ASPECTE TEHNICO ECONOMICE PRIVIND PRELUCRAREA REPERULUI DORN CONTROL PE MASINI CNC

Student: **Constantin** Robert Florin
Conducator Stiintific Conf. Univ. Dr. Ing. **Doru BARDAC**

Rezumat: Lucrarea prezinta o analiza tehnico-economica a posibilitatilor de fabricare a reperului de tip arbore pe trei tipuri de strunguri. In lucrarea sunt analizate principalele caracteristici ale masinilor, dizpositivelor si sculelor, in vederea cresterii productivitatii care sa duca la o eficientizare a fabricatiei pieselor de tip arbore in conditiile impuse.

Cuvinte cheie: strunguri CNC, centru de prelucrat vertical, scule, timp de lucru, cost, productivitate.

1. INTRODUCERE

In cazul piesei analizate , "Dorn de control" este o piesa de tip arbore care pe langa prelucrari ale suprafetelor exterioare, necesita si prelucrari ale celor interioare. Prelucrarea acestui reper se va analiza in urmatoarele trei cazuri:
I. Strung CNC Haas ST-10;
II.Strung CNC Okuma L300-M;
III.Strung CNC Nakamura-Tome WT-300.

2. DORN DE CONTROL

Pentru analiza tehnico economica a fost data piesa dorn de control, piesa de tip arbore de dimensiuni medii (Fig.1)

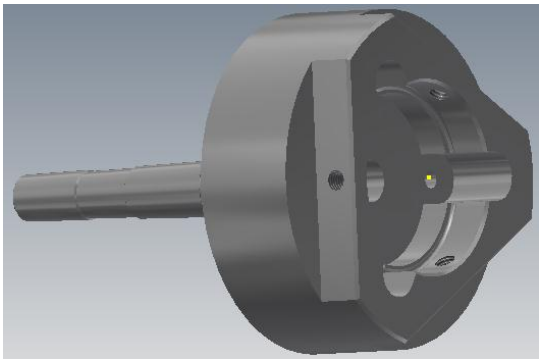


Fig.1 Dorn de control

3. PRELUCRAREA PIESELOR DE TIP ARBORE PE STRUNGURI CNC .

In acest capitol se vor prezenta specificatiile strungurilor comparate.

In figura 1 este prezentat strungul normal CNC Haas ST-10.

Fig.2 Haas ST-10

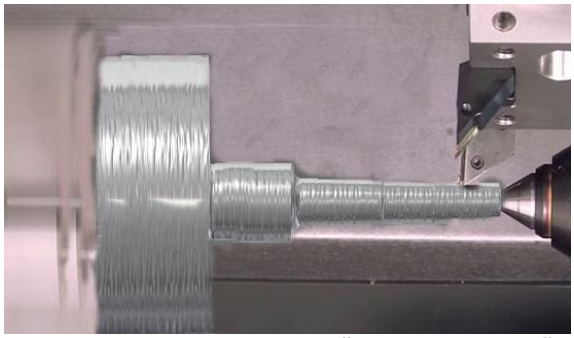


Figura 3. Prelucrare piesa "Dorn de control"

In ciuda suprafetei pe care o ocupa, strungul Haas ST-10 este extrem de rigid, ofera o precizie foarte buna a suprafetelor si este foarte stabil termic.

Caracteristicile strungului ST-10 sunt prezentate in tabelul 1 :

Tabelul 1. Caracteristici

Dimensiunea mandrinei	165[mm]
Deplasarea pe X	200 [mm]
Deplasarea pe Z	356 [mm]
Turatia maxima ax	1300 [rpm]
Viteza maxima	6000 [rpm]
Avans axa X	30.5[m/min]
Avans axa Z	30.5[m/min]
Capacitatea de stocare a sculelor	12 [scule]

In figura 4 este prezentat strungul OKUMA Genos L300-M.

Fig. 4 OKUMA Genos L300-M

Contructia sa unibloc (fig.5), avand o baza de otel, ii ofera stabilitate, rigiditate si o buna precizie pentru o gama larga de aplicatii. Accesibilitatea intalneste flexibilitatea.

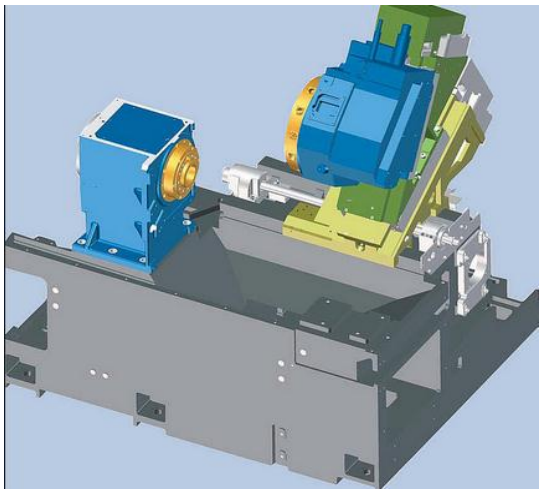


Fig. 5 Constructia unibloc OKUMA L300-M

Caracteristicile strungului OKUMA Genos L300-M sunt prezentate in tabelul 2 :

Tabelul 2. Caracteristici

Dimensiunea mandrinei	300[mm]
Deplasarea pe X	200 [mm]
Deplasarea pe Z	520 [mm]
Deplasarea pe Y	150 [mm]
Lungimea maxima de lucru	450 [mm]
Viteza maxima ax	5000 [rpm]
Capacitatea de stocare a sculelor	12 [scule]

In figura 6 este prezentat strungul NAKAMURA-TOME WT-300.

Fig. 6 WT-300

De mare viteza, cu o constructie compacta, centrul WT-300 ofera o mare rigiditate si posibilitatea unui multi-tasking datorita celor doua turele.

Fig.7 Sistemul 2S al strungului WT-300

Caracteristicile strungului WT-300 sunt prezentate in tabelul 3 :

Tabelul 3. Caracteristici

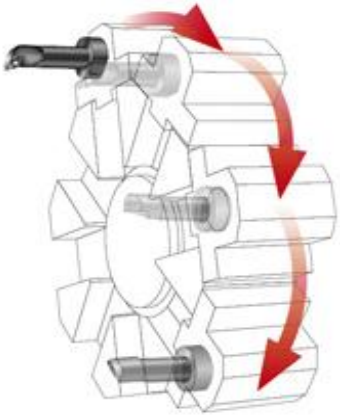
Diametrul maxim de prelucrat	270 [mm]
Lungimea maxima	780 [mm]
Turatia	4500 [rpm]
Distanta intre arbori	1100 [mm]
	250 [mm]
Putere motor arbore	25HP
Controler folosit	Fanuc 18i TB CNC

3.1. Tipuri de turele

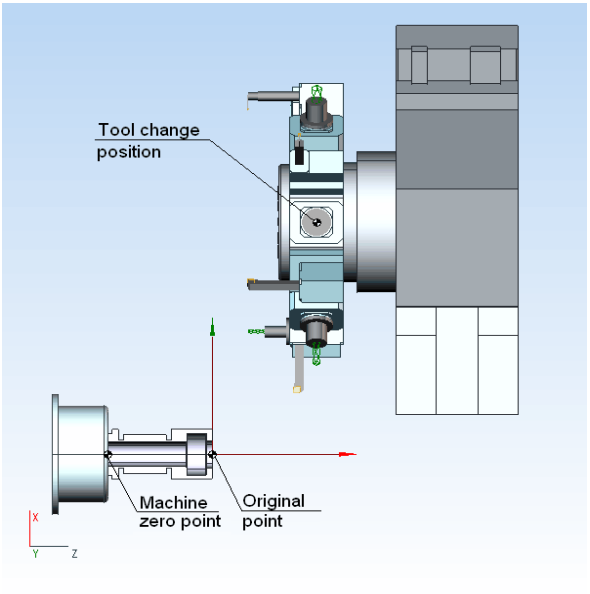
In toate cele trei situatii mentionate mai sus, turelele sunt automate, comandate de catre calculator.

Fig.8 Turela

Turela strungului Haas ST-10, cat si a strungului Genos L300-M, au o capacitate de 12 scule.



Trecere de la o scula la alta se face intr-un interval de 0.2 secunde, acuratetea prezentandu-se foarte buna, ea fiind de 0.003 mm la fiecare schimbare .



In cazul strungului NAKAMURA-TOME WT-300, cele doua turele si cei doi arbori, avand axa Y integrata, duc la cresterea productivitatii, fiind posibila prelucrarea a unuia sau a doua repere simultan.

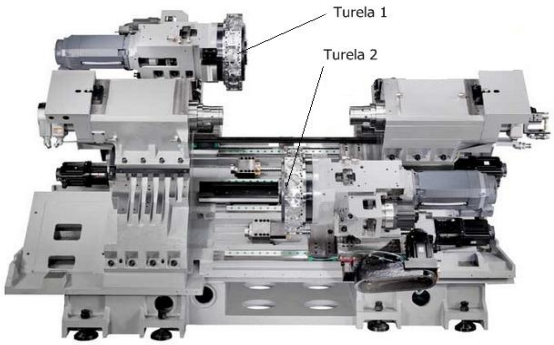


Fig.9 Sistemul cu doua turele

In modul acesta, prelucrarea la ambele capete ale reperului este posibila dintr-o singura prindere, minimizand manevrarile de catre operator si reducerea timpului de lucru.

4.ELABORAREA PROGRAMULUI CNC PENTRU PIESA "DORN DE CONTROL"

Avand o forma complexa, piesa "Dorn de control" se poate prelucra din doua prinderi.

Pentru realizarea programului CNC al piesei analizate a fost utilizat programul Heidenhain iTNC530.

4.1 Prima prindere

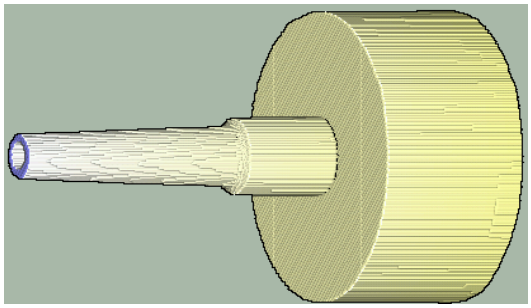


Figura 10. Piesa dupa prima prindere

```
0  BEGIN PGM Piesa MM
1  BLK FORM 0.1 Z  X-57.6  Y-57.5
    Z-168.85
2  BLK FORM 0.2  X+57.5  Y+57.5  Z+0
3  TOOL CALL 16 Z S1000
4  L  Z+200 R0 FMAX M3
5  CYCL DEF 257 CIRCULAR STUD
   Q223=+110  ;FINISHED PART DIA.
   Q222=+130  ;WORKPIECE BLANK DIA.
   Q368=+0    ;ALLOWANCE FOR SIDE
   Q207=+500  ;FEED RATE FOR MILLNG
   Q351=+1    ;CLIMB OR UP-CUT
   Q201=-170  ;DEPTH
   Q202=+5    ;PLUNGING DEPTH
   Q206=+3000 ;FEED RATE FOR PLNGNG
   Q200=+2    ;SET-UP CLEARANCE
   Q203=+0    ;SURFACE COORDINATE
   Q204=+50   ;2ND SET-UP CLEARANCE
   Q370=+1    ;TOOL PATH OVERLAP
6  CYCL CALL POS  X+0  Y+0  Z+0 FMAX
7  TOOL CALL 25 Z S1000
8  CYCL DEF 257 CIRCULAR STUD
   Q223=+30   ;FINISHED PART DIA.
   Q222=+50   ;WORKPIECE BLANK DIA.
   Q368=+0    ;ALLOWANCE FOR SIDE
   Q207=+500  ;FEED RATE FOR MILLNG
   Q351=+1    ;CLIMB OR UP-CUT
   Q201=-116.6 ;DEPTH
   Q202=+5    ;PLUNGING DEPTH
   Q206=+3000 ;FEED RATE FOR PLNGNG
   Q200=+2    ;SET-UP CLEARANCE
   Q203=+0    ;SURFACE COORDINATE
9  CYCL CALL POS  X+0  Y+0  Z+0 FMAX
10 CYCL DEF 290 INTERPOLATION TURNIN
   Q200=+2    ;SET-UP CLEARANCE
   Q445=+50   ;CLEARANCE HEIGHT
   Q336=+0    ;ANGLE OF SPINDLE
   Q440=+50   ;CUTTING SPEED
   Q441=+0.3  ;INFEED
   Q442=+0    ;STARTING ANGLE
   Q443=+1    ;MACHINING DIRECTION
   Q444=+6    ;INTERPOLATED AXIS
   Q491=+18   ;DIAMETER AT CONTOUR
   Q492=+0    ;CONTOUR START IN Z
   Q493=+30   ;CONTOUR END IN X
   Q494=-83   ;CONTOUR END IN Z
   Q495=+2    ;ANGLE OF CYLINDER SU
   Q496=+0    ;ANGLE OF FACE
   Q500=+3    ;RADIUS OF CONTOUR ED
11 CYCL CALL POS  X+0  Y+0  Z+0 FMAX
12 TOOL CALL 5 Z S1000
13 CYCL DEF 200 DRILLING
   Q200=+2    ;SET-UP CLEARANCE
   Q201=-169  ;DEPTH
   Q206=+150  ;FEED RATE FOR PLNGNG
   Q202=+5    ;PLUNGING DEPTH
   Q210=+0    ;DWELL TIME AT TOP
   Q203=+0    ;SURFACE COORDINATE
   Q204=+50   ;2ND SET-UP CLEARANCE
   Q211=+0    ;DWELL TIME AT DEPTH
14 CYCL CALL POS  X+0  Y+0  Z+0 FMAX
15 L  Z+200 R0 FMAX M30
16 END PGM Piesa MM
```

4.2 A doua prindere

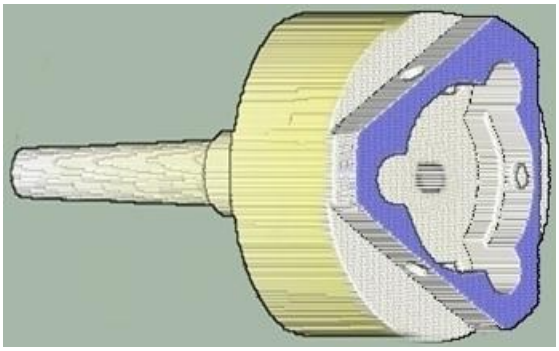


Figura 11. Piesa dupa a doua prindere

```
0  BEGIN PGM Piesa2 MM
1  BLK FORM 0.1 Z  X-57.5  Y-57.5
    Z-168.85
2  BLK FORM 0.2  X+57.5  Y+57.5  Z+0
3  TOOL CALL 16 Z S1000
4  L  Z+200 R0 FMAX M3
5  CYCL DEF 257 CIRCULAR STUD
   Q223=+110  ;FINISHED PART DIA.
   Q222=+130  ;WORKPIECE BLANK DIA.
   Q368=+0    ;ALLOWANCE FOR SIDE
   Q207=+500  ;FEED RATE FOR MILLNG
   Q351=+1    ;CLIMB OR UP-CUT
   Q201=-170  ;DEPTH
   Q202=+5    ;PLUNGING DEPTH
   Q206=+3000 ;FEED RATE FOR PLNGNG
```

```
    Q200=+2     ;SET-UP CLEARANCE
    Q203=+0     ;SURFACE COORDINATE
    Q204=+50    ;2ND SET-UP CLEARANCE
    Q370=+1     ;TOOL PATH OVERLAP
6   CYCL CALL POS  X+0  Y+0  Z+0 FMAX
7   CYCL DEF 252 CIRCULAR POCKET
    Q215=+0     ;MACHINING OPERATION
    Q223=+56    ;CIRCLE DIAMETER
    Q368=+0     ;ALLOWANCE FOR SIDE
    Q207=+500   ;FEED RATE FOR MILLNG
    Q351=+1     ;CLIMB OR UP-CUT
    Q201=-24    ;DEPTH
    Q202=+5     ;PLUNGING DEPTH
    Q369=+0     ;ALLOWANCE FOR FLOOR
    Q206=+150   ;FEED RATE FOR PLNGNG
    Q338=+0     ;INFEED FOR FINISHING
    Q200=+2     ;SET-UP CLEARANCE
    Q203=+0     ;SURFACE COORDINATE
    Q204=+50    ;2ND SET-UP CLEARANCE
    Q370=+1     ;TOOL PATH OVERLAP
    Q366=+1     ;PLUNGE
    Q385=+500   ;FINISHING FEED RATE
8   CYCL CALL POS  X+0  Y+0  Z+0 FMAX
9   CYCL DEF 252 CIRCULAR POCKET
    Q215=+0     ;MACHINING OPERATION
    Q223=+62    ;CIRCLE DIAMETER
    Q368=+0     ;ALLOWANCE FOR SIDE
    Q207=+500   ;FEED RATE FOR MILLNG
    Q351=+1     ;CLIMB OR UP-CUT
    Q201=-14    ;DEPTH
    Q202=+5     ;PLUNGING DEPTH
    Q369=+0     ;ALLOWANCE FOR FLOOR
    Q206=+150   ;FEED RATE FOR PLNGNG
    Q338=+0     ;INFEED FOR FINISHING
    Q200=+2     ;SET-UP CLEARANCE
    Q203=+0     ;SURFACE COORDINATE
    Q204=+50    ;2ND SET-UP CLEARANCE
    Q370=+1     ;TOOL PATH OVERLAP
    Q366=+1     ;PLUNGE
    Q385=+500   ;FINISHING FEED RATE
10  CYCL CALL POS  X+0  Y+0  Z+0 FMAX
11  TOOL CALL 8 Z S1000
12  L  X+0  Y+0  Z+5 R0 FMAX
13  L  Z-24 R0 F400
14  L  Y-35
15  L  Z+5 R0 FMAX
16  L  X+0  Y+0 R0 FMAX
17  L  Z-24
18  L  X+30.31  Y+17.5
19  L  Z+5 R0 FMAX
20  L  X+0  Y+0 R0 FMAX
21  L  Z-24
22  L  X-31.31  Y+17.5
23  L  Z+15 R0 FMAX
24  TOOL CALL 3 Z S1000
25  CYCL DEF 200 DRILLING
    Q200=+2     ;SET-UP CLEARANCE
    Q201=-54    ;DEPTH
    Q206=+150   ;FEED RATE FOR PLNGNG
    Q202=+5     ;PLUNGING DEPTH
    Q210=+0     ;DWELL TIME AT TOP
    Q203=+0     ;SURFACE COORDINATE
    Q204=+50    ;2ND SET-UP CLEARANCE
    Q211=+0     ;DWELL TIME AT DEPTH
26  CYCL CALL POS  X+0  Y-35  Z-24 FMAX
27  CYCL DEF 200 DRILLING
    Q200=+2     ;SET-UP CLEARANCE
    Q201=-54    ;DEPTH
    Q206=+150   ;FEED RATE FOR PLNGNG
    Q202=+5     ;PLUNGING DEPTH
    Q210=+0     ;DWELL TIME AT TOP
    Q203=+0     ;SURFACE COORDINATE
    Q204=+50    ;2ND SET-UP CLEARANCE
    Q211=+0     ;DWELL TIME AT DEPTH
28  CYCL CALL POS  X+30.31  Y+17.5
     Z-24 FMAX
29  CYCL DEF 200 DRILLING
    Q200=+2     ;SET-UP CLEARANCE
    Q201=-54    ;DEPTH
    Q206=+150   ;FEED RATE FOR PLNGNG
    Q202=+5     ;PLUNGING DEPTH
    Q210=+0     ;DWELL TIME AT TOP
    Q203=+0     ;SURFACE COORDINATE
    Q204=+50    ;2ND SET-UP CLEARANCE
    Q211=+0     ;DWELL TIME AT DEPTH
30  CYCL CALL POS  X-30.31  Y+17.5
     Z-24 FMAX
31  TOOL CALL 10 Z S1000
32  L  Z+2 R0 FMAX
33  L  X+80  Y+49 R0 FMAX
34  L  Z-15
35  L  X-80  Y+49 R0 F500
36  L  X+0  Y-90
37  L  X+80  Y+49
38  L  Z+100 R0 FMAX
39  TOOL CALL 4 Y S1000
40  CYCL DEF 200 DRILLING
    Q200=+2     ;SET-UP CLEARANCE
    Q201=-30    ;DEPTH
    Q206=+150   ;FEED RATE FOR PLNGNG
    Q202=+5     ;PLUNGING DEPTH
    Q210=+0     ;DWELL TIME AT TOP
    Q203=+0     ;SURFACE COORDINATE
    Q204=+50    ;2ND SET-UP CLEARANCE
    Q211=+0     ;DWELL TIME AT DEPTH
41  CYCL CALL POS  X+0  Y+0  Z-7 FMAX
42  CYCL DEF 200 DRILLING
    Q200=+2     ;SET-UP CLEARANCE
    Q201=-20    ;DEPTH
    Q206=+150   ;FEED RATE FOR PLNGNG
    Q202=+5     ;PLUNGING DEPTH
    Q210=+0     ;DWELL TIME AT TOP
    Q203=+0     ;SURFACE COORDINATE
    Q204=+50    ;2ND SET-UP CLEARANCE
    Q211=+0     ;DWELL TIME AT DEPTH
43  CYCL CALL POS  X+0  Y+0  Z-7
     C+120 FMAX
44  CYCL DEF 200 DRILLING
    Q200=+2     ;SET-UP CLEARANCE
    Q201=-20    ;DEPTH
    Q206=+150   ;FEED RATE FOR PLNGNG
    Q202=+5     ;PLUNGING DEPTH
    Q210=+0     ;DWELL TIME AT TOP
    Q203=+0     ;SURFACE COORDINATE
    Q204=+50    ;2ND SET-UP CLEARANCE
    Q211=+0     ;DWELL TIME AT DEPTH
45  CYCL CALL POS  X+0  Y+0  Z-7
     C-120 FMAX
46  L  Y+200 R0 FMAX M30
47  END PGM Piesa2 MM
```

5 Alegerea sistemelor de scule

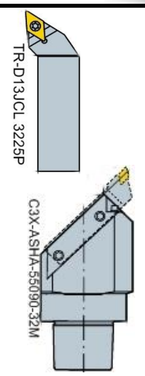
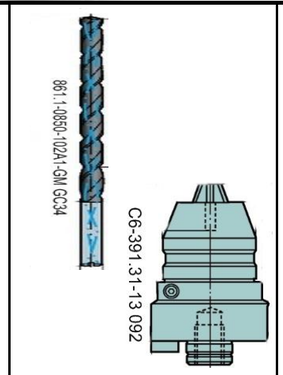
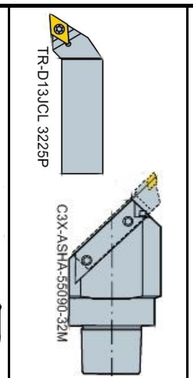
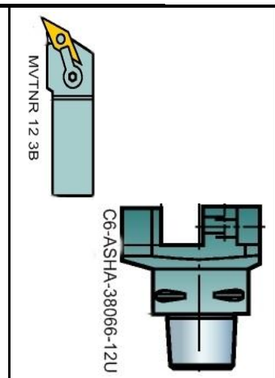
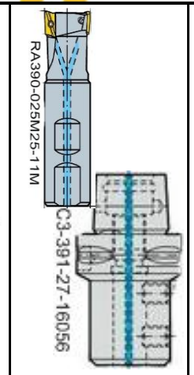
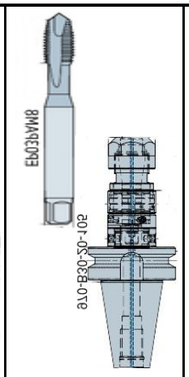
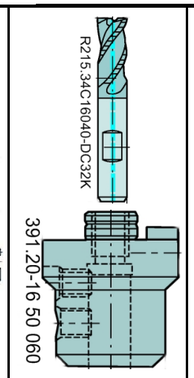
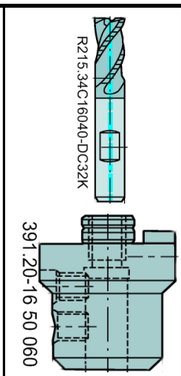
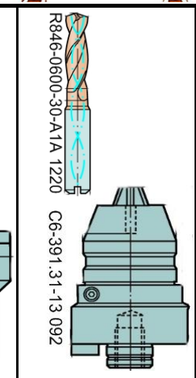
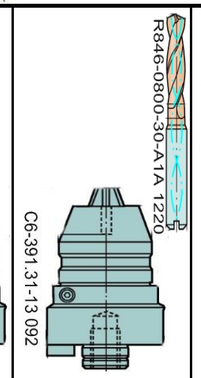
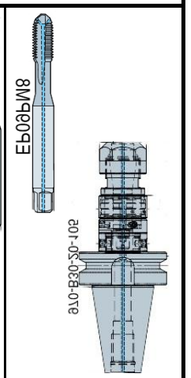
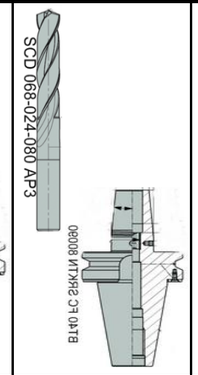
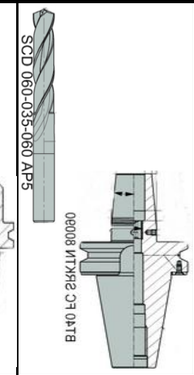
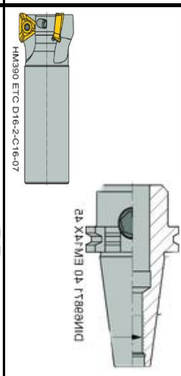
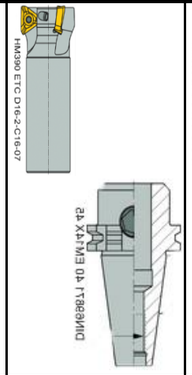
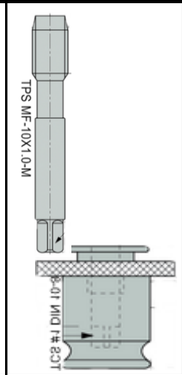
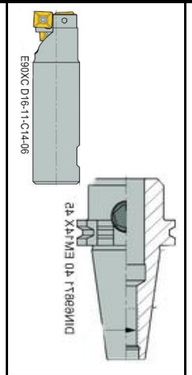
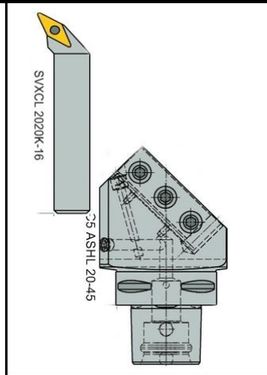
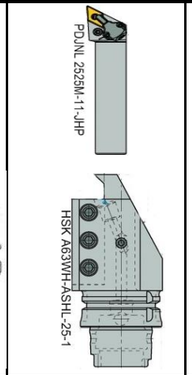
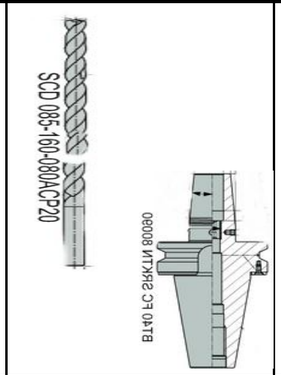
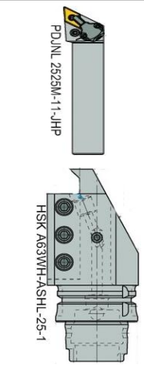
MASINA UNEALTA			
SCULE			
SANDVIK Coromant			
PORTSCULE			
SCULE			
Member IMC Group ISCAR			
PORTSCULE			
SCULE			
WALTER			
PORTSCULE			

Figura 12. Sisteme de scule

6. INTOCMIREA SCHITELOR OPERATIILOR

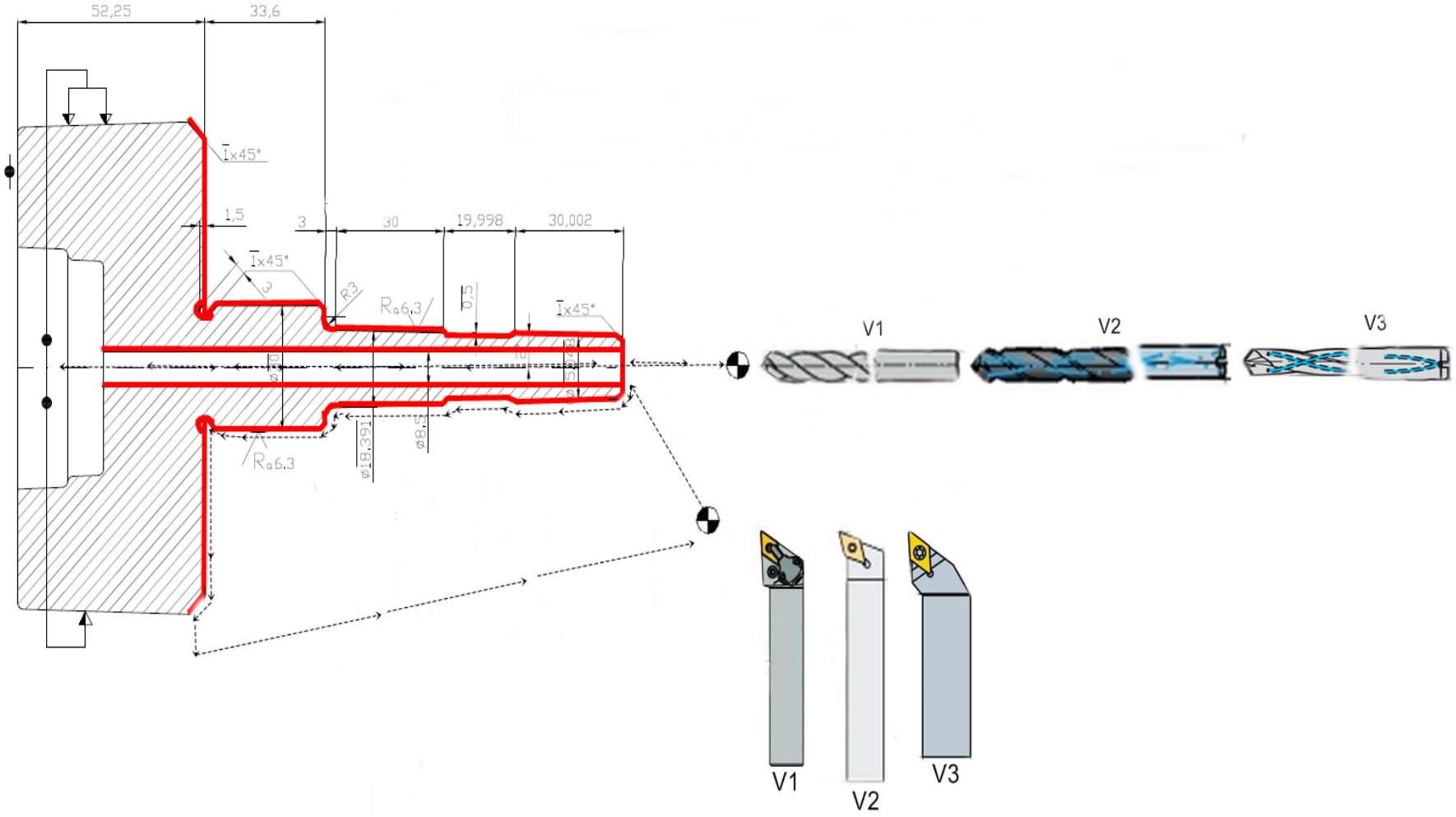


Fig. 13 Strunjire, gaurire

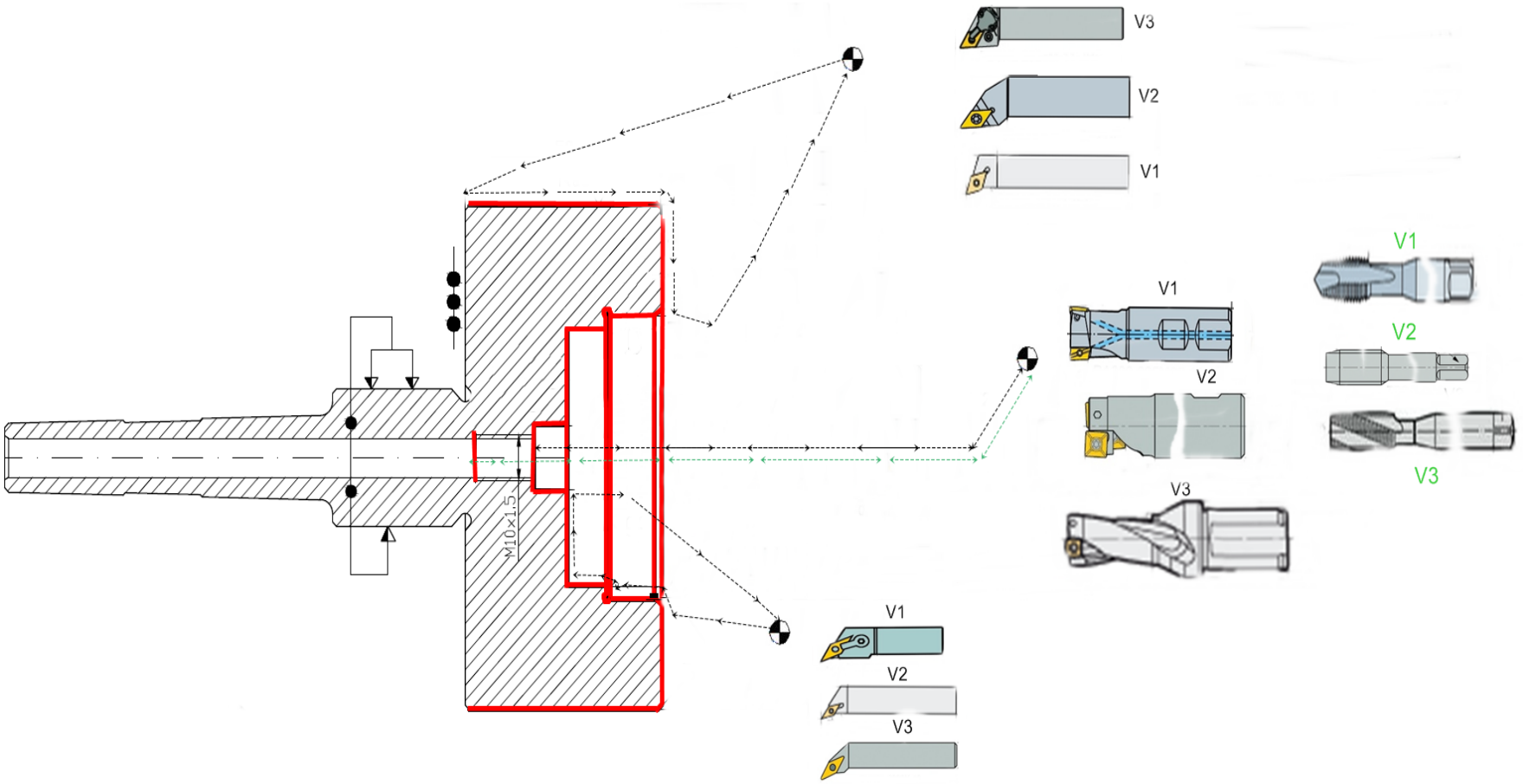


Fig. 14 Strunjire, alezare, filetare

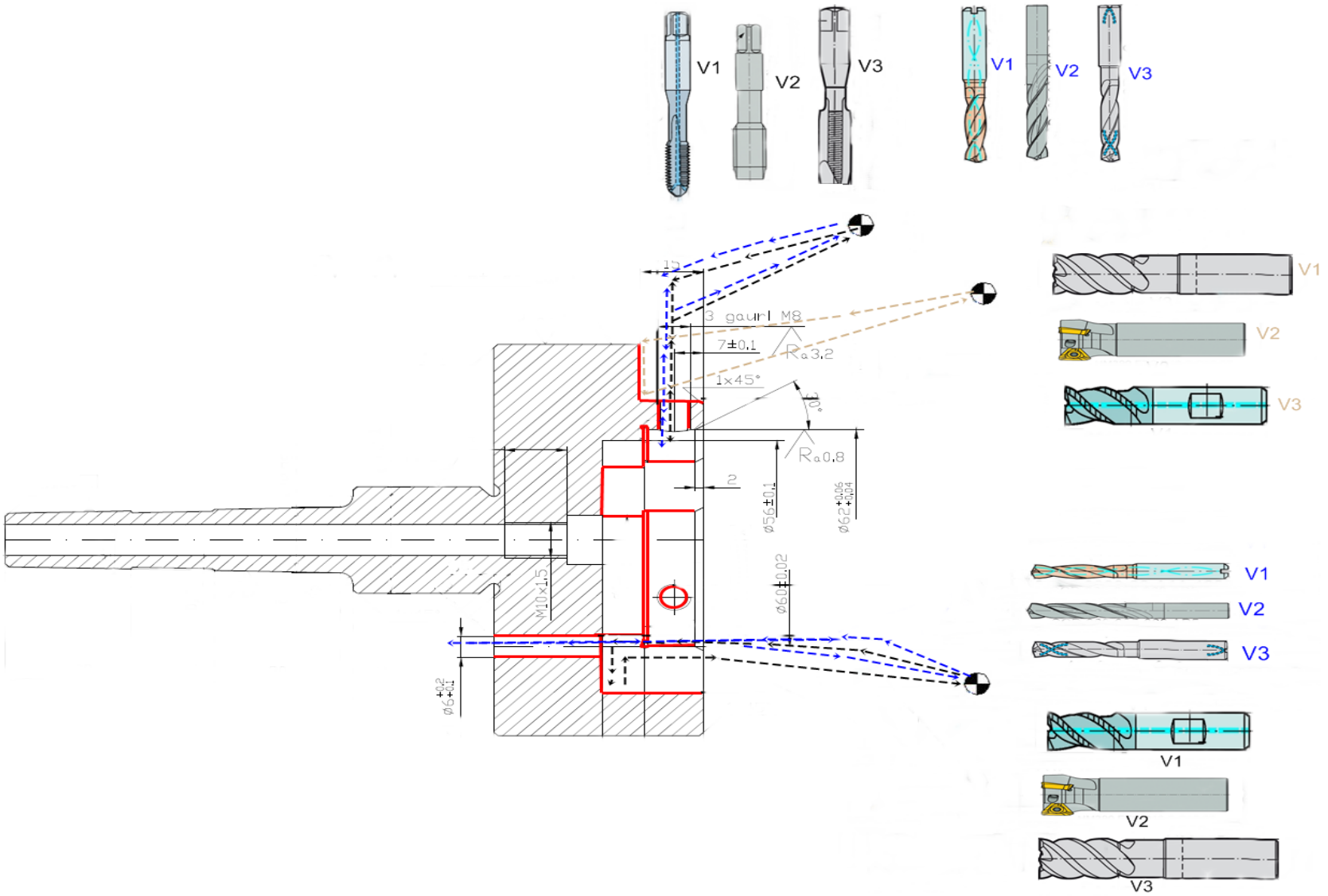


Fig. 15 Frezare, gaurire, filetare

7. CELULA FLEXIBILA DE FABRICATIE

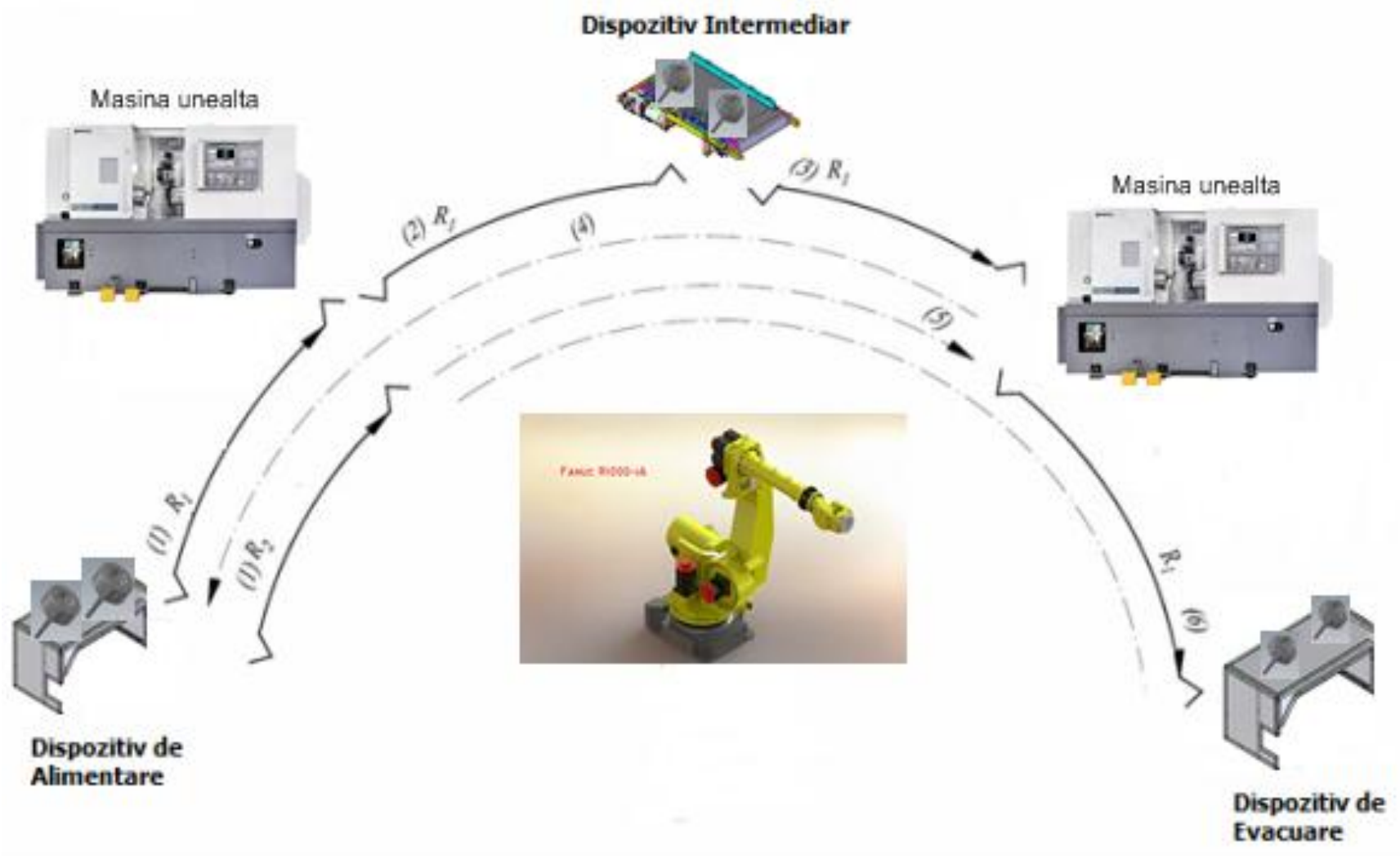


Fig. 16 Celula flexibila de fabricatie a reperului "Dorn de control"

7.1 Sistemul compliant si dispozitivul de apucare si fixare

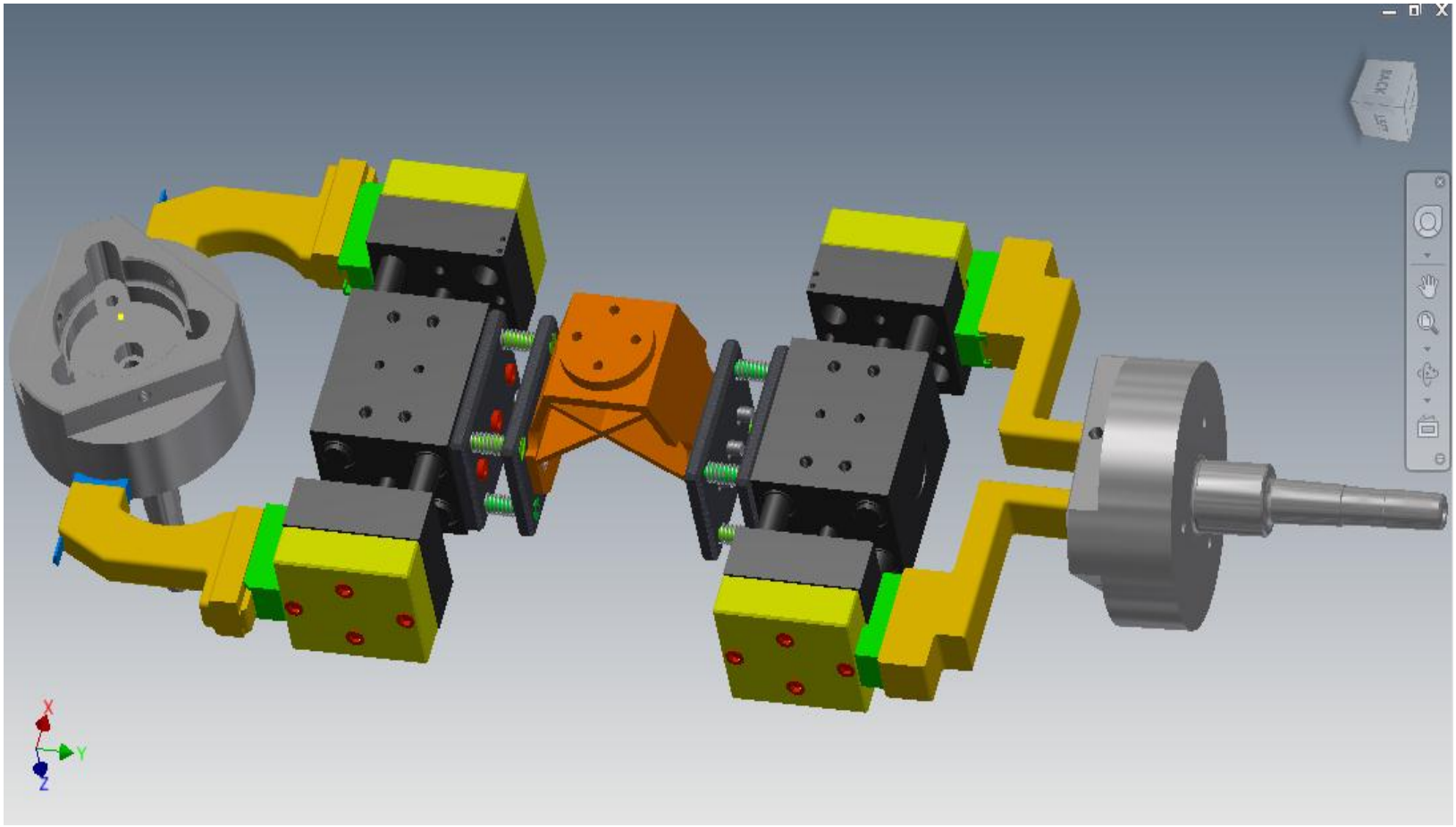


Fig. 17 Sistemul compliant, dispozitiv de apucare si fixare

7.2 Integrarea dispozitivului de apucare si fixare pe robot

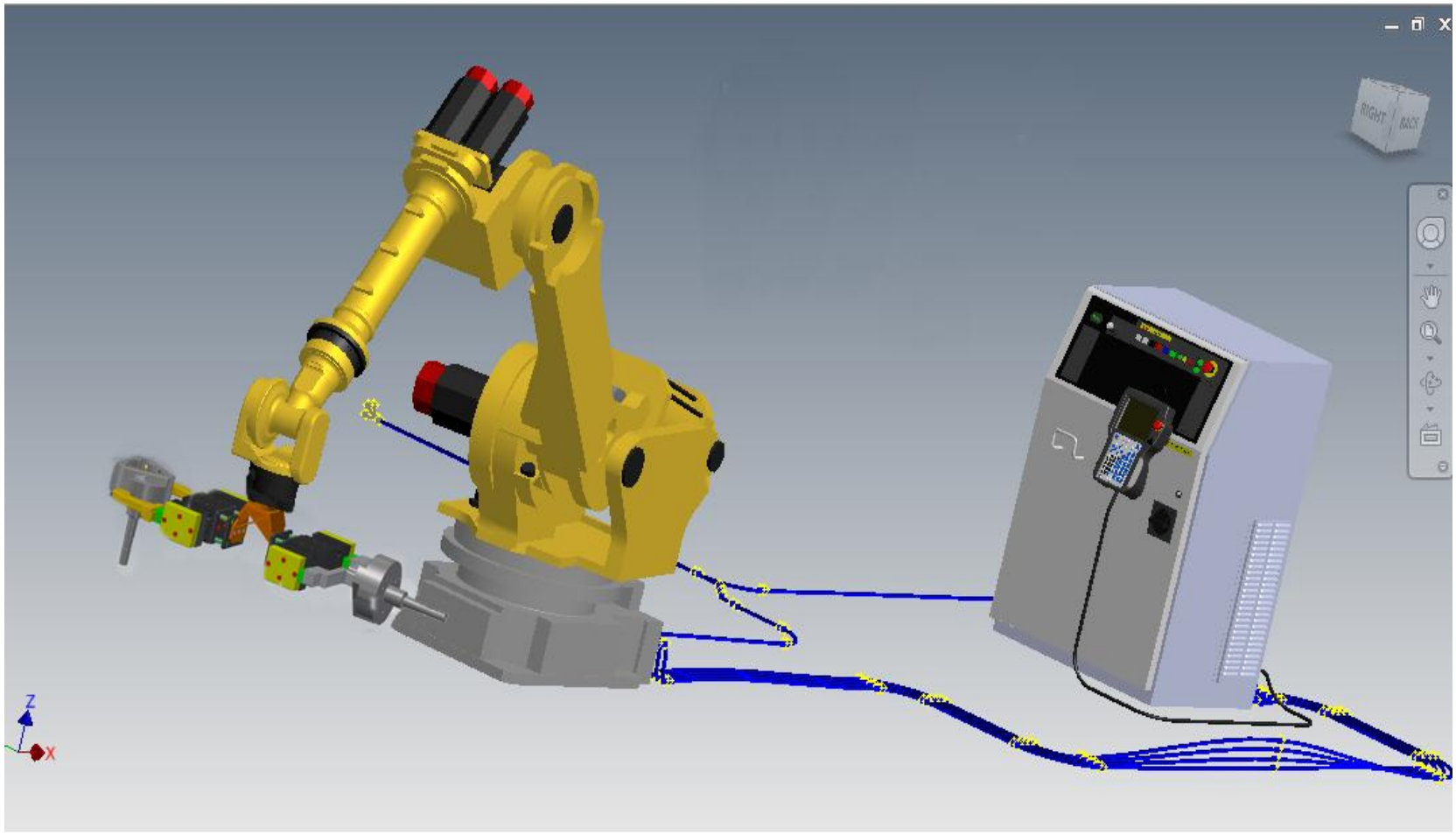


Fig. 18 Integrarea dispozitivului de apucare si fixare pe robot

8.Aspecte tehnico-economice

8.1. Costuri de achizitie

Pentru strungul Haas ST-10, costul de achizitie este de 50.000$. Pentru strungul Okuma Genos L300-M, strung avand si axa Y, costul de achizitie este 110.000$. In final, strungul NAKAMURA-TOME WT-300, un centru avand in dotare doua turele si doi arbori principali, costul de achizitie este de

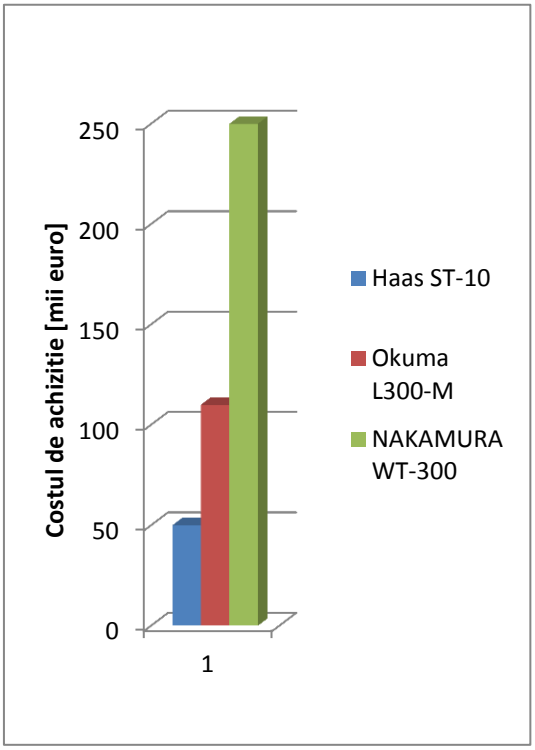


Fig.19 Costuri de achizitie

8.2. Analiza productivitatii

Incepand de la strungul Haas ST-10, un strung fara axa Y, apoi strungul Okuma L300-M avand axa Y, pana la centrul cu doua turele si doi arbori NAKAMURA-TOME WT-300, productivitatea creste considerabil in ordinea spusa mai sus.

Rezultatele obtinute reiese graficul din figura 20.

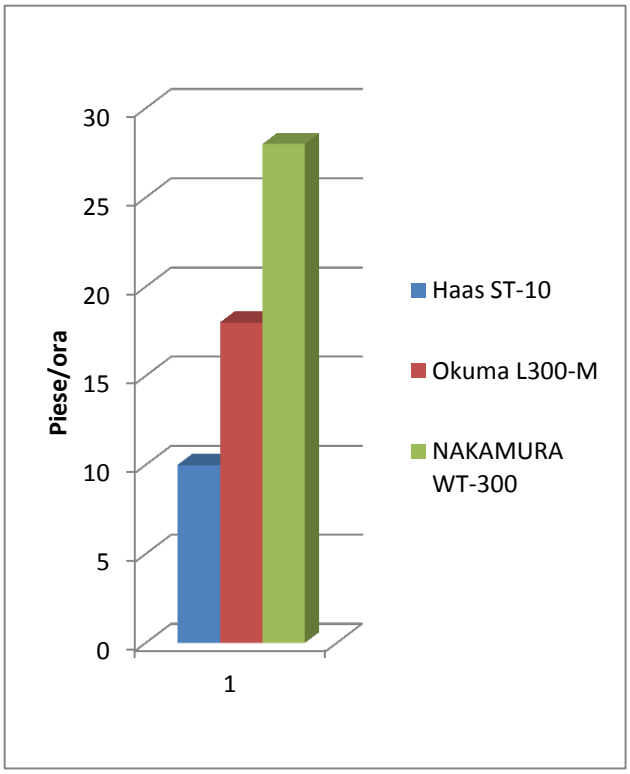


Fig. 20 Productivitate

8.3. Analiza costului piesei

Costul pentru fiecare piesa in parte, creste odata cu complexitatea strungului/centrului pe care are loc prelucrarea, dispozitivelor, sistemelor de scule etc. .

Tinand cont de cele de mai sus, reiese graficul din figura 21 :

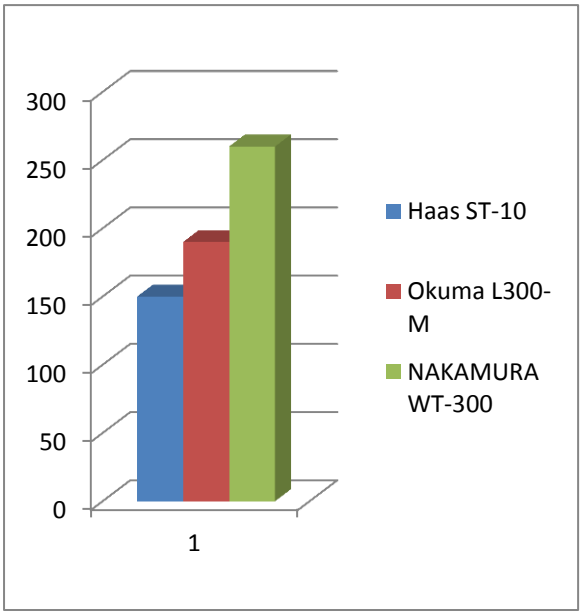


Fig. 21 Costul per piesa

9. AVANTAJE, DEZAVANTAJE SI CONCLUZII

Avand in vedere procesul tehnologic, caracteristicile strungurilor pe care are loc prelucrarea si a graficelor figurate mai sus, putem enumera o serie de avantaje si dezavantaje ale masinilor studiate:

Haas ST-10

*Avantaje - cost de achizitie scazut;
-pretul per piesa scazut;
*Dezavantaje - timp de prelucrare ridicat;

Okuma L300-M

*Avantaje - timp de prelucrare mediu;
- pretul per piesa mediu;
*Dezavantake - cost achizite ridicat;

Nakamura Tome WT-300

*Avantaje - timp de prelucrare scazut;
*Dezavantaje - cost de achizitie ridicat;
- pretul per piesa

Concluzie. Tinand cont de avantajele si dezavantajele mai sus mentionate, putem spune ca pentru fabricarea piesei "Dorn de control", cea mai rentabila masina unealta este strungul orizontal *Okuma L300-M.*

10. BIBLIOGRAFIE

[1].https://www.sandvik.coromant.com
[2].http://www.iscar.com/eCatalog
[3].http://www.walter-tools.com
[4].http://www.nakamura-tome.co.jp/products
[5].https://www.haascnc.com
[6].http://www.okuma.com/genos-l300-turning-center