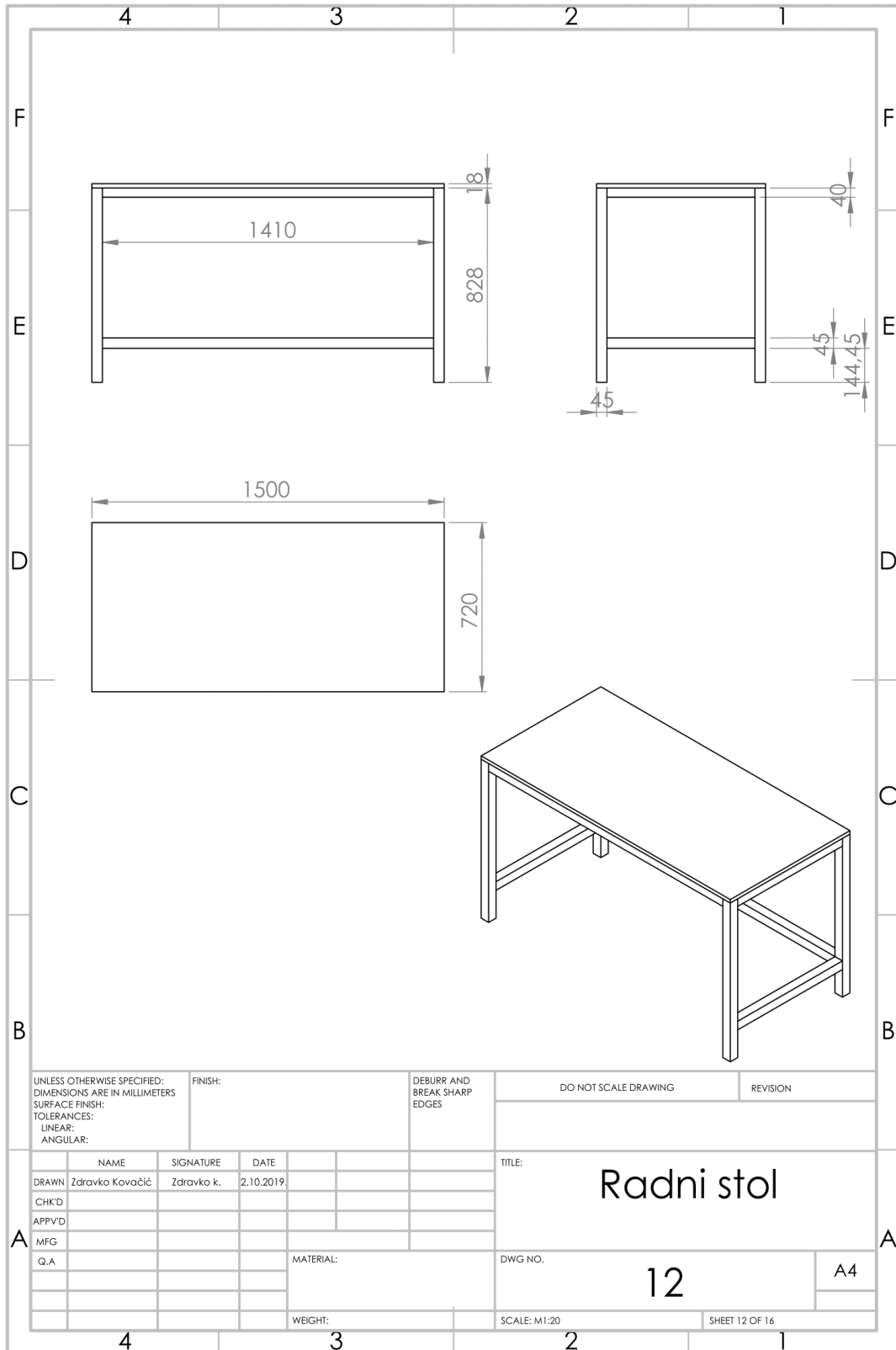
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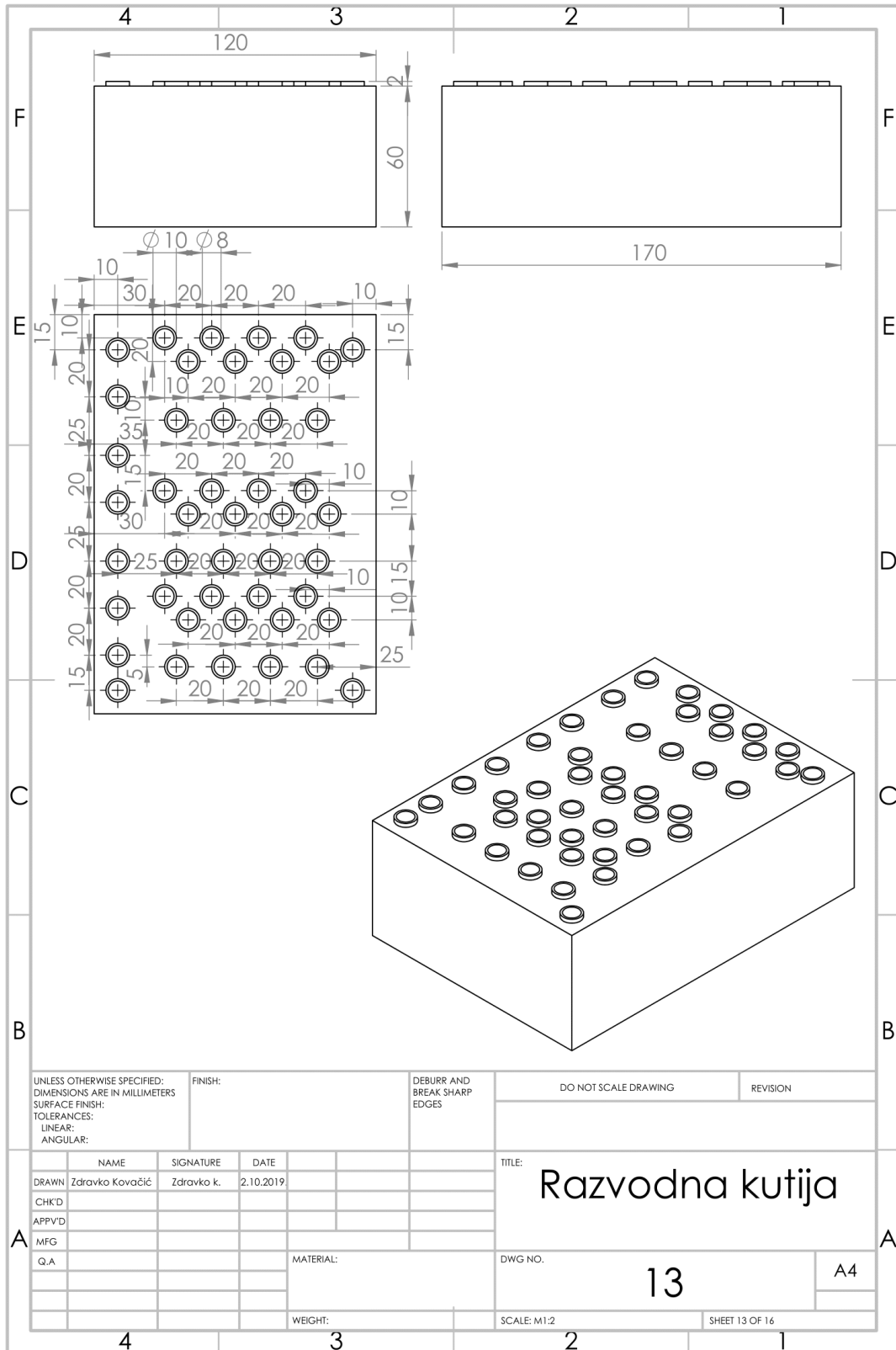


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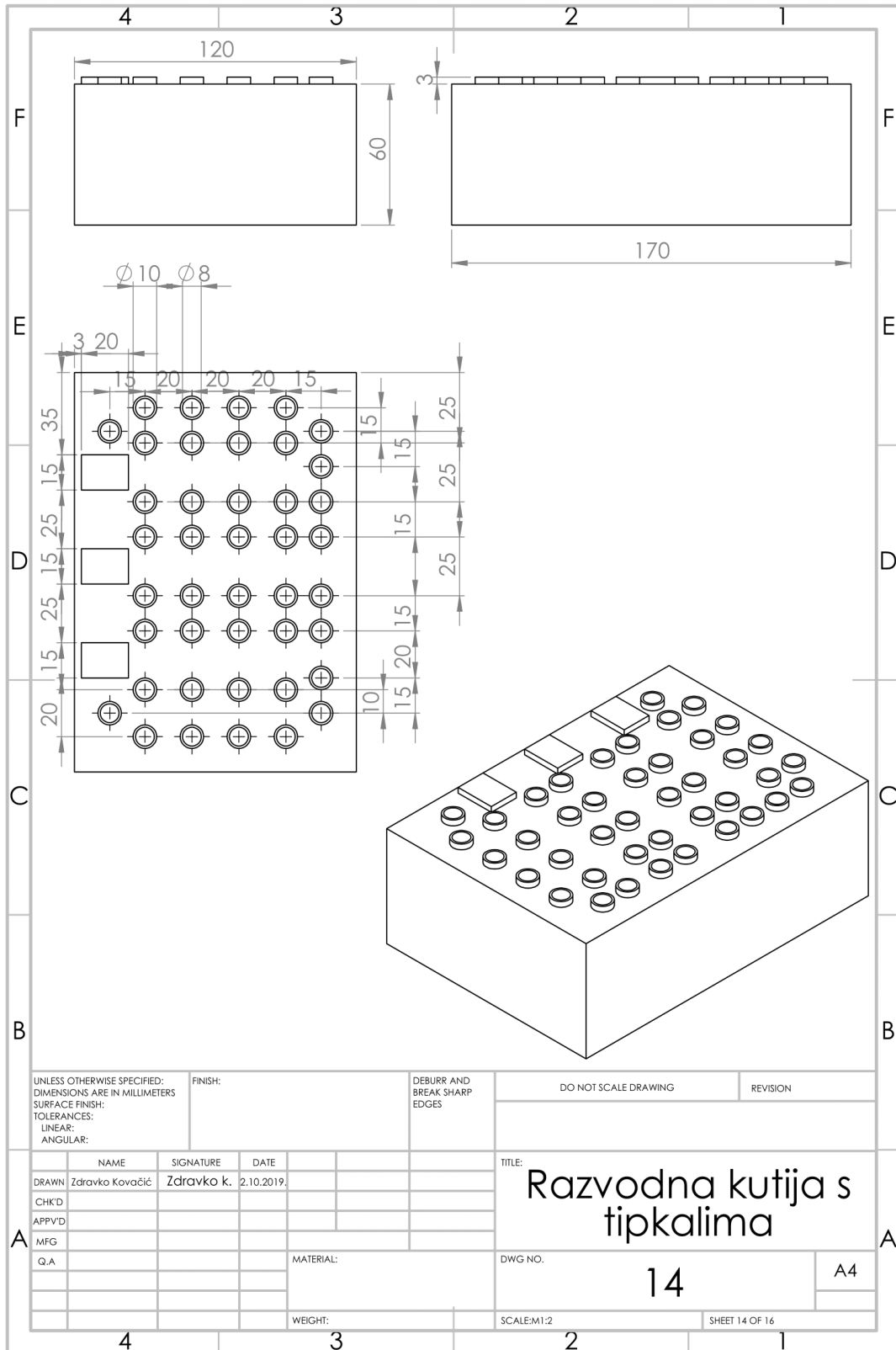
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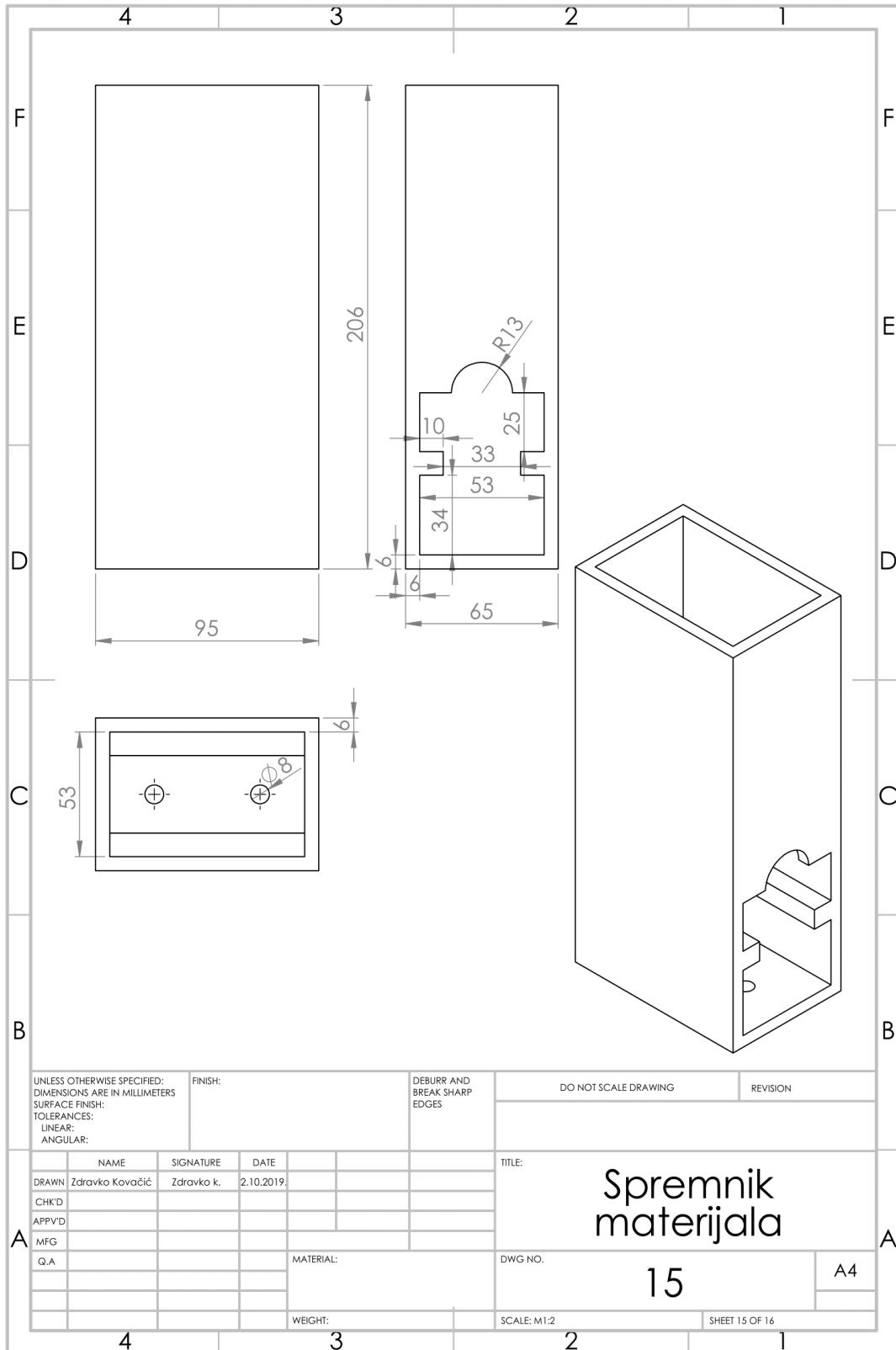
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