

Aspecte tehnico-economice privind prelucrarea reperului „Scut subansamblu” pe masini CNC

Cioboata Florin Cristian

Conducator Stiintific Conf. Univ. Dr. Ing. **Doru BARDAC**

Rezumat: Lucrarea consta in analiza tehnico-economica privind prelucrarea reperului "Scut subansamblu" pe centre de prelucrat vertical. In aceasta analiza au fost evidentiata caracteristicile centrelor verticale, urmand a fi alese sculele de la Sandvik , Iscar si Walter pentru a putea realiza prelucrarea reperului.Urmatorul pas dupa alegerea sculelor este realizarea regimurilor de aschiere si alegerea dispozitivelor de orientare si fixare. In vederea realizarii analizei a fost necesara elaborarea programului CNC pentru piesa "Scut subansamblu", atat cu viteze mari cat si conventional.

CUVINTE CHEIE: centru vertical, productivitate , cost , frezare, program CNC

1 INTRODUCERE

Prelucrarea pieselor de tip carcasa prezinta o serie de particularitati in functie de tipul de masina cu comanda numerica aleasa. Pentru reperul „scut subansamblu” vom analiza prelucrarea pe trei tipuri de centre verticale dupa cum urmeaza:

- Makino V22
- Sodik UH430L
- DMG MORI Ultrasonic 20

2 CRITERIILE DE ALEGERE A MASINII CNC

- Modelul trebuie sa se adapteze cerintelor pietei

In momentul in care alegem o masina unealta , trebuie sa luam in considerare in primul rand reperul pe care vrem sa il prelucram.

- Productivitatea

Productivitatea este cea care influenteaza costurile de productie al unui reper , asadar este un criteriu important si trebuie luat in considerare

- Fiabilitatea

Pentru a functiona in parametrii si a putea fi cat mai eficienta , inseamna ca trebuie ca masina cnc sa fie cat mai fiabila

3 PREZENTAREA UTILAJELOR

3.1 Specificatii generale

In figura 1 este prezentat centrul vertical Makino V22, iar in Tab 1 sunt prezentate specificatiile centrului vertical

¹ Specializarea Tehnologia Constructiilor de Masini, Facultatea IMST;

E-mail: cioboataflorin@gmail.com;



Fig. 1 Centru vertical Makino V22 [8]

Tab 1. Specificatii tehnice Makino V22 [8]

Cursa	Cursa axei X	mm	320
	Cursa axei Y	mm	280
	Cursa axei Z	mm	300
Masa	Dimensiunea mesei	mm	450x370
	Greutatea maxima	kg	100
Ax	Viteza axului	RPM	40000
Magazie	Numar scule	buc	15 (30)
	Timpul de schimbare al sculei	sec	8
Avansul	Viteza maxima	m/min	10

	de avans		
	Avansul de taiere	Mm/min	20
Motor	Putere electrica	kW	8.4
Gabarit	Lxlxh	mm	1500x2000x2250
	Greutate	kg	4200

Centrul vertical Makino V22 este extrem de rigid ,ofera o precizie foarte buna a suprafetelor si este foarte stabil termic.

In figura 2 este prezentat centrul vertical Sodik UH430L



Fig 2. Centru vertical Sodik UH430L [7]

Tab 2. Specificatii tehnice Sodik UH430L [7]

Cursa	Cursa axei X	mm	420
	Cursa axei Y	mm	350
	Cursa axei Z	mm	200
Masa	Dimensiunea mesei	mm	600x400
	Greutatea maxima	kg	60
Ax	Viteza axului	RPM	40000[60000]
Magazie	Numar scule	buc	16
	Tipul de prindere		HSK [BT40]
Avansul	Viteza maxima de avans	m/min	36
	Avansul de taiere	Mm/min	36
Motor	Putere electrica	kW	15/11[20/15]
Gabarit	Lxlxh	mm	3035x1635x2200
	Greutate	kg	6000

In figura 3 este prezentat centrul vertical DMG MORI Ultrasonic 20



Fig 3. Centru vertical Ultrasonic 20 [6]

Tab 3 Specificatii tehnice Ultrasonic 20 [6]

Cursa	Cursa axei X	mm	200
	Cursa axei Y	mm	220
	Cursa axei Z	mm	280
Masa	Dimensiunea mesei	mm	370x320
	Greutatea maxima	kg	100
Ax	Viteza axului	RPM	50000
Magazie	Numar scule	buc	24
	Tipul de prindere		HSK
Avansul	Viteza maxima de avans	m/min	40
	Avansul de taiere	mm/min	20000
Motor	Putere electrica	kW	40
Gabarit	Lxlxh	mm	1775x1530x2253
	Greutate	kg	3750

3.2 Piesa prelucrata

Piesa „Scut subsansamblu” este confectionala dintr-un aliaj de AISi12 , este o piesa de tip carcasa care necesita o succesiune de prelucrari atat interioare cat si exterioare.

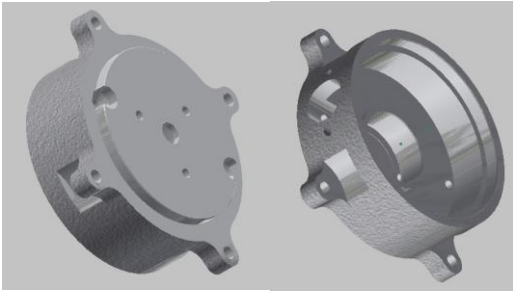


Fig. 4 Scut subansamblu

Pentru reperul din figura 4 sunt necesare urmatoarele prelucrari:

- Frezare plana exteriora
- Frezare umar
- Frezare interioara
- Gaurire

3.3 Scule utilizate

3.3.1 Scule Sandvik

Pentru frezarea exteriora plana se va folosi freza CoroMill 316 ,cod freza A316-16FM650-06215L

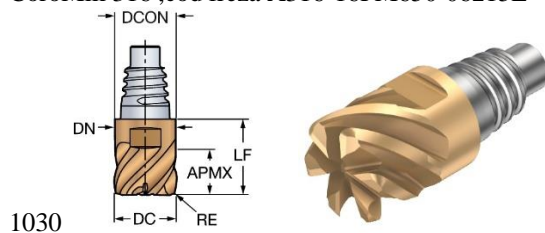


Fig.5 [3]

Tab.4 Caracteristici [3]

DC	DCON	RE	APMX
15.875mm	15.5mm	1.575mm	8.5mm

Cu port-scula C4-A391.EH-16 034

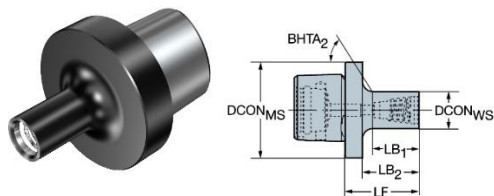


Fig.6 [3]

Tab.5 Caracteristici [3]

DCON _{MS}	DCON _{WS}	LF	BHTA ₂
40mm	15.4mm	34mm	45°

Pentru frezarea umarului se va folosi freza CoroMill 316 , cod freza 316-25SM345-25000A H10F

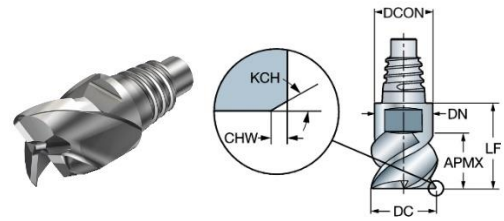


Fig.7 [3]

Tab.6 Caracteristici [3]

DC	DCON	LF	APMX
25mm	24.2mm	25.6mm	13.5mm

Cu port-scula E25-A32-SS-080

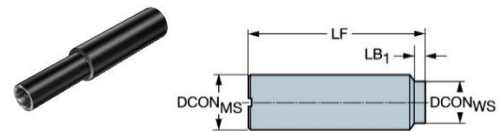


Fig.8 [3]

Tab.7 Caracteristici [3]

DCON _{MS}	DCON _{WS}	LF	BHTA ₂
32mm	24.1mm	80mm	0°

Pentru frezarea interioara se va folosi freza CoroMill 390 , cod freza R390-020A20-07M

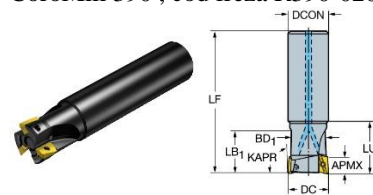


Fig.9 [3]

Tab.8 Caracteristici [3]

DC	DCON	LF	APMX
20mm	20mm	110mm	5.8mm

Folosita cu placutele 390R-070202E-NL H13A

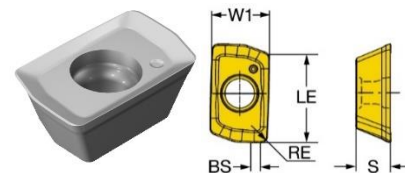


Fig.10 [3]

Tab.9 Caracteristici [3]

S	RE	W1	LE
2.4	0.2	4mm	5.9mm

CoroMill Plura : R215.34C20040-DS20K 1640

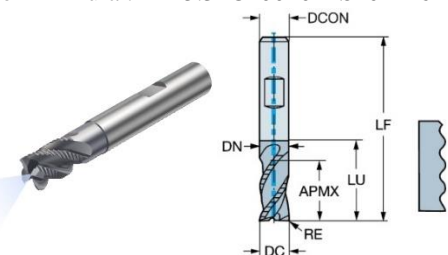


Fig.11 [3]

Tab.10 Caracteristici [3]

DC	DCON	LF	APMX
20mm	20mm	92mm	20mm

CoroMill Plura: R216.33-10040-AJ14U H10F

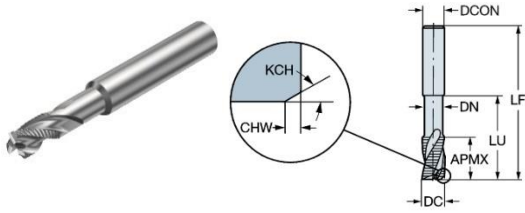


Fig.12 [3]

Tab.11 Caracteristici [3]

DC	DCON	LF	APMX
10mm	12mm	83mm	14mm

Gaurire Ø6.5 cu CoroDrill 860 cod burghiu: 860.1-0650-020A1-NM H10F

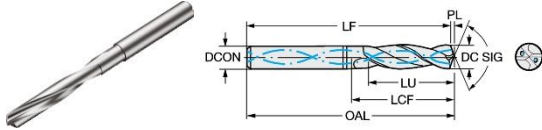


Fig.13 [3]

Tab.12 Caracteristici [3]

DC	DCON	LF	LU
6.5mm	8mm	78.1mm	20.4mm

3.3.2 Scule Iscar

Pentru frezarea exterioara folosim freza HOF D063-04-22-R07

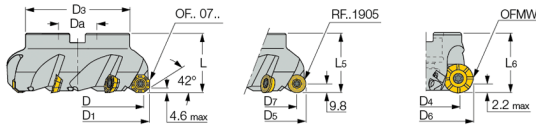


Fig.14 [4]

Tab.13 Caracteristici [4]

D3	L	Da	D
48mm	40mm	22mm	63mm

Pentru frezarea anarului folosim freza ECA-H4 20-40/60C20CFR02

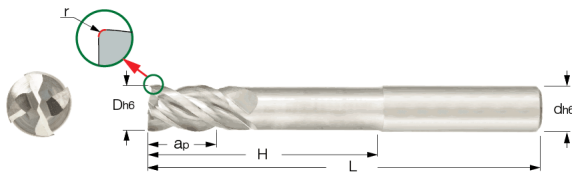


Fig.15 [4]

Tab.14 Caracteristici [4]

Dh6	L	ap	dh6
20mm	110mm	40mm	20mm

Pentru frezarea interioara folosim freza HM90 E90AD-D32-3-W32

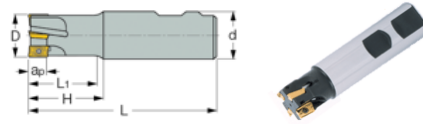


Fig. 16 [4]

Tab.15 Caracteristici [4]

D	L	Ap	d
32mm	110mm	14.3mm	32mm

Cu placutele HM90 ADCR 1505PDFR-P

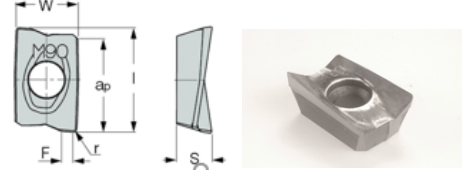


Fig.17 [4]

Tab.16 Caracteristici [4]

W	S	Ap	r
9.55mm	6.90mm	15.3mm	0.8mm

Folosim freza ECA-H4 20-40/60C20CFR02

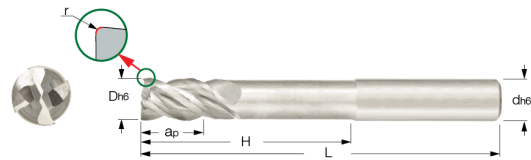


Fig.18 [4]

Tab.17 Caracteristici [4]

Dh6	L	ap	dh6
20mm	110mm	40mm	20mm

Folosim freza ECA-H4 12-24/36C12CFR02

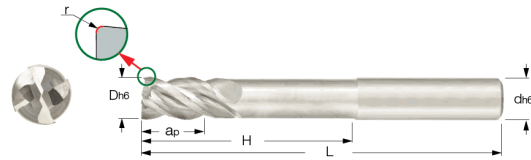


Fig.19 [4]

Tab.18 Caracteristici [4]

Dh6	L	ap	dh6
12mm	83mm	24mm	12mm

Gaurire Ø6.5 folosim burghiul SCD 065-064-080 ACP8

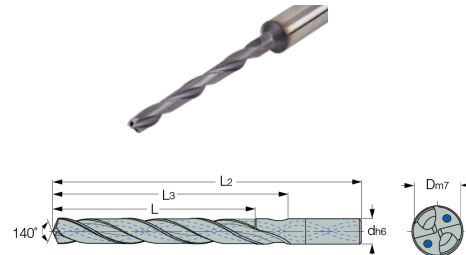


Fig.20 [4]

Tab.19 Caracteristici [4]

L2	L	dh6	Dm7
114mm	64mm	8mm	6.5mm

3.3.3 Scule Walter

Pentru frezarea exteriora plana se va folosi freza Protostar AL 45, cod:H602411-8

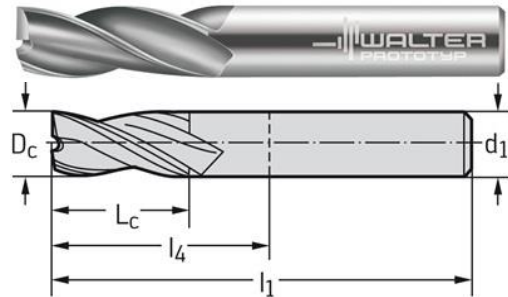


Fig.21 [5]

Tab.20 Caracteristici [5]

DC	L _c	d ₁	L ₁
7mm	13mm	8mm	63mm

Pentru frezarea umarului se va folosi freza F4723.B22.050.Z05.05.D

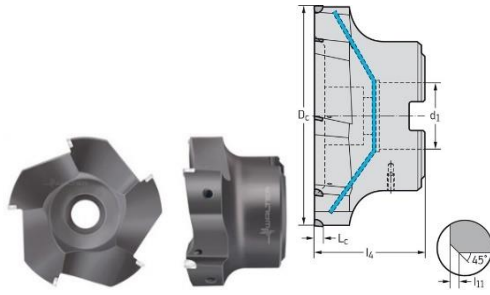


Fig.22 [5]

Tab.21 Caracteristici [5]

DC	L ₄	d ₁	L _c
50.6mm	40mm	22mm	5mm

Pentru frezarea interioara se va folosi freza Protostar AL 45 , cod H6023114-12

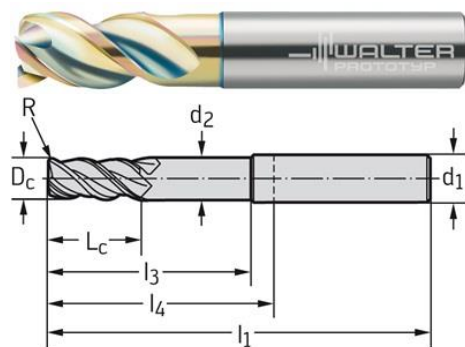


Fig.23 [5]

Tab.22 Caracteristici [5]

DC	L _c	d ₁	L ₁
12mm	22mm	12mm	83mm

Protostar AL 45, cod:H6023114-10

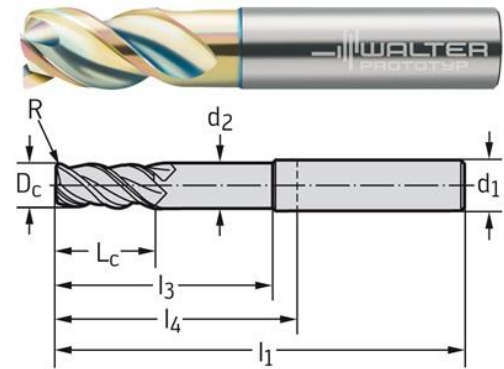


Fig.24 [5]

Tab.23 Caracteristici [5]

DC	L _c	d ₁	L ₁
10mm	19mm	10mm	72mm

Protostar AL 45, cod:H6023114-12

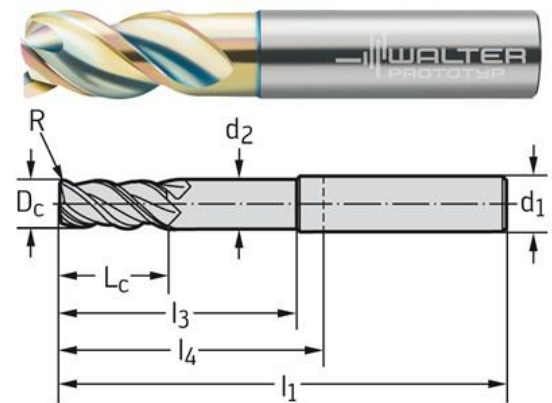


Fig.25 [5]

Tab.24 Caracteristici [5]

DC	L _c	d ₁	L ₁
12mm	22mm	12mm	83mm

Protostar HSC 30 cod :H404491-3-30

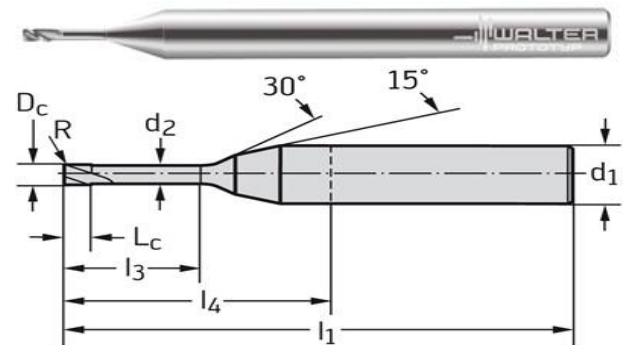


Fig.26 [5]

Tab.25 Caracteristici [5]

DC	L _c	d ₁	L ₁
3mm	3mm	10mm	60mm

4 REGIMURI DE ASCHIERE

4.1 Regimuri de aschiere pentru prelucrarile conventionale

Frezarea exterioara plana : A316-16FM650-06215L 1030

	1	
Working engagement (AE)	11.4	mm
Depth of cut (AP)	5	mm
Number of passes in AE direction (NOPAE)	7	
Number of passes in AP direction (NOPAP)	2	
Cutting speed (VC)	200	m/min
Spindle speed (N)	4010	1/min
Feed per tooth (FZ)	0.193	mm
Feed speed at machined diameter (VFM)	4640	mm/min
Cutting power (PPC)	3.14	kW
Cutting torque (MMC)	7.47	Nm
Material removal rate (QQ)	265	cm ³ /min
Cutting time total (TCCT)	00:15.900	min:s
Non cutting time total (TNCT)	00:01.716	min:s
Tool life length (TLIFEL)	1600	m
Tool life time (TLIFET)	340	min

Fig.27 [3]

Frezare umar : 316-25SM345-25000A H10F

	1	
Working engagement (AE)	10	mm
Depth of cut (AP)	4	mm
Number of passes in AE direction (NOPAE)	1	
Number of passes in AP direction (NOPAP)	1	
Cutting speed (VC)	370	m/min
Spindle speed (N)	4710	1/min
Feed per tooth (FZ)	0.419	mm
Feed speed at machined diameter (VFM)	5920	mm/min
Cutting power (PPC)	2.39	kW
Cutting torque (MMC)	4.85	Nm
Material removal rate (QQ)	237	cm ³ /min
Cutting time total (TCCT)	00:00.636	min:s
Tool life length (TLIFEL)	820	m
Tool life time (TLIFET)	140	min

Fig.28 [3]

Frezare interioara : R390-020A20-07M

	1	1	
Working engagement (AE)	19.8	8.2	mm
Depth of cut (AP)	2	4	mm
Number of passes in AE direction (NOPAE)	1	1	
Number of passes in AP direction (NOPAP)	2	1	
Machined diameter start (DMS)	39.6		mm
Effective ramping angle (RMP)	1.86		°
Cutting speed (VC)	1170	936	m/min
Spindle speed (N)	18600	14900	1/min
Feed per tooth (FZ)	0.101	0.103	mm
Feed speed at machined diameter (VFM)	7540	6130	mm/min
Feed speed (VF)	3730		mm/min
Cutting power (PPC)	4.75	3.29	kW
Cutting torque (MMC)	2.44	2.11	Nm
Material removal rate (QQ)	148	201	cm ³ /min
Cutting time total (TCCT)	00:01.980	00:01.470	min:s
Tool life length (TLIFEL)	270	340	m
Tool life time (TLIFET)	36	56	min

Fig.29 [3]

CoroMill Plura : R215.34C20040-DS20K 1640

	1	
Working engagement (AE)	13.1	mm
Depth of cut (AP)	15.5	mm
Number of passes in AE direction (NOPAE)	1	
Number of passes in AP direction (NOPAP)	1	
Cutting speed (VC)	301	m/min
Spindle speed (N)	4790	1/min
Feed per tooth (FZ)	0.353	mm
Feed speed at machined diameter (VFM)	6760	mm/min
Cutting power (PPC)	9.51	kW
Cutting torque (MMC)	19	Nm
Material removal rate (QQ)	1370	cm ³ /min
Cutting time total (TCCT)	00:01.086	min:s
Tool life length (TLIFEL)	4700	m
Tool life time (TLIFET)	690	min

Fig.30 [3]

CoroMill Plura: R216.33-10040-AJ14U H10F

	€	1	
Working engagement (AE)	10	1	mm
Depth of cut (AP)	5.8	11.6	mm
Number of passes in AE direction (NOPAE)	1	1	
Number of passes in AP direction (NOPAP)	2	2	
Machined diameter start (DMS)	20		mm
Effective ramping angle (RMP)	10.5		°
Cutting speed (VC)	358	161	m/min
Spindle speed (N)	11400	5120	1/min
Feed per tooth (FZ)	0.141	0.289	mm
Feed speed at machined diameter (VFM)	4820	4440	mm/min
Feed speed (VF)	2410		mm/min
Cutting power (PPC)	2.9	0.535	kW
Cutting torque (MMC)	2.43	0.997	Nm
Material removal rate (QQ)	140	51.5	cm ³ /min
Cutting time total (TCCT)	00:03.126	00:01.782	min:s
Tool life length (TLIFEL)	390	6600	m
Tool life time (TLIFET)	81	1500	min

Fig.31 [3]

Frezare umar : 316-25SM345-25000A H10F

	1	
Working engagement (AE)	10	mm
Depth of cut (AP)	4	mm
Number of passes in AE direction (NOPAE)	1	
Number of passes in AP direction (NOPAP)	1	
Cutting speed (VC)	1840	m/min
Spindle speed (N)	23400	1/min
Feed per tooth (FZ)	0.419	mm
Feed speed at machined diameter (VFM)	29400	mm/min
Cutting power (PPC)	11.9	kW
Cutting torque (MMC)	4.85	Nm
Material removal rate (QQ)	1180	cm ³ /min
Cutting time total (TCCT)	00:00.127	min:s
Tool life length (TLIFEL)	230	m
Tool life time (TLIFET)	7.8	min

Fig.33 [3]

4.2 Regimuri de aschiere pentru prelucrarile cu viteze mari

Frezarea exterioara plana : A316-16FM650-06215L 1030

	1	
Working engagement (AE)	11.4	mm
Depth of cut (AP)	5	mm
Number of passes in AE direction (NOPAE)	7	
Number of passes in AP direction (NOPAP)	2	
Cutting speed (VC)	1500	m/min
Spindle speed (N)	30100	1/min
Feed per tooth (FZ)	0.193	mm
Feed speed at machined diameter (VFM)	34800	mm/min
Cutting power (PPC)	23.5	kW
Cutting torque (MMC)	7.47	Nm
Material removal rate (QQ)	1990	cm ³ /min
Cutting time total (TCCT)	00:02.118	min:s
Non cutting time total (TNCT)	00:01.716	min:s
Tool life length (TLIFEL)	320	m
Tool life time (TLIFET)	9.2	min

Fig.32 [3]

Frezare interioara : R390-020A20-07M

	€	1	
Working engagement (AE)	19.8	8.2	mm
Depth of cut (AP)	2	4	mm
Number of passes in AE direction (NOPAE)	1	1	
Number of passes in AP direction (NOPAP)	2	1	
Machined diameter start (DMS)	39.6		mm
Effective ramping angle (RMP)	1.86		°
Cutting speed (VC)	1170	1620	m/min
Spindle speed (N)	18600	25800	1/min
Feed per tooth (FZ)	0.101	0.103	mm
Feed speed at machined diameter (VFM)	7540	10600	mm/min
Feed speed (VF)	3730		mm/min
Cutting power (PPC)	4.75	5.69	kW
Cutting torque (MMC)	2.44	2.11	Nm
Material removal rate (QQ)	148	348	cm ³ /min
Cutting time total (TCCT)	00:01.980	00:00.846	min:s
Tool life length (TLIFEL)	270	190	m
Tool life time (TLIFET)	36	18	min

Fig.34 [3]

CoroMill Plura : R215.34C20040-DS20K 1640

	1	
Working engagement (AE)	13.1	mm
Depth of cut (AP)	15.5	mm
Number of passes in AE direction (NOPAE)	1	
Number of passes in AP direction (NOPAP)	1	
Cutting speed (VC)	1780	m/min
Spindle speed (N)	28300	1/min
Feed per tooth (FZ)	0.353	mm
Feed speed at machined diameter (VFM)	40000	mm/min
Cutting power (PPC)	56.3	kW
Cutting torque (MMC)	19	Nm
Material removal rate (QQ)	8120	cm ³ /min
Cutting time total (TCCT)	00:00.184	min:s
Tool life length (TLIFEL)	1100	m
Tool life time (TLIFET)	28	min

Fig.35 [3]

CoroMill Plura: R216.33-10040-AJ14U H10F

	2	1	
Working engagement (AE)	10	1	mm
Depth of cut (AP)	5.8	11.6	mm
Number of passes in AE direction (NOPAE)	1	1	
Number of passes in AP direction (NOPAP)	2	2	
Machined diameter start (DMS)	20		mm
Effective ramping angle (RMP)	10.5		°
Cutting speed (VC)	358	942	m/min
Spindle speed (N)	11400	30000	1/min
Feed per tooth (FZ)	0.141	0.289	mm
Feed speed at machined diameter (VFM)	4820	26000	mm/min
Feed speed (VF)	2410		mm/min
Cutting power (PPC)	2.9	3.13	kW
Cutting torque (MMC)	2.43	0.997	Nm
Material removal rate (QQ)	140	302	cm ³ /min
Cutting time total (TCCT)	00:03.126	00:00.305	min:s
Tool life length (TLIFEL)	390	1600	m
Tool life time (TLIFET)	81	62	min

Fig.36 [3]

Gaurire Ø6.5 cu CoroDrill 860 cod burghiu: 860.1-0650-020A1-NM H10F

Cutting speed (VC)	360	m/min
Spindle speed (N)	17600	1/min
Feed per revolution (FN)	0.533	mm
Feed speed (VF)	9400	mm/min
No. of holes (TLIFEC)	294000	Holes
Tool life time (TLIFET)	94	min
Tool life length (TLIFEL)	880	m
Cutting power (PPC)	4.07	kW
Cutting torque (MMC)	2.21	Nm
Feed force (FFF)	513	N

Fig.37 [3]

4.3 Prezentarea dispozitivelor de orientare si fixare

Pentru centrul vertical Makino V22 putem alege statia de prindere cvadrupla AMF No. 6204S4HA-001

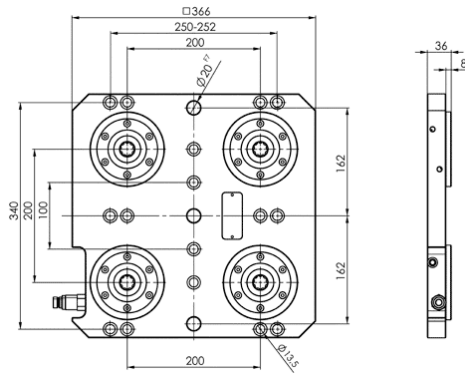


Fig.38 [9]

Este o statie de prindere hidraulica folosita pentru optimizarea timpilor de prindere ale pieselor pe masa masinii unelte , avand distanta dintre fante de 63, 100 si 125 mm. Prinderea se face cu suruburi M12 , dimensiunea de insertie a modulelor de prindere este de 200 mm.

Pentru centrul vertical Sodik UH430L putem alege statia de prindere cu sase posturi AMF No. 6204S6HA-001



Fig.39 [9]

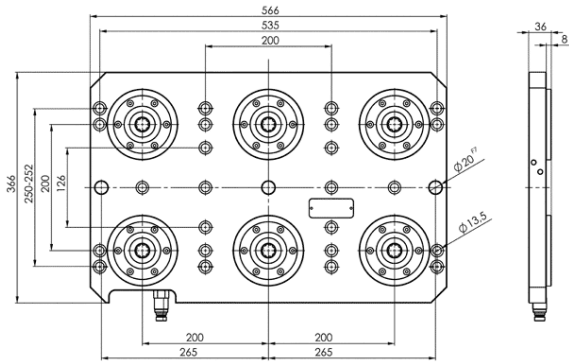


Fig.40 [9]

Deblocare hidraulica

Placa de baza: Otel

Precizia pentru fiecare repetare: <math><0.005\text{ mm}</math>

Pentru centrul vertical DMG MORI Ultrasonic 20 folosim suportul de prindere dublu AMF No. 6204K2HA-013

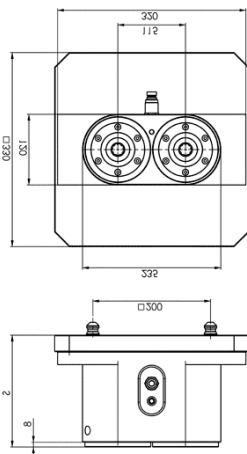


Fig.41 [9]

Deblocare hidraulica

Placa de baza: Otel

Precizia pentru fiecare repetare: <math><0.005\text{ mm}</math>

5 ELABORAREA PROGRAMULUI CNC

Programul CNC a fost realizat cu ajutorul programului HEIDENHAIN TNC-640, programul fiind o versiune educationala.

Conventional:

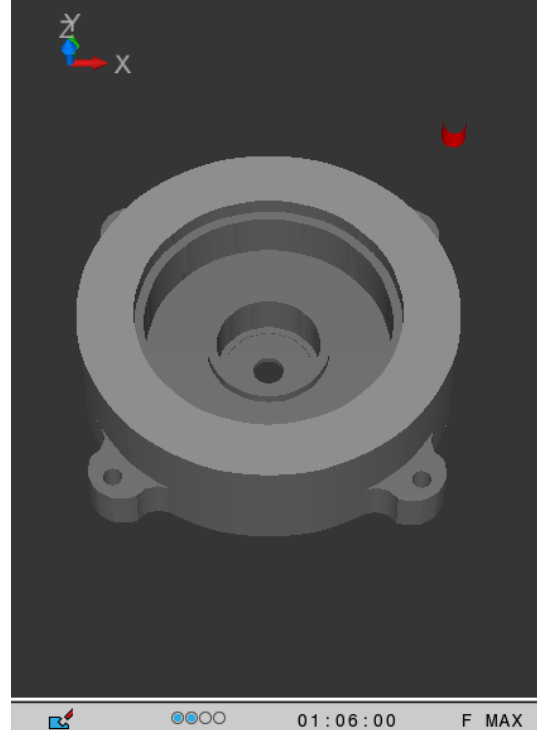


Fig.42

Timpul efectiv de prelucrare este de 66 minute.

Viteze mari:

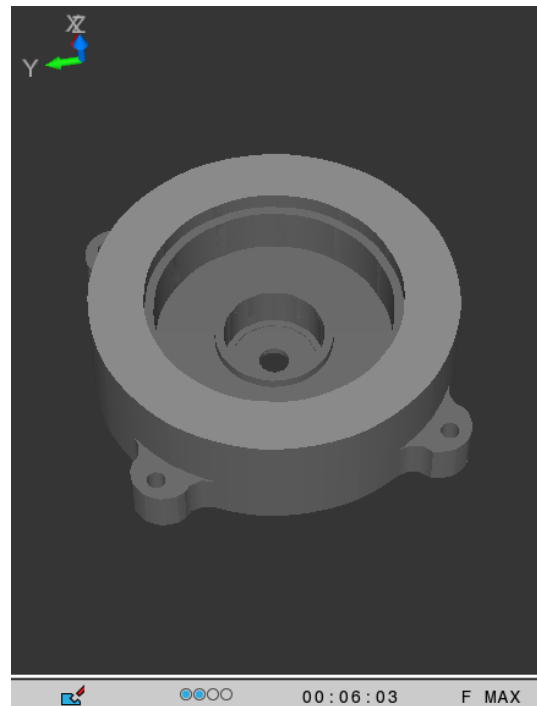


Fig.43

Timpul efectiv de prelucrare este de 6 minute

6 SCHEMA LOGICA A PROGRAMULUI CNC

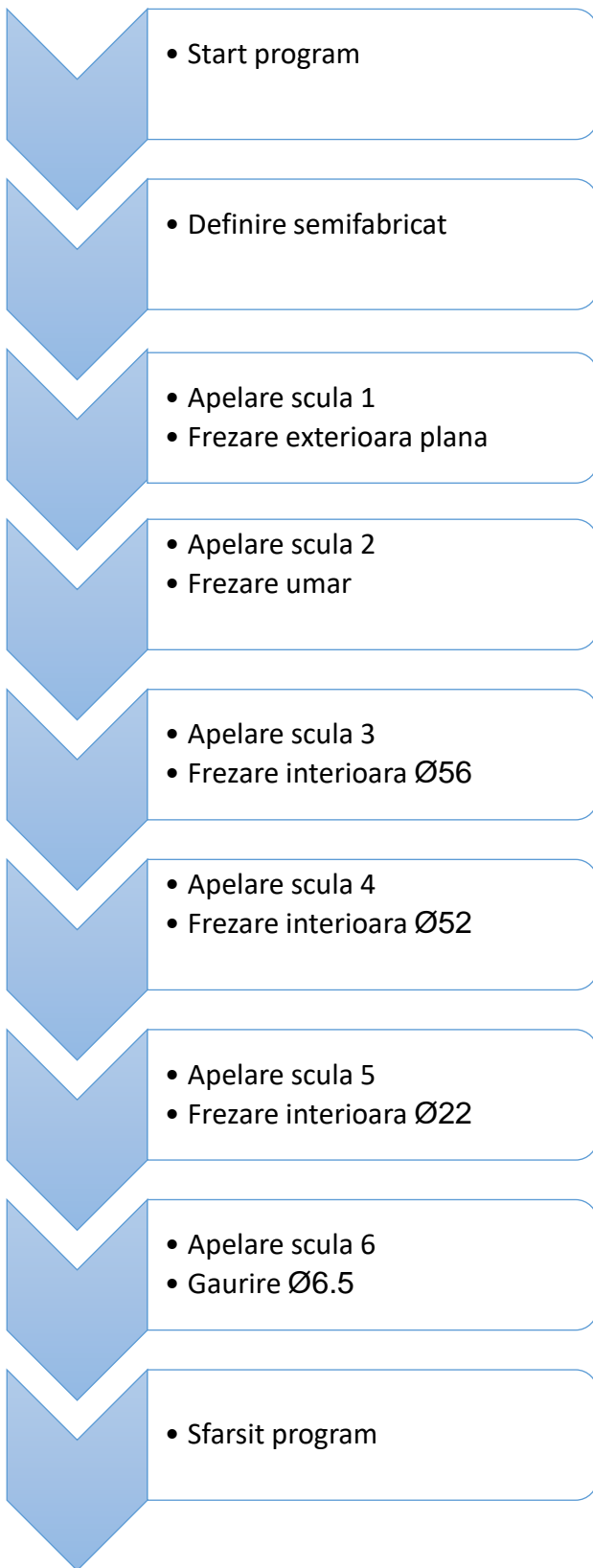


Fig.44

7 ASPECTE TEHNICO-ECONOMICE

7.1 Costuri de achizitie

In figura 44 este prezentat graficul costului de achizitie exprimat in Euro

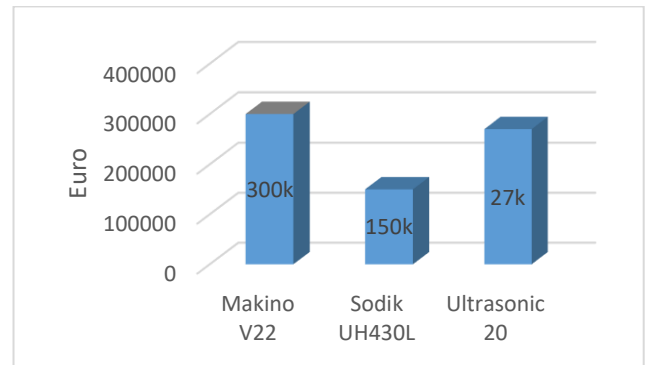


Fig.45

7.2 Analiza productivitatii

In figura 45 este prezentata productivitatea masinilor exprimata in piese/ora

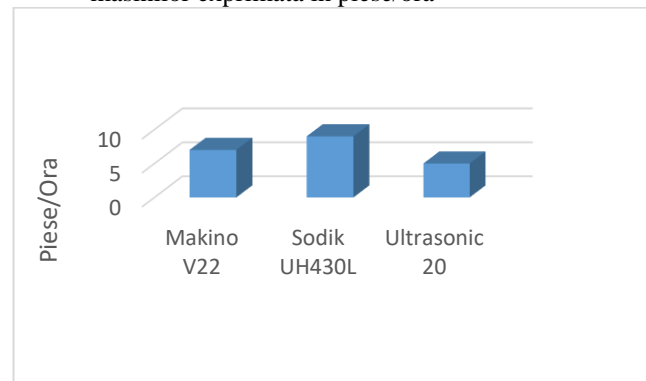


Fig.46

7.3 Timpul de realizare.

In figura 46 este prezentat timpul de realizare al unui reper atat conventional , cat si cu viteze mari.

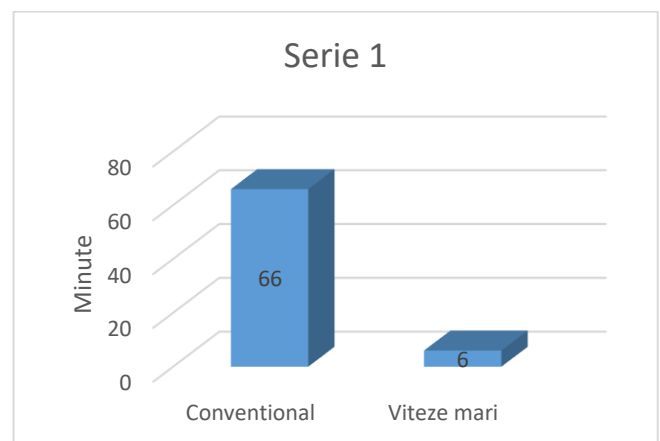


Fig.47

7.4 Numarul de operatori

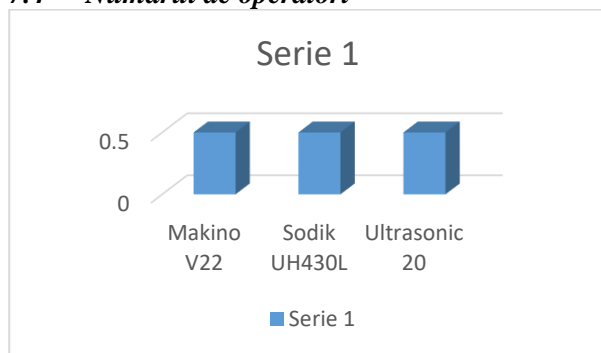


Fig.48

8. CONCLUZII

Dupa elaborarea programului putem observa ca prelucrarile cu viteze mari sunt mult mai avantajoase din punct de vedere al productivitatii , fata de prelucrarile conventionale , fiind necesar un timp de executie al piesei de pana la 10x mai mare.

9. MULTUMIRI

Multumiri Scolii de Studii Avansate in Fabricarea pe Masini CNC , Laboratorului de Tehnologii Avansate de Fabricatie pe Masini CNC cat si firemelor DMG MORI , WALTER , ISCAR SANDVIK COROMANT , AMF, HEIDENHAIN

10. BIBLIOGRAFIE

- [1] Bardac D. Curs de programare a Masinilor CNC-UPB-IMST-2017
- [2] Bardac D. Curs Prelucrari cu Viteze Mari-UPB-IMST-2017
- [3]Aplicatie de alegere a sculelor Sandvik Coromant (<http://www.sandvik.coromant.com>)
Accesat la data de 22-04-2017
- [4]Aplicatie de alegere a sculelor Iscar tools (<http://www.iscar.com>)
Accesat la data de 22-04-2017
- [5] Aplicatie de alegere a sculelor Walter tools (<http://www.walter-tools.com>)
Accesat la data de 24-04-2017
- [6]Catalog centre verticale DMG MORI (www.dmgmori.co.jp/en/)
Accesat la data de 21-04-2017
- [7] Sodik (<http://www.sodick.com>)
Accesat la data de 21-04-2017
- [8] Makino (<https://www.makino.com/>)
Accesat la data de 21-04-2017
- [9] Catalog electronic AMF (<http://www.amf.de/en/home/>)
Accesat la data de 26-04-2017
- [10] Heidenhain(<http://www.heidenhain.ro>)
- [11] <http://www.ttonline.ro/sectiuni/masini-unealte/articole/12097-cum-alegem-corect-o-masina-unealta-cu-comanda-numerica-de-ce-okuma>
Accesat la data de 21-04-2017