BIDANG PROSES PENDIDIKAN DAN PENGAJARAN :

BERITA ACARA PERKULIAHAN
Kuliah Online (*E-Learning*)

Periode Semester Ganjil 2020/2021

MATAKULIAH :

CAD/CAM dan Pemrograman NC

LAMPIRAN BERITA ACARA PERKULIAHAN :

1. Presensi Kehadiran Dosen dan Materi Ajar (SAP)
2. Presensi Kehadiran Kuliah Mahasiswa
3. Presensi Kehadiran Ujian Tengah Semester (UTS)
4. Hasil Evaluasi Belajar Mahasiswa (Nilai Akhir)
5. Contoh Hand-out Bahan Ajar

Program Studi Teknik Industri – S1
Fakultas Teknologi Industri
Institut Sains dan Teknologi Nasional
J a k a r t a
2 0 2 1

	BERITA ACARA PERKULIAHAN (PRESENSI KEHADIRAN DOSEN) SEMESTER GANJIL TAHUN AKADEMIK 2020/2021 PROGRAM STUDI TEKNIK INDUSTRI S1 -FTI ISTN		
	MATA KULIAH	: CAD/CAM dan Pemrograman NC	SEMESTER: 5
	DOSEN	: Ir. Komarudin, MT.	SKS : 2
	HARI/JAM	: Senin / 13.00 - 14.40	KELAS : A

No.	Tanggal	Materi	Jumlah mhs	Ttd dosen
1	21–09-2020	Pengantar (Silabus dan Kontrak Perkuiahan)	6	
2	28-09-2020	Sejarah Perkembangan Teknologi Proses Manufaktur dan Tugas 1	6	
3	05-10-2020	Modul CAD/CAM (Fungsi, Spesifikasi Alat, Software dan Menu Operasi)	10	
4	12-10-2020	Desain Pemodelan (geometrical) CAD dan Tugas 2	14	
5	19-10-2020	Operasi CAM dan Integrasi CAD/CAM	16	
6	26-10-2020	Ujian Tengah Semester (UTS)	10	
7	02-11-2020	Simulasi CAM, Output Program dan Tugas 3	9	
8	18-01- 2021	Sejarah Perkembangan Mesin Produksi (Konvensional ke CNC)	14	

	BERITA ACARA PERKULIAHAN (PRESENSI KEHADIRAN DOSEN) SEMESTER GANJIL TAHUN AKADEMIK 2020/2021 PROGRAM STUDI TEKNIK INDUSTRI S1 -FTI ISTN		
	MATA KULIAH	: CAD/CAM dan Pemrograman NC	SEMESTER: 5
	DOSEN	: Ir. Komarudin, MT.	SKS : 2
	HARI/JAM	: Senin / 13.00 - 14.40	KELAS : A

No.	Tanggal	Materi	Jumlah mhs	Ttd dosen
9	16–11-2020	Prinsip dan Konsep Dasar Pemrograman CNC	12	
10	23-11-2020	Pemrograman Mesin Turning	13	
11	30-12-2020	Tugas 5 (Pemrograman Turning)	12	
12	07-12-2020	Pemrograman Mesin Milling	10	
13	14-12-2020	Tugas 6 (Pemrograman Millinng)	13	
14	23-12-2020	Pengaturan Pahat Pada Milling Machine	15	
15	30-12-2020	Review Materi dan Kisi-kisi UAS	15	
16	18-01- 2021	Ujian Akhir Semester (UAS)	14	

Mengetahui,

(Ir. Iriandi Ilyas, MT.)
Ka. Prodi Teknik Industri-FTI

Dosen Pengampu,

(Ir. Komarudin, MT)

DAFTAR HADIR MAHASISWA

SEMESTER GANJIL REGULER TAHUN 2020/2021

Program Studi : Teknik Industri S1
Matakuliah : CAD/CAM dan Pemrograman NC
Kelas / Peserta : A / 16
Perkuliahan : Kampus ISTN Bumi Srengseng Indah
Dosen : Komarudin, Ir.MT

No	NIM	N A M A	Pertemuan															
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	18230015	Aditya Putra	-	-	v	-	v	UTS	-	v	v	-	v	-	v	v	v	UAS
2	18230003	Ahmad Vauzi	-	-	v	-	v	UTS	-	v	v	v	v	-	-	v	v	--
3	16230009	Anindita Mutia Widodo	v	v	v	v	v	-	v	v	v	v	v	v	v	v	v	UAS
4	18230007	Banu Galih Hasta	v	v	v	v	v	UTS	v	v	v	v	v	v	v	v	v	UAS
5	18230016	Budi Haryanto	v	v	v	v	v	UTS	v	v	v	v	v	v	v	v	v	UAS
6	18230009	Dikki Godipa Saragih	-	-	-	v	v	UTS	-	v	v	-	v	-	v	v	v	UAS
7	18230005	Fajar Dwi Adistra	-	-	-	v	v	-	v	v	-	v	-	v	v	v	-	UAS
8	18230011	Kinanti Alifah Wildana	-	-	-	v	v	-	-	-	v	v	v	v	v	v	v	--
9	15230001	Laga Alur Semesta	-	-	-	v	v	UTS	-	v	v	-	-	v	v	v	v	UAS
10	18230010	Moehammad Iqbhal Asseghaf	v	v	v	V	v	UTS	v	v	v	v	v	v	v	v	v	UAS
11	18230001	Muhamad Sadam Pangestu	-	-	v	v	v	-	-	v	-	v	v	-	v	-	v	UAS
12	18230006	Muhammad Firman Rayani	-	-	-	v	v	UTS	v	v	-	v	-	-	-	v	v	UAS
13	18230004	Muhammad Zahran Raihan Nur Rabbani	-	-	v	-	v	UTS	-	v	v	v	-	-	v	v	v	UAS
14	18230002	Venantius Marcel Ell	v	v	v	v	v	UTS	v	v	v	v	v	v	v	v	v	UAS
15	18230013	Yoel Arya Pradana	-	-	-	v	v	-	v	-	-	v	v	v	-	v	v	UAS
16	16230012	Yusuf Rizky Efendi	v	v	v	v	v	-	v	v	v	v	v	v	v	v	v	UAS

Jakarta, Januari 2021

Dosen Pengajar

Komarudin, Ir.MT

Nilai Hasil Evaluasi Belajar Mahasiswa

Mata Kuliah :

CAD/CAM dan Pemrograman NC

Kelas A

Dosen :

Ir. Komarudin, MT.

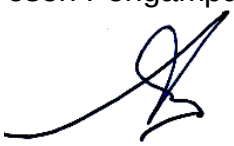
Program Studi Teknik Industri – S1
Fakultas Teknologi Industri
Institut Sains dan Teknologi Nasional
J a k a r t a
2 0 2 1

DAFTAR HADIR
UJIAN AKHIR SEMESTER
SEMESTER GANJIL TAHUN AKADEMIK 2020/2021

Program Studi	:	**Teknik Industri S-1, Reg., Kls : A, FTI – ISTN**
Mata Kuliah	:	**Pemrograman CNC dan CAD/CAM**
Hari/Tanggal	:	**Senin, 18 Januari 2021**
Jam	:	**13.00 - 14.40 WIB**
Ruang	:	**Virtual (Online)**
Sifat Ujian	:	**Take Home Test**
Dosen	:	**Ir. Komarudin, MT**

NO	NAMA LENGKAP	NIM	HADIR/TIDAK HADIR
1	Aditya Putra	18230015	Hadir
2	Ahmad Vauzi	18230003	Tidak Hadir
3	Anindita Mutia Widodo	16230009	Hadir
4	Banu Galih Hasta	18230007	Hadir
5	Budi Haryanto	18230016	Hadir
6	Dikki Godipa Saragih	18230009	Hadri
7	Fajar Dwi Adistra	18230005	Hadir
8	Kinanti Alifah Wildana	18230011	Tidak Hadir
9	Laga Alur Semesta	15230001	Hadir
10	Moehammad Iqbhal Asseghaf	18230010	Hadir
11	Muhamad Sadam Pangestu	18230001	Hadir
12	Muhammad Firman Rayani	18230006	Hadir
13	Muhammad Zahran Raihan Nur Rabbani	18230004	Hadir
14	Venantius Marcel Ell	18230002	Hadir
15	Yoel Arya Pradana	18230013	Hadir
16	Yusuf Rizky Efendi	16230012	Hadir
17			
18			

Jakarta, 18 Januari 2021
Dosen Pengampu



Ir. Komarudin, MT
NIDN : 0323016303

DAFTAR NILAI

SEMESTER GANJIL REGULER TAHUN 2020/2021

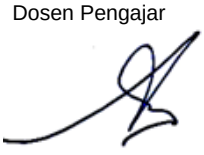
Program Studi : Teknik Industri S1
Matakuliah : Pemrograman CNC dan CAD/CAM
Kelas / Peserta : A
Perkuliahan : Kampus ISTN Bumi Srengseng Indah
Dosen : Komarudin, Ir.MT

No	NIM	N A M A	ABSEN	TUGAS	UTS	UAS	MODEL	PRESENTASI	NA	HURUF
			10%	20%	30%	40%	0%	0%		
1	15230001	**Laga Alur Semesta**	57	40	65	70	0	0	61.2	**C**
2	16230009	**Anindita Mutia Widodo**	100	0	0	0	0	0	0	
3	16230012	**Yusuf Rizky Efendi**	100	0	0	0	0	0	0	
4	18230001	**Muhamad Sadam Pangestu**	57	0	0	75	0	0	35.7	**E**
5	18230002	**Venantius Marcel Ell**	100	99	70	75	0	0	80.8	**A**
6	18230003	**Ahmad Vauzi**	57	0	50	0	0	0	0	
7	18230004	**Muhammad Zahran Raihan Nur Rabbani**	57	40	50	75	0	0	58.7	**C**
8	18230005	**Fajar Dwi Adistra**	57	0	0	0	0	0	0	
9	18230006	**Muhammad Firman Rayani**	57	40	70	70	0	0	62.7	**C+**
10	18230007	**Banu Galih Hasta**	100	66	75	85	0	0	79.7	**A-**
11	18230009	**Dikki Godipa Saragih**	57	40	70	55	0	0	56.7	**C**
12	18230010	**Moehammad Iqbhal Asseghaf**	100	100	68	65	0	0	76.4	**A-**
13	18230011	**Kinanti Alifah Wildana**	57	0	0	0	0	0	0	
14	18230013	**Yoel Arya Pradana**	57	0	0	70	0	0	33.7	**E**
15	18230015	**Aditya Putra**	57	40	55	65	0	0	56.2	**C**
16	18230016	**Budi Haryanto**	100	66	85	80	0	0	80.7	**A**

Rekapitulasi Nilai							
A	2	B+	0	C+	1	D+	0
A-	2	B	0	C	4	D	0
		B-	0	C-	0	E	2

Jakarta,2 February 2021

Dosen Pengajar



Komarudin, Ir.MT

CAD/CAM
&
Pemrograman CNC

by komarudin

Industri Manufactur Berbasis Komputer

Perkembangan Teknologi Proses Produksi Manufaktur

❖ **Proses Produksi Manufaktur Konvensional :**

➢ Produksi Terbatas
Produk kurang akurat (konfigurasi Permukaan)
Waktu produksi lama
Operator harus selalu berada berhadapan dengan mesin
Faktor terjadinya reject besar

✓ **Perkembangan Teknologi Komputer**
✓ **Tingkat persaingan**
✓ **Mengurangi tingkat reject**

FMS : Flexible Machine Systems

by komarudin

FMS : Flexible Machine Systems

Hardware

- Numerically controlled machines
- Material handling devices
- Buffers
- etc

Software

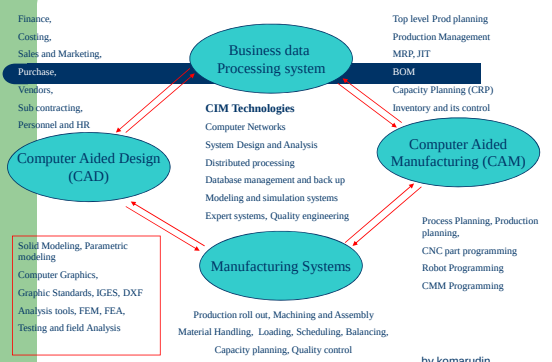
- Information flow
- data base content,
- etc

Produktivitas Tinggi Efisiensi tinggi

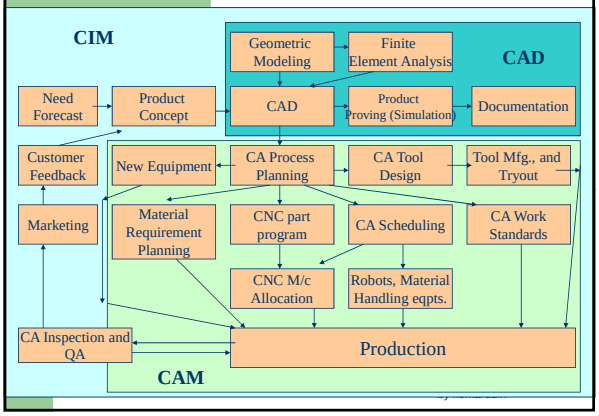
Development Program : CIM

by komarudin

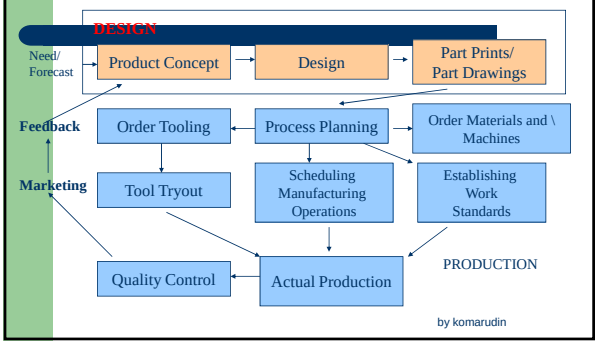
Pengaruh Komputer Dalam Lingkungan Mfg.

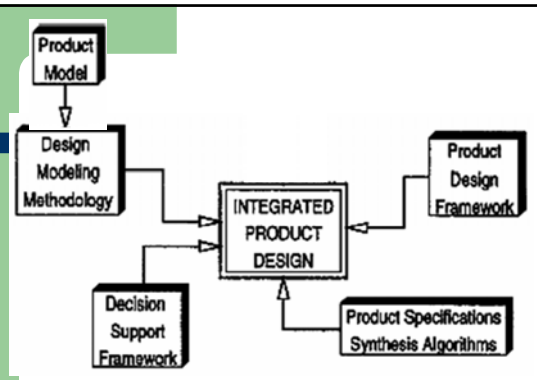


Product Cycle in Computerized Mfg. Environment



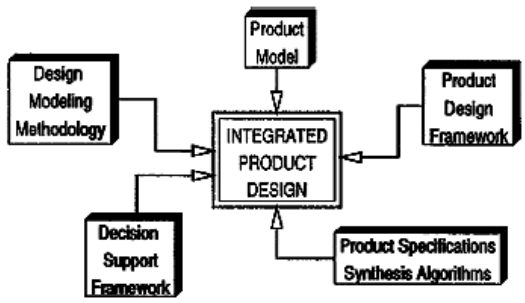
Product Cycle in conventional Manufacturing systems





Gambar Proses Produksi Manufaktur (Produk Baru)

by komarudin



Gambar Proses Produksi Manufaktur (Produk Pengembangan)

by komarudin

Computers in Industrial Manufacturing

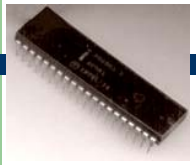
- What is computer?
- What is a Microprocessor?
- History of computing

by komarudin

Computers in Industrial Manufacturing

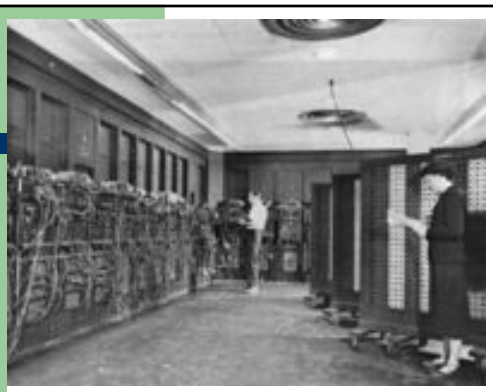
- **computer** adalah mesin untuk memanipulasi data sesuai dengan daftar instruksi
- **microprocessor** merupakan komponen elektronik program digital yang menggabungkan fungsi sebuah central processing unit (CPU) pada satu semikonduktor sirkuit terintegrasi (IC).

by komarudin



8080 Microprocessor

by komarudin

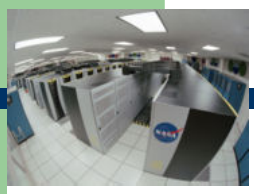


ENIAC Computer in the 60's

by komarudin

UNIVAC Computer

by komarudin



Columbia Super Computer

NASA Advanced Super computing Facility

Steve Mann Wrist Computer

by komarudin

Computer Aided Engineering

Peran komputer di bidang manufaktur,

* Direct participation
* In-direct Participation

by komarudin

Direct Participation

- Komputer digunakan untuk memantau dan mengendalikan proses manufaktur

  Komputer secara langsung tersambung ke perangkat manufaktur untuk sebagian besar sebagai pemantauan dan pengendalian dan fungsi korektif. Biasanya digunakan dalam proses industri, produksi massal ...

by komarudin

Indirect Participation

- Digunakan untuk fungsi pendukung. Biasanya untuk pra-produksi dan pasca produksi aplikasi.

  Examples of this are, CAD, CAM, CAE, CAPP, CATD…

by komarudin

Industry or Business

What is it?

Input → Black Box → Output

IDEA

RESOURCE

PEOPLE

MARKET

by komarudin

Pentingnya Database

Common Database menghubungkan berbagai fungsi seperti :

CAD, Design Analysis, FEM, Simulation, Scheduling, MRP, Production Management, Project Control, Process planning, Tool Design, CNC Programme, Material Handling, CMM programs, Production Controls and Robot Programming, Inventory…

by komarudin

Sumber Data (*Sources of Data*)

Product Engineering

- Product functions
- Specifications
- Concept design
- Ergonomics and Aesthetics
- Standards
- Detailed design
- Simulation
- Analysis
- DfA (Design for Assembly)
- DfM (Design for Manufacturing)
- Prototype
- Testing

by komarudin

Sources of Data

- Manufacturing
  - Process planning
  - Process sheets
  - Tooling
  - Cutting tools
  - Jigs and Fixtures
  - Dies and Moulds
  - CNC Programs
  - Robot Programs
  - BOM (Bill of materials)
  - Production Planning
  - Shop floor control
  - Quality Assuarance

by komarudin

Advantages of CAD technology

- CAD lebih cepat dan lebih akurat
- Model pengembangan dan kegiatan yang terkait seperti Drafting mudah dan akurat
- Manipulasi dimensi, atribut yang mudah
- Pengulangan entitas dihilangkan
- Akurasi model perakitan mengurangi masalah
- Penggunaan komponen standar, sub majelis mempercepat desain
- Meningkatkan visualisasi 3D sangat Desain modifikasi mudah dan memakan waktu kurang

by komarudin

Computer Aided Manufacturing

- Aplikasi komputer untuk membantu merancang, mengembangkan, mengelola, mengendalikan, sistem manufaktur ini disebut Computer Aided Manufacturing (CAM)

by komarudin

Manufacturing Processes

- Mass Production
- Batch Production
- Job Shop or One off production

by komarudin

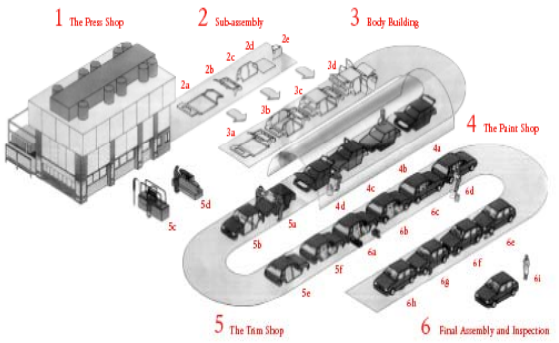
Mass Production

- Besar produksi yang banyak
  - Volume produksi yang tinggi, dari ribuan sampai jutaan
  - Khusus manufaktur atau perakitan
  - Waktu produksi singkat
  - Efisiensi produksi yang tinggi
  - Biaya awal tinggi
  - Biaya operasional rendah

EX: Automobiles, two wheelers, Consumer products

by komarudin

Mass Production



Batch Production

- Medium Lots
  - Khas ukuran batch adalah dari 100 hingga beberapa ribu
  - Mesin bekerja dengan tujuan khusus
  - Produktivitas tinggi
  - Dapat menangani beragam produk dengan mudah
  - Kepuasan kerja tinggi
  - Biaya produk cukup rendah

EX: machine tools, Aircrafts, Vitrified tiles,

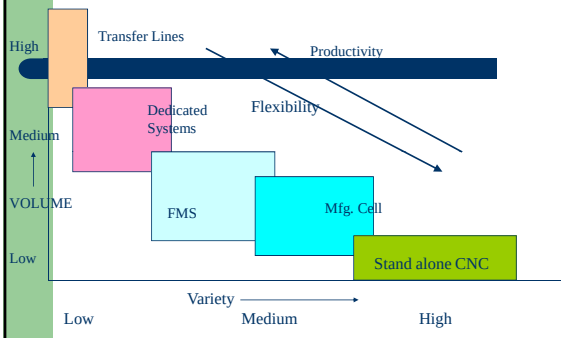
by komarudin

Job Shop Production

- Small lots or one off
  - Lot size dapat menjadi salah satu unit atau beberapa puluh unit
  - Mesin memiliki tujuan umum
  - Biasanya bagian akan menjadi besar atau rumit
  - Biaya produksi tinggi
  - lead time lebih panjang

by komarudin

Computer Aided Production



by komarudin

Advantages of CAM

- Desain terintegrasi dengan menggabungkan sehingga mudah untuk membuat perubahan
- Produktivitas yang lebih besar
- Fleksibilitas dalam proses manufaktur
- Lead time lebih pendek
- Less down times dan karena produktivitas yang lebih baik
- Mengurangi pemeliharaan (Self alat diagnostik dan pemantauan fasilitas dibangun dengan sendiri)
- Mengurangi scrap dan pengerjaan ulang (dry runs and CAM simulators)
- pemanfaatan mesin lebih baik

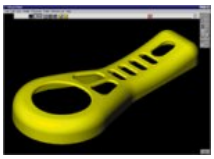
by komarudin

CAD/CAM Integration

CAD (computer-aided design) secara luas digunakan untuk menjelaskan perangkat lunak apapun yang mampu mendefinisikan komponen mekanis dengan geometri, permukaan atau solid model.

CAM (computer-aided manufacturing) adalah software yang digunakan untuk mengembangkan program NC (Program Output).

Gambar. 1 – Contoh Model remote control plastikpadat hasil desain



by komarudin

CAD/CAM Integration

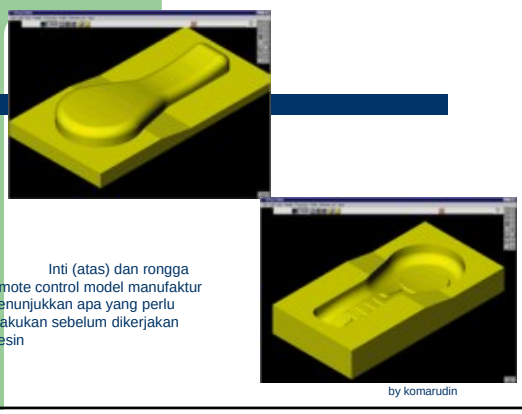
Engineering design dan manufaktur menggunakan software CAD / CAM untuk tiga tujuan yang berbeda jelas:

- ***Desain Modeling***- Seorang insinyur desain mekanik menggunakan perangkat lunak CAD untuk membuat sebuah bagian. Definisi bagian dapat disebut dengan model. Model ini dapat direpresentasikan sebagai gambar atau file data CAD.

Manufacturing Modeling- pemrograman NC oleh insinyur manufaktur atau menggunakan perangkat lunak CAD untuk sejumlah tugas-tugas penting. Mungkin yang paling umum adalah untuk mengembangkan model komputer bagian yang sebelumnya hanya ditentukan oleh sebuah gambar. Tugas umum lainnya adalah untuk mengevaluasi dan memperbaiki data CAD yang ada sehingga dapat digunakan untuk fungsi manufaktur. Manufaktur insinyur juga kadang-kadang menciptakan model bagian baru dari desain asli untuk memungkinkan manufacturability. Ini termasuk rancangan menambahkan sudut atau mengembangkan model-model dari bagian untuk langkah-langkah yang berbeda dalam proses multi-manufaktur. Dan, tentu saja, seseorang di sisi manufaktur harus merancang model perlengkapan, core dan rongga cetakan, cetakan dasar dan perkakas lain.

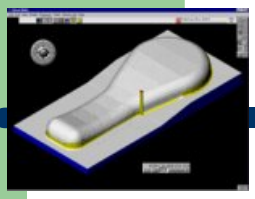
- ***NC Programming***-Bagi seorang insinyur manufaktur pemrograman NC menggunakan perangkat lunak CAM untuk memilih alat-alat, metode dan prosedur untuk mesin model manufaktur didefinisikan dalam bagian pemodelan yang dijelaskan di atas. Perhatikan bahwa siapa pun yang melakukan model manufaktur biasanya orang yang sama yang melakukan pemrograman NC.

by komarudin

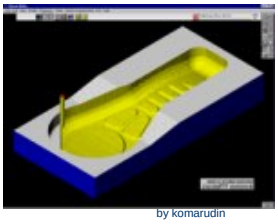


Inti (atas) dan rongga remote control model manufaktur menunjukkan apa yang perlu dilakukan sebelum dikerjakan mesin

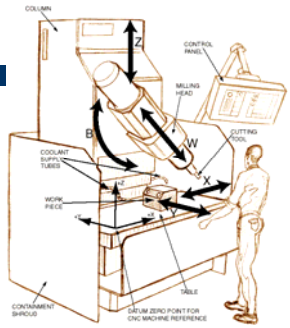
by komarudin



Mesin yang rutin untuk mengerjakan inti (atas) dan rongga adalah contoh dari apa yang diciptakan programmer. NC

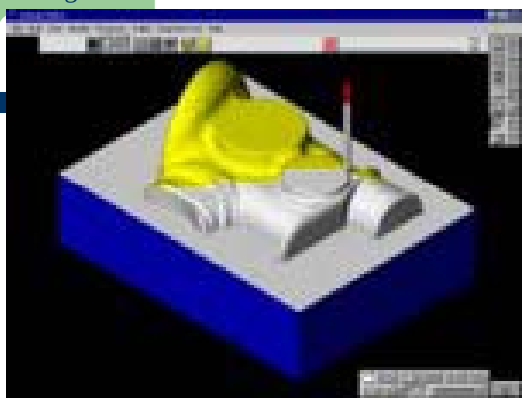


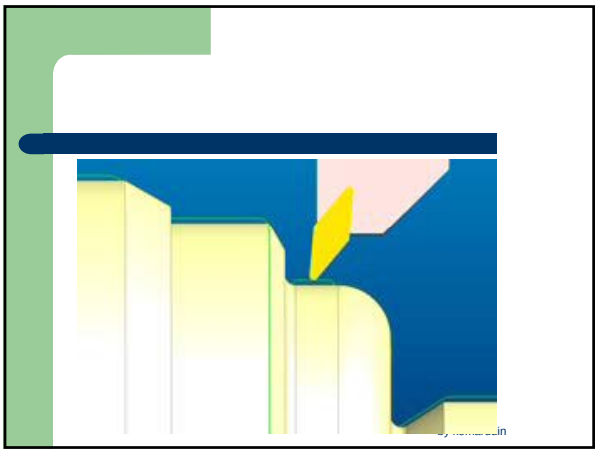
by komarudin



by komarudin

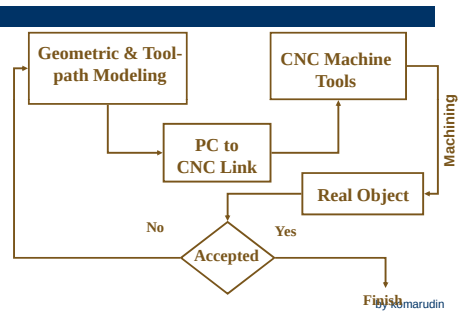
Machining Simulation





Methods & Techniques

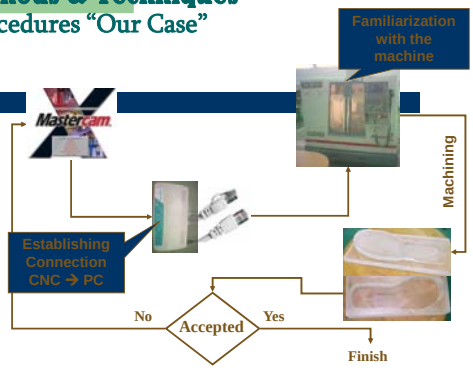
Procedures "General" (Integrated CAD/CAM to CNC)



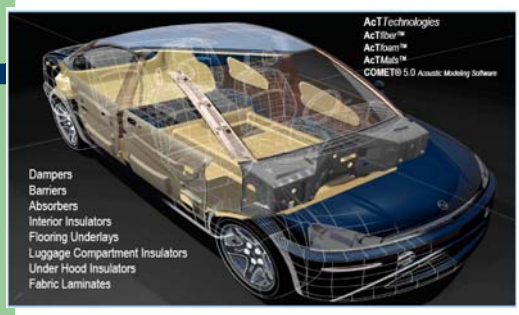
by komarudin

Methods & Techniques

Procedures "Our Case"



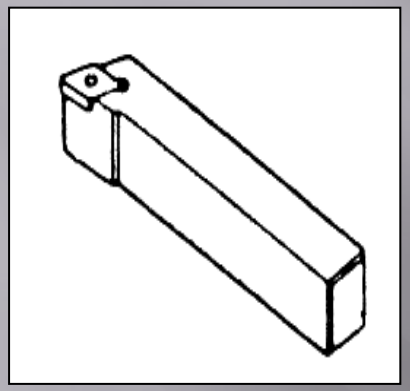
by komarudin



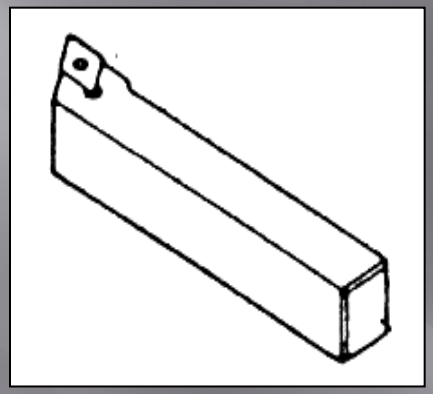
by komarudin

MEMILIH PERKAKAS POTONG

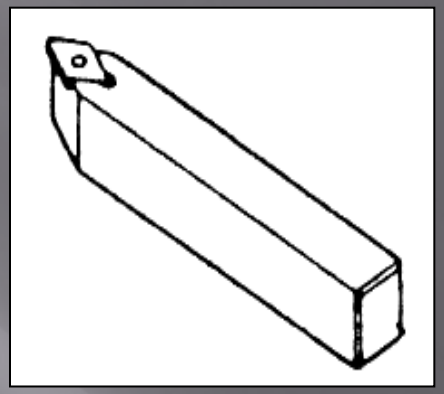
Turning



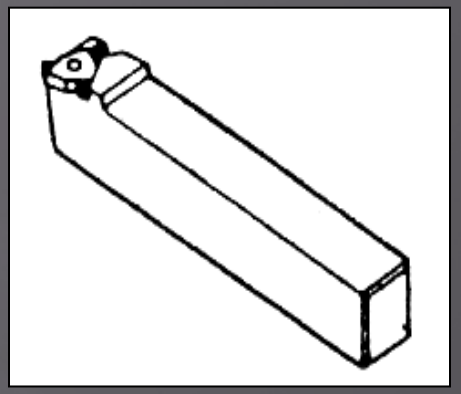
Pahat sisi kanan



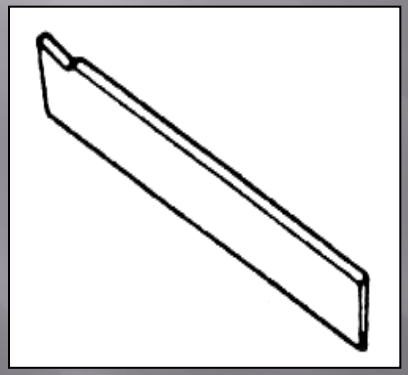
Pahat sisi kiri



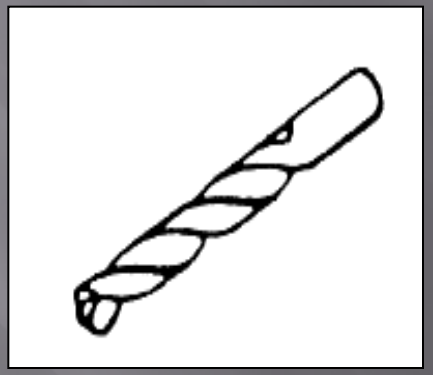
Pahat Netral



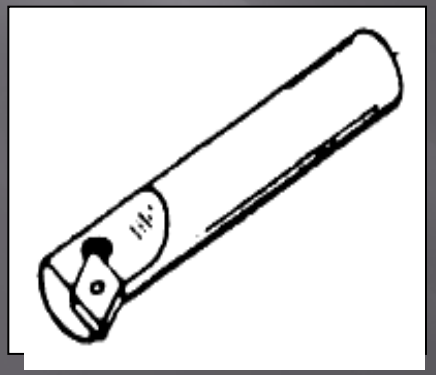
Pahat Ulir



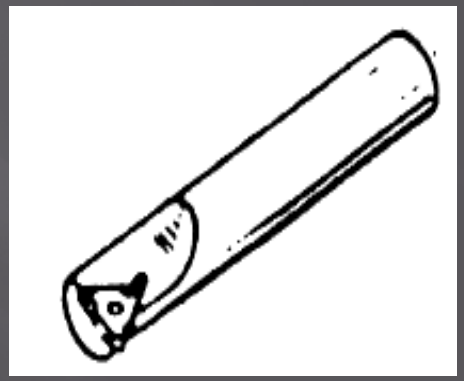
Pahat Alur



Pahat Drill



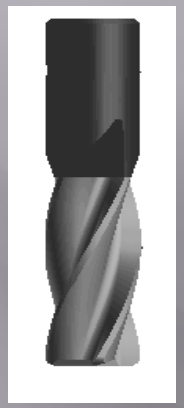
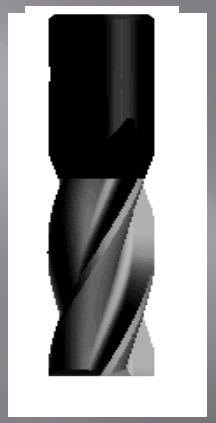
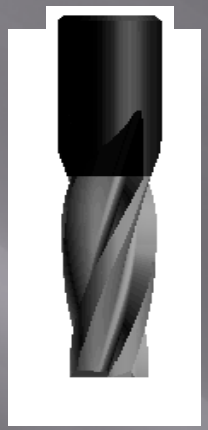
Pahat Dalam

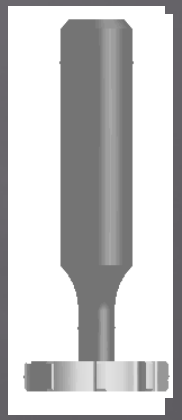
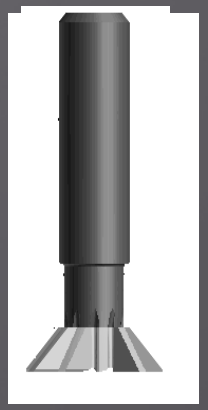


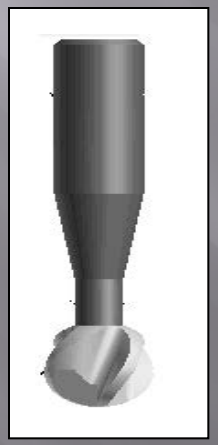
Pahat Ulir dalam

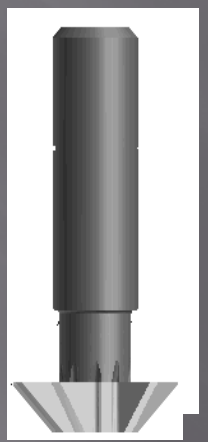
MEMILIH PERKAKAS POTONG

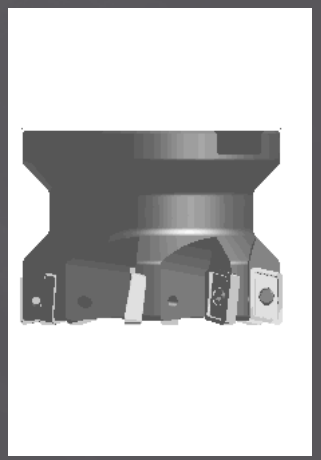
MILLING/ FRAIS

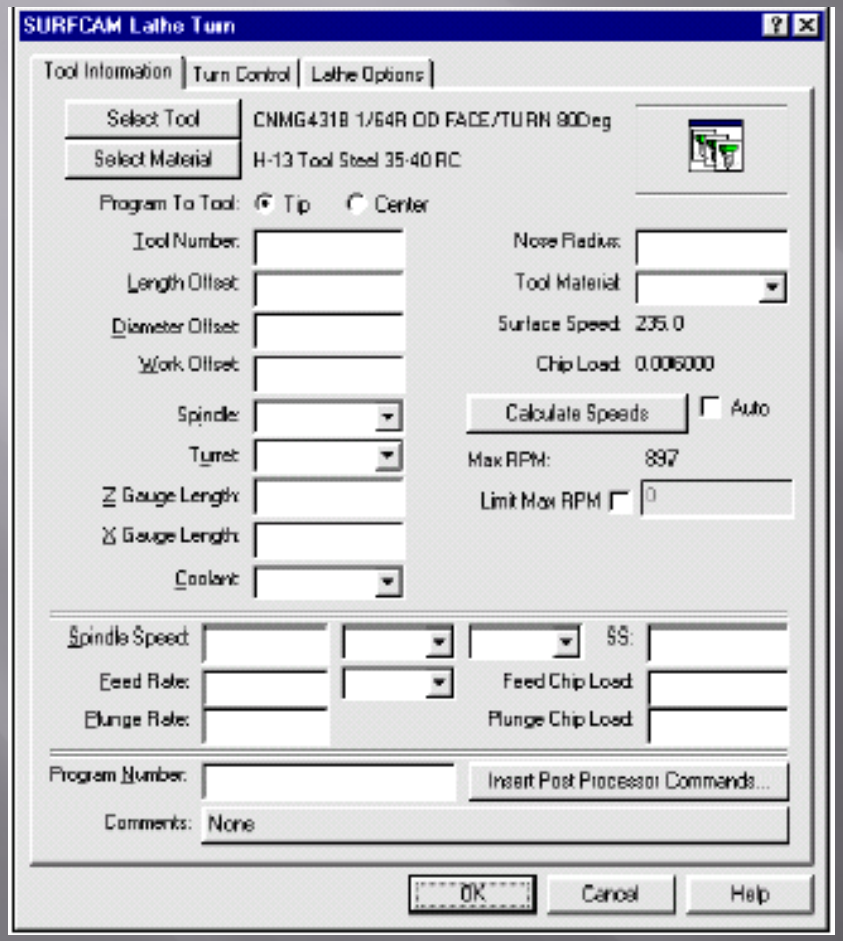



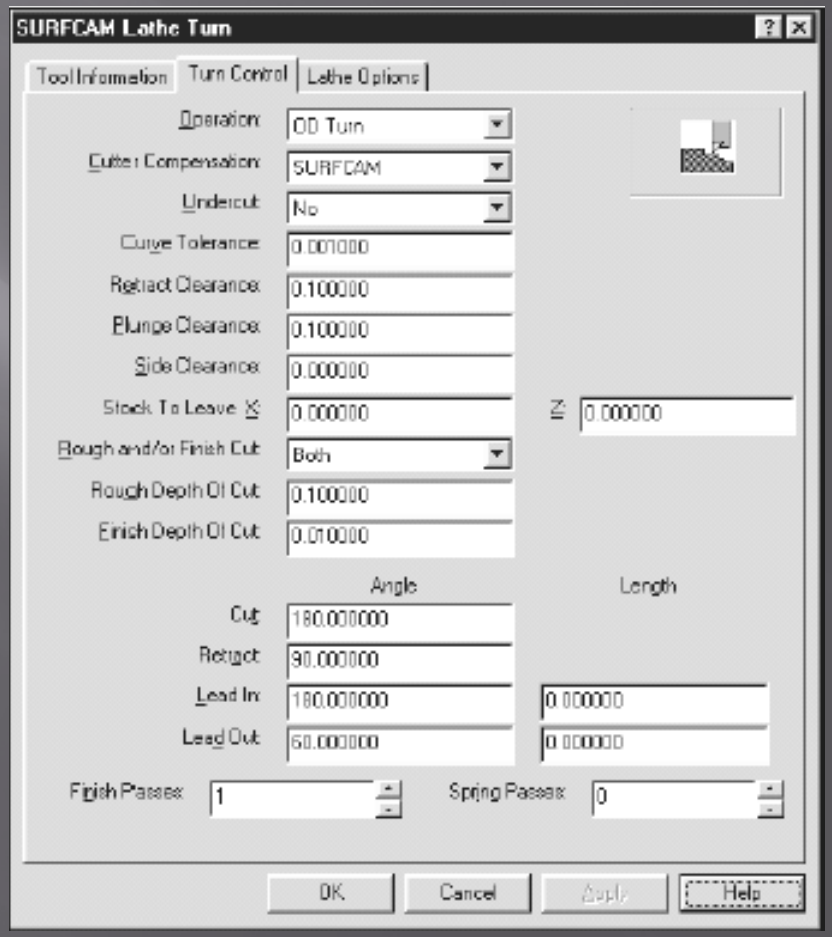




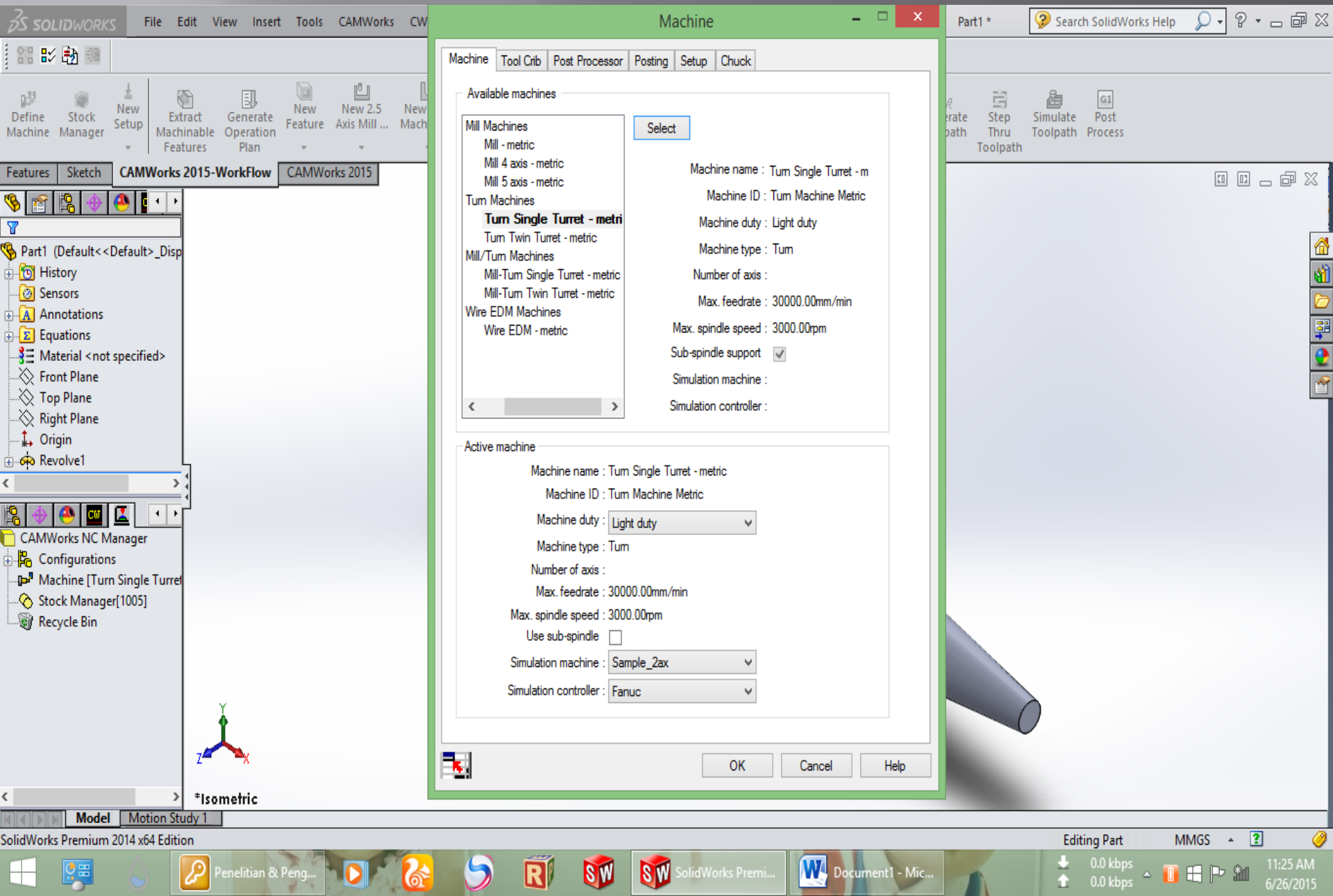



TOOL INFORMATION TAB

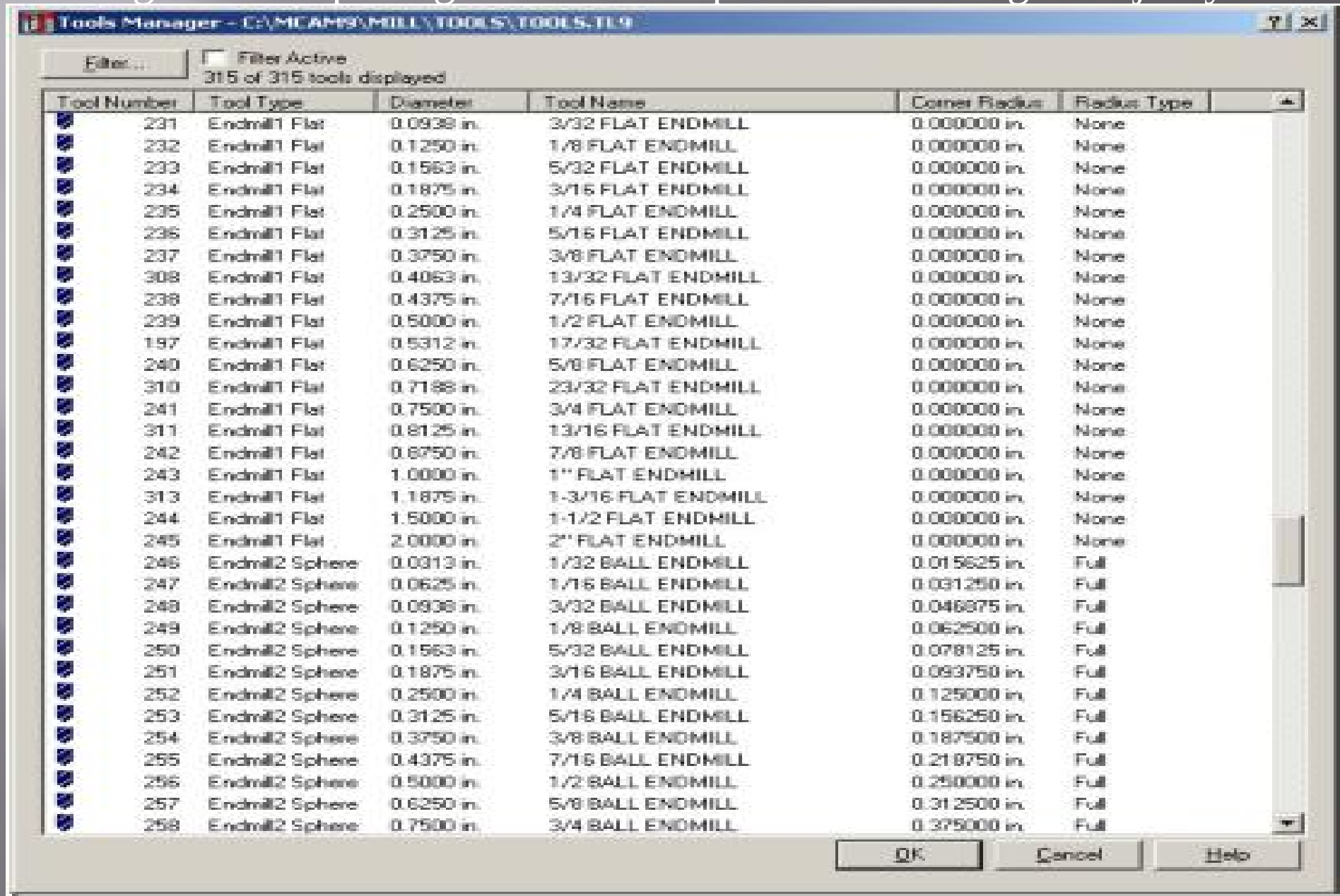




Pemilihan proses permesinan CNC meggunakan *software* CAMWorks

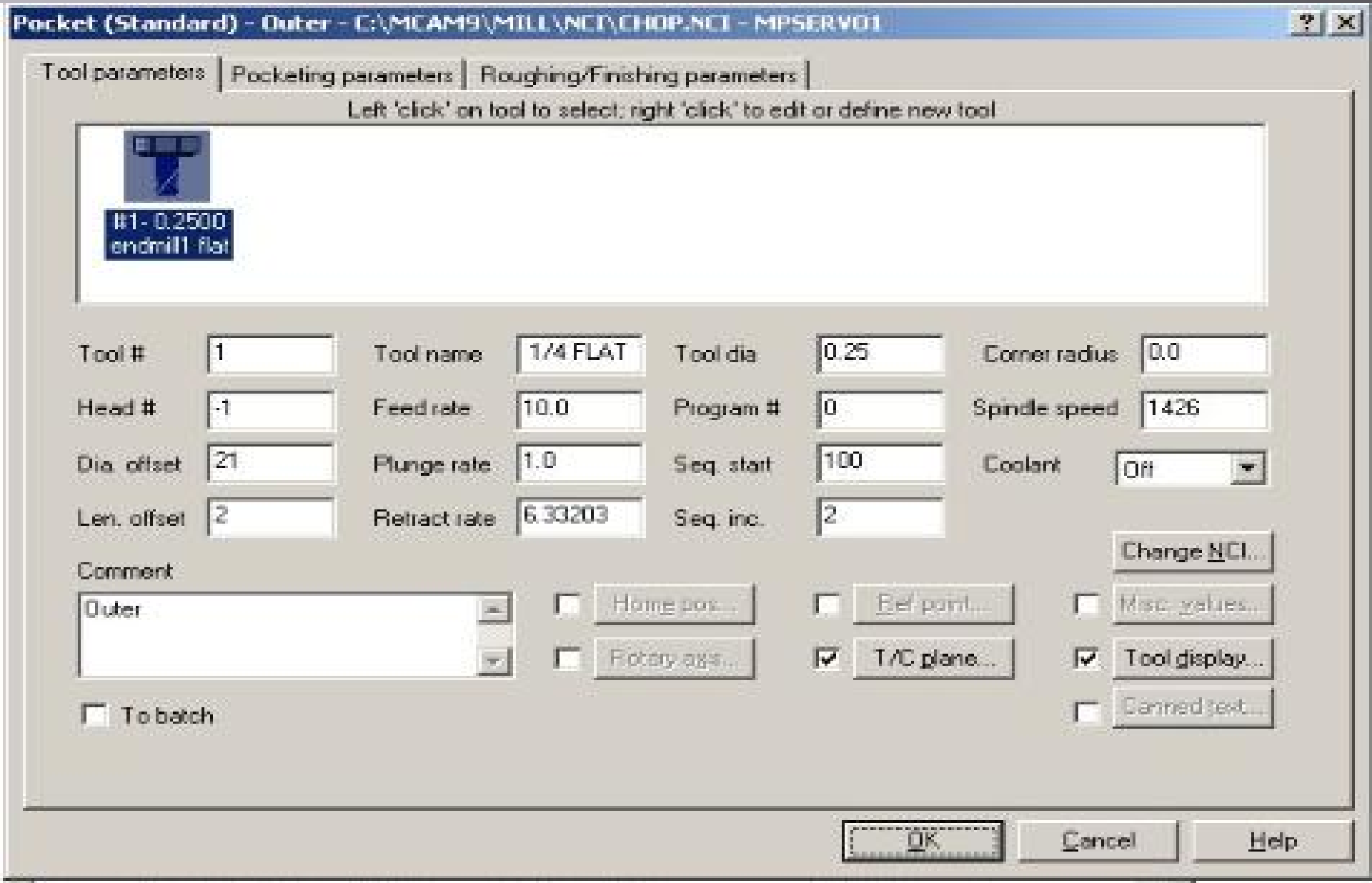


Periksa tool apa saja yang telah digunakan sebelumnya dan jika memungkinkan dapat digunakan untuk proses machining selanjutnya

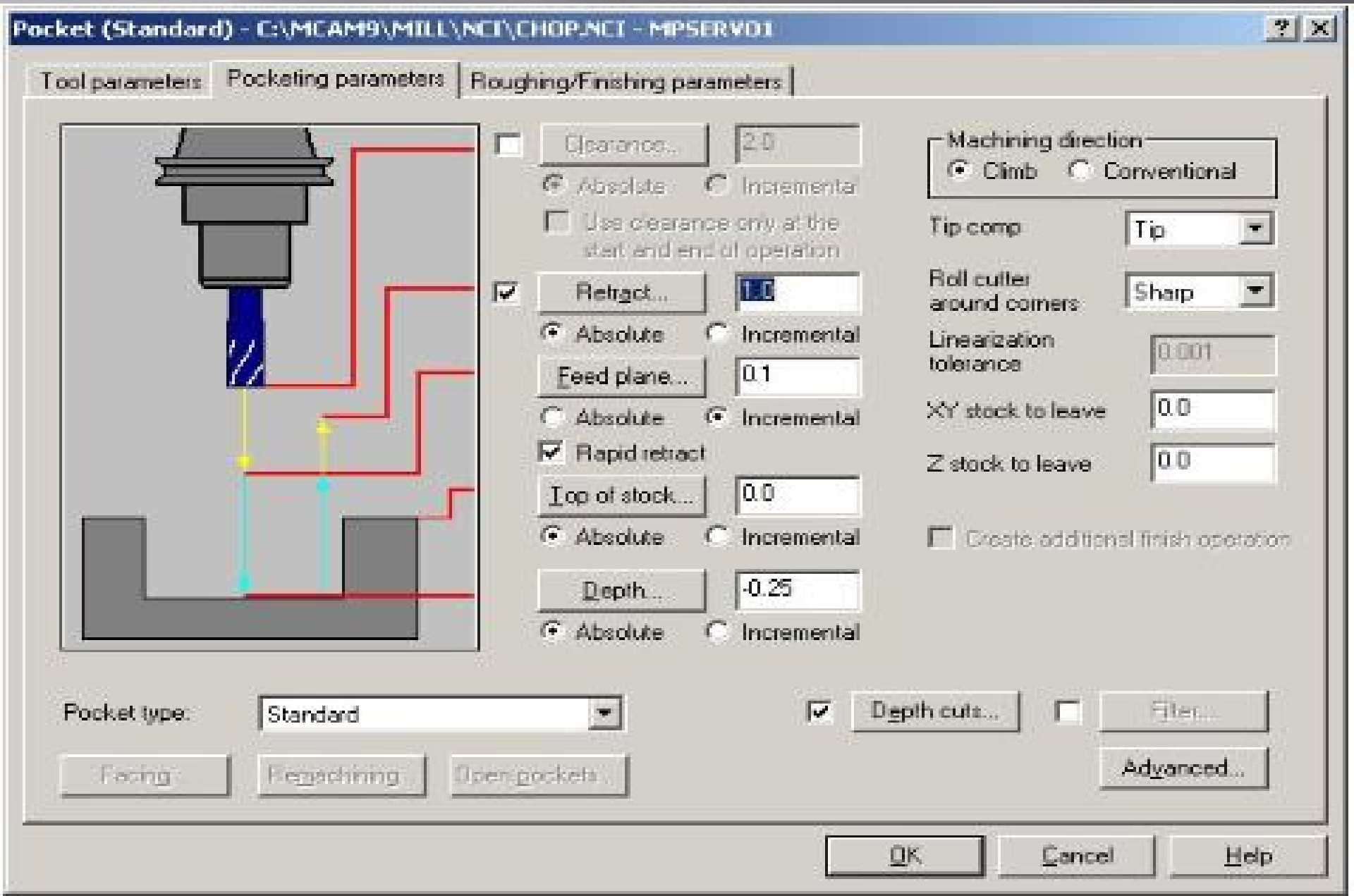


Tool Number	Tool Type	Diameter	Tool Name	Corner Radius	Radius Type
231	Endmill Flat	0.0938 in.	3/32 FLAT ENDMILL	0.000000 in.	None
232	Endmill Flat	0.1250 in.	1/8 FLAT ENDMILL	0.000000 in.	None
233	Endmill Flat	0.1563 in.	5/32 FLAT ENDMILL	0.000000 in.	None
234	Endmill Flat	0.1875 in.	3/16 FLAT ENDMILL	0.000000 in.	None
235	Endmill Flat	0.2500 in.	1/4 FLAT ENDMILL	0.000000 in.	None
236	Endmill Flat	0.3125 in.	5/16 FLAT ENDMILL	0.000000 in.	None
237	Endmill Flat	0.3750 in.	3/8 FLAT ENDMILL	0.000000 in.	None
308	Endmill Flat	0.4063 in.	13/32 FLAT ENDMILL	0.000000 in.	None
238	Endmill Flat	0.4375 in.	7/16 FLAT ENDMILL	0.000000 in.	None
239	Endmill Flat	0.5000 in.	1/2 FLAT ENDMILL	0.000000 in.	None
197	Endmill Flat	0.5312 in.	17/32 FLAT ENDMILL	0.000000 in.	None
240	Endmill Flat	0.6250 in.	5/8 FLAT ENDMILL	0.000000 in.	None
310	Endmill Flat	0.7188 in.	23/32 FLAT ENDMILL	0.000000 in.	None
241	Endmill Flat	0.7500 in.	3/4 FLAT ENDMILL	0.000000 in.	None
311	Endmill Flat	0.8125 in.	13/16 FLAT ENDMILL	0.000000 in.	None
242	Endmill Flat	0.8750 in.	7/8 FLAT ENDMILL	0.000000 in.	None
243	Endmill Flat	1.0000 in.	1" FLAT ENDMILL	0.000000 in.	None
313	Endmill Flat	1.1875 in.	1-3/16 FLAT ENDMILL	0.000000 in.	None
244	Endmill Flat	1.5000 in.	1-1/2 FLAT ENDMILL	0.000000 in.	None
245	Endmill Flat	2.0000 in.	2" FLAT ENDMILL	0.000000 in.	None
246	Endmill2 Sphere	0.0313 in.	1/32 BALL ENDMILL	0.015625 in.	Full
247	Endmill2 Sphere	0.0625 in.	1/16 BALL ENDMILL	0.031250 in.	Full
248	Endmill2 Sphere	0.0938 in.	3/32 BALL ENDMILL	0.046875 in.	Full
249	Endmill2 Sphere	0.1250 in.	1/8 BALL ENDMILL	0.062500 in.	Full
250	Endmill2 Sphere	0.1563 in.	5/32 BALL ENDMILL	0.078125 in.	Full
251	Endmill2 Sphere	0.1875 in.	3/16 BALL ENDMILL	0.093750 in.	Full
252	Endmill2 Sphere	0.2500 in.	1/4 BALL ENDMILL	0.125000 in.	Full
253	Endmill2 Sphere	0.3125 in.	5/16 BALL ENDMILL	0.156250 in.	Full
254	Endmill2 Sphere	0.3750 in.	3/8 BALL ENDMILL	0.187500 in.	Full
255	Endmill2 Sphere	0.4375 in.	7/16 BALL ENDMILL	0.218750 in.	Full
256	Endmill2 Sphere	0.5000 in.	1/2 BALL ENDMILL	0.250000 in.	Full
257	Endmill2 Sphere	0.6250 in.	5/8 BALL ENDMILL	0.312500 in.	Full
258	Endmill2 Sphere	0.7500 in.	3/4 BALL ENDMILL	0.375000 in.	Full

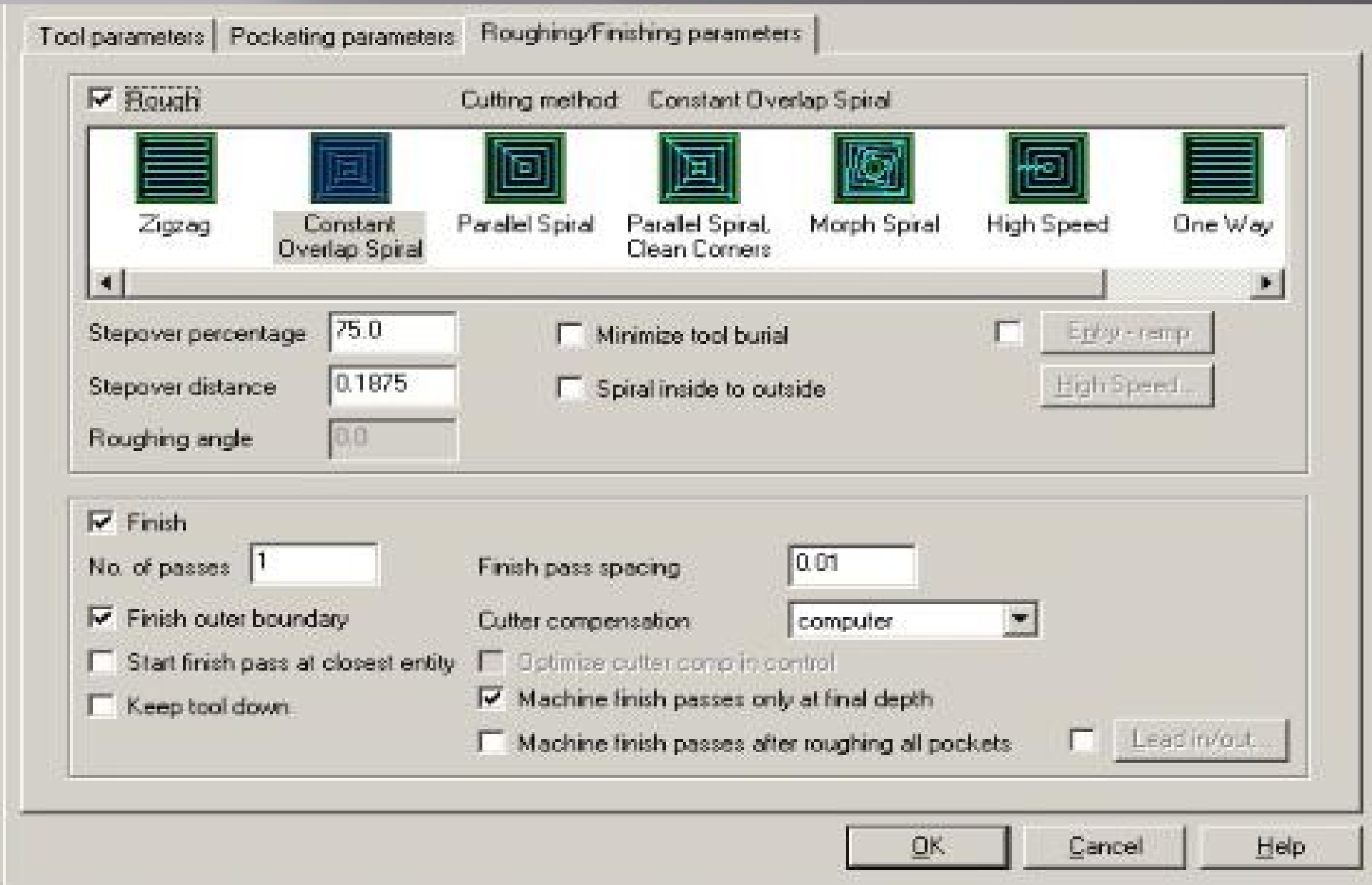
Mengatur parameter dari tool (kecepatan makan, offset, diameter dan sebagainya)



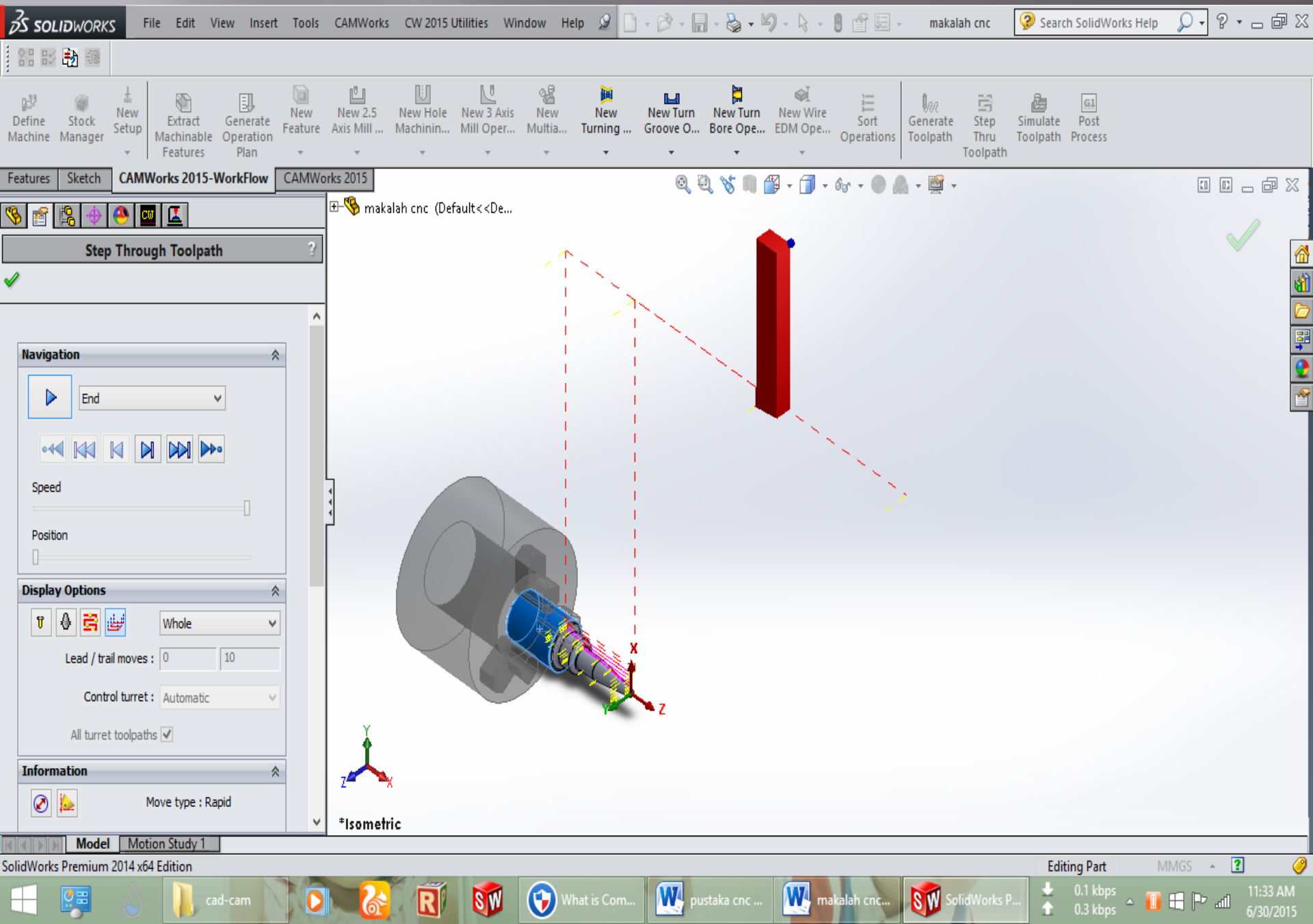
Mengatur sistem gerakan pada tool (incremental atau absolut) pada setiap parameter



Mengatur parameter kasar (pemotongan awal) dan finishing (penyempurnaan akhir) dari proses



Simulasi *toolpath*.



SOLIDWORKS File Edit View Insert Tools CAMWorks CW 2015 Utilities Window Help makalah cnc Search SolidWorks Help

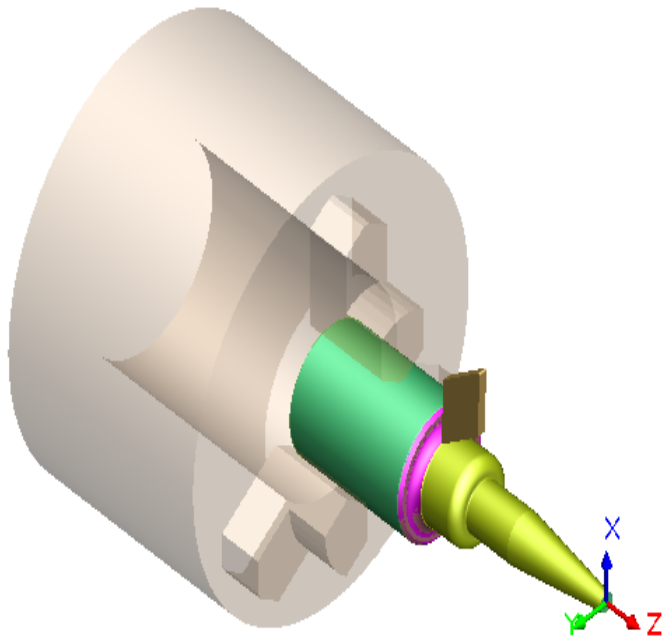
Toolpath Simulation

End

Define Machine | Stock Manager | New Multia... | New Turning ... | New Turn Groove O... | New Turn Bore Ope... | New Wire EDM Ope... | Sort Operations | Generate Toolpath | Step Thru Toolpath | Simulate Toolpath | Post Process

Features | Sketch | CAMWorks 2015-WorkFlow | CAMWorks 2015

CAMWorks NC Manager
- Configurations
- Machine [Turn Single Turret
- Stock Manager[1005]
- Turn Setup1 [Turn OpSetup1
  - Face Rough1[T01.00 - 0.4
  - Face Finish1[T01.00 - 0.4
  - Turn Rough1[T01.00 - 0.4
  - Turn Finish1[T02.00 - 0.4
- Recycle Bin

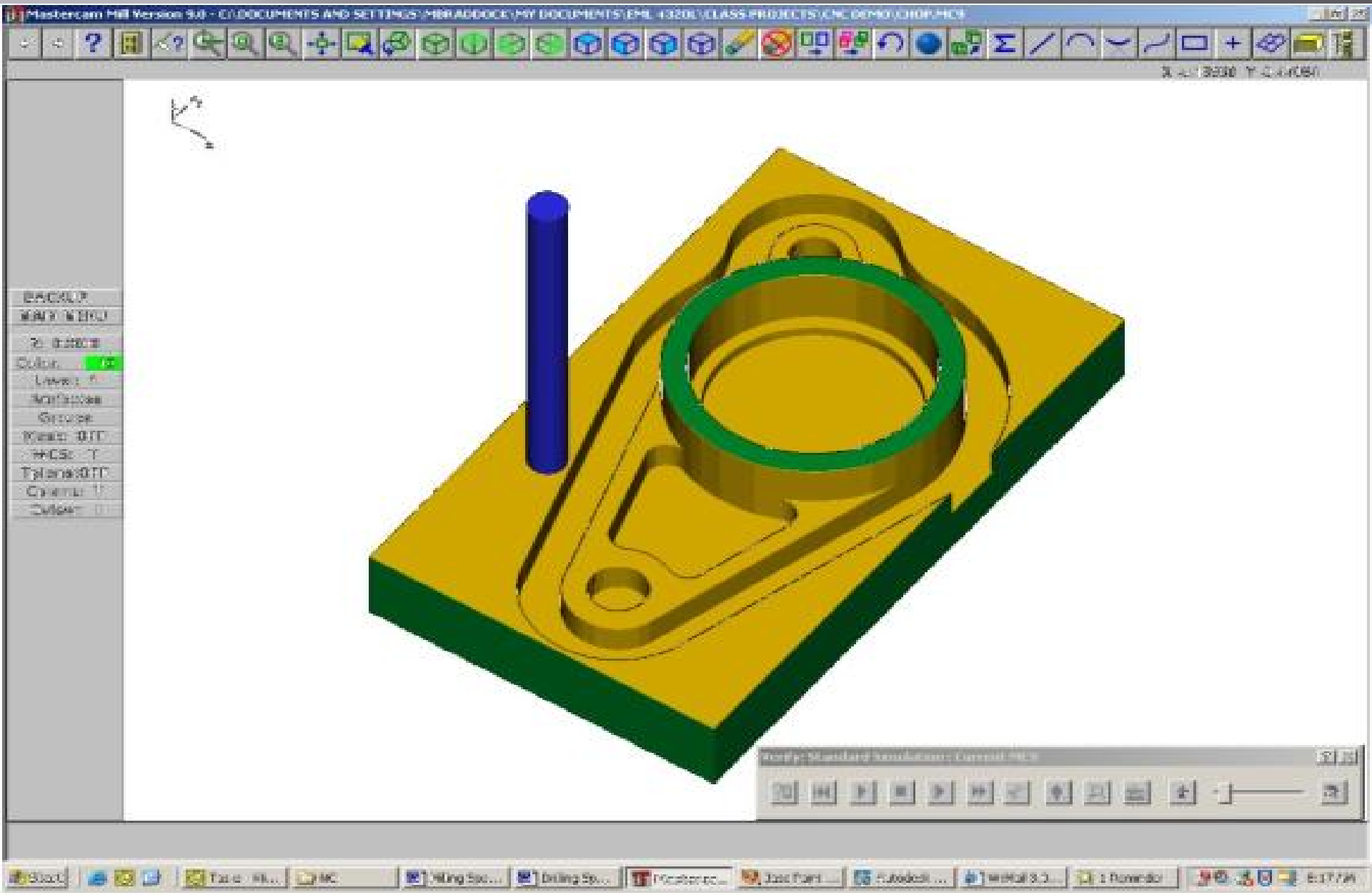


Model | Motion Study 1

SolidWorks Premium 2014 x64 Edition Editing Part MMGS

cad-cam | What is Com... | pustaka cnc ... | makalah cnc... | SolidWorks P... | 4.2 kbps 0.5 kbps | 11:34 AM 6/30/2015

Melakukan running simulasi siklus verifikasi virtual untuk mendeteksi error yang terjadi sebalum dilakukan proses pemotongan



Program akhir siap untuk dijalankan dan dilanjutkan pada proses pemotongan oleh mesin CNC

CHOP.NC

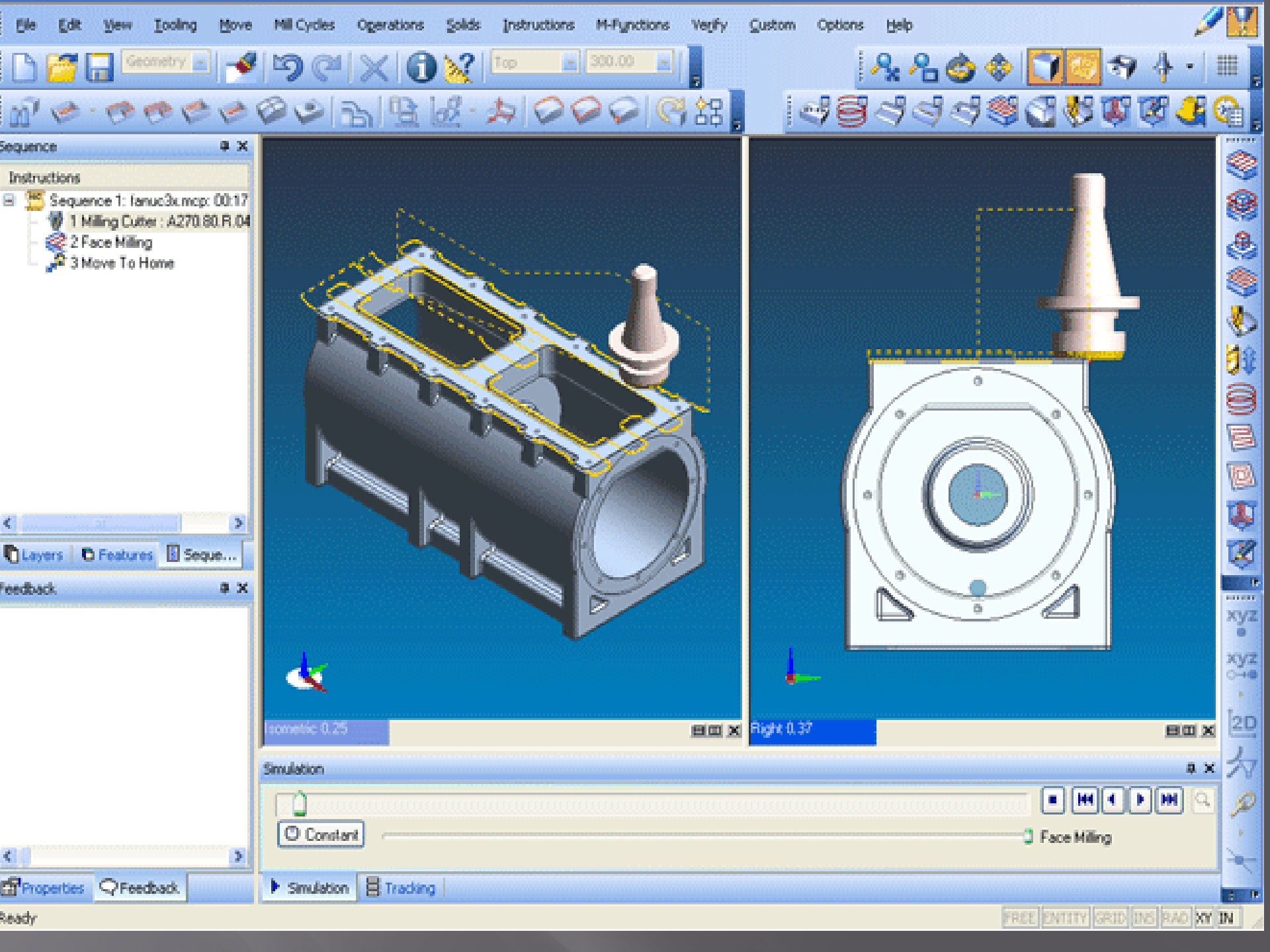
```
( CHOP NC    DATE-DD-MM-YY - 20-10-83   TIME-HH:MM - 20:57 )
(  3/8 FLAT ENDMILL    TOOL - 1 DIA. OFF. - 21 LEN. - 2 DIA. - .25 )
N100 G70
N102 G00 G40 G80 G90
/ N104 G91 Z0.
/ N106 X0. Y0.
/ N108 G92 X0. Y0. Z0.
N110 T1
N112 G00 G90 X-1.2427 Y1.5415 S1426 M03
N114 Z1.
N116 Z.1
N118 G01 Z-.05 E1.
N120 X1.8315 Y1.5548 F10.
N122 Y.1194
N124 G03 X-1.8384 Y0. I-1.8315 J-.1194
N126 X1.8315 Y-.1194 I1.8384
N128 G01 Y-2.6286
N130 X-1.2427
N132 Y1.5415
N134 X-1.8882 Y1.3839
N136 X-.869 Y1.3964
N138 X-.8565 Y1.2964
N140 Y.8839
N142 X-.8815 Y.7464
N144 X-.8387 Y.8839
N146 X-.6547 Y1.0214
N148 X-.4578 Y1.1214
N150 X-.2345 Y1.1839
N152 X-.139 Y1.1964
N154 X-.139
N156 X-.3455 Y1.1589
N158 X-.5679 Y1.0714
N160 X-.7593 Y.9464
N162 X-.9365 Y.7714
N164 X-1.0782 Y.5714
N166 X-1.0983 Y.4964
N168 X-1.1285 Y.2339
N170 X-1.0677 Y.0339
N172 Y1.3339
N174 X-.8927 Y1.2214
N176 X-.494 Y1.2464
N178 X-.6171 Y1.2339
N180 X-.7383 Y1.1839
N182 X-.8861 Y1.0839
N184 X-.9852 Y.9964
N186 X-.8882 Y1.1589
```

SURFCAM NC Editor - [latihanSetup_One.NCC]

File Edit Search Global Calcs Analysis Options Window Help

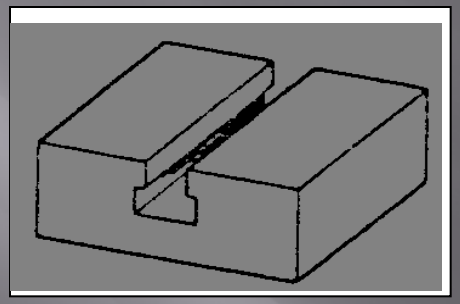
```
N001 G92 X0000 Z0000
N002 G90 T001 M43
N003 G94 S1136 M08
N004 G01 X394876 Z66625 F80000
N005 X419876
N006 Z2010
N007 X359525
N008 G01 X334525 F213000
N009 Z-962044 F426000
N010 X343045 Z-979084
N011 G03 X354500 Z-1027607 I-97045 K-48523
N012 G01 Z-1304000
N013 X379500 F80000
N014 Z2010
N015 X339525
N016 X314525 F213000
N017 Z-922044 F426000
N018 X334525 Z-962044
N019 X359525 F80000
N020 Z2010
N021 X319525
N022 X294525 F213000
N023 Z-882044 F426000
```

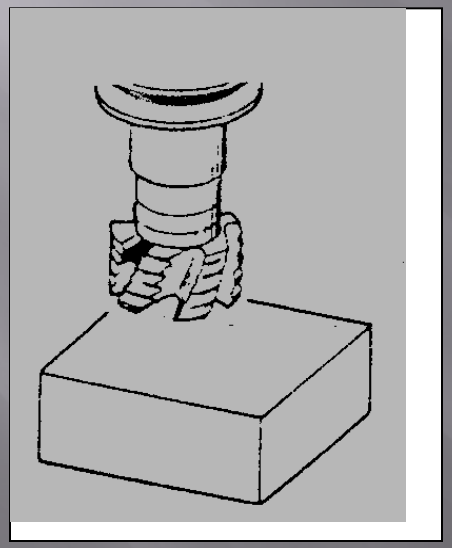
1/125


File
Edit
View
Tooling
Move
Mill Cycles
Operations
Solids
Instructions
M-Functions
Verify
Custom
Options
Help
Geometry
Top
Sequence
Instructions
Sequence 1: fanuc3x.mcp: 00:17
1 Milling Cutter : A270.80.R.04
2 Face Milling
3 Move To Home
Layers
Features
Seque...
Feedback
Properties
Feedback
Isometric 0.25
Right 0.37
Simulation
Constant
Face Milling
Simulation
Tracking
Ready
FREE
ENTITY
GRID
ORTHO
RAD
XY
IN

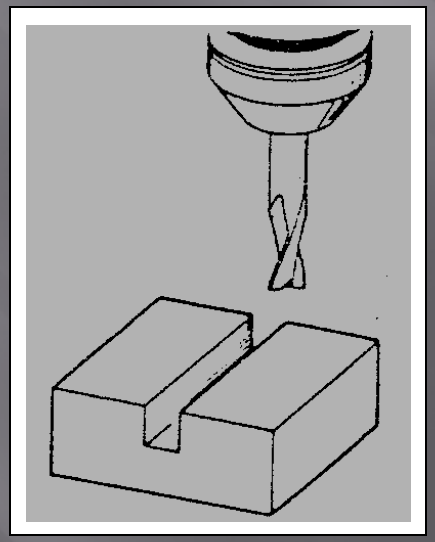
MENGATUR OPERASI PEMESINAN

Komponen dengan alur berbentuk T

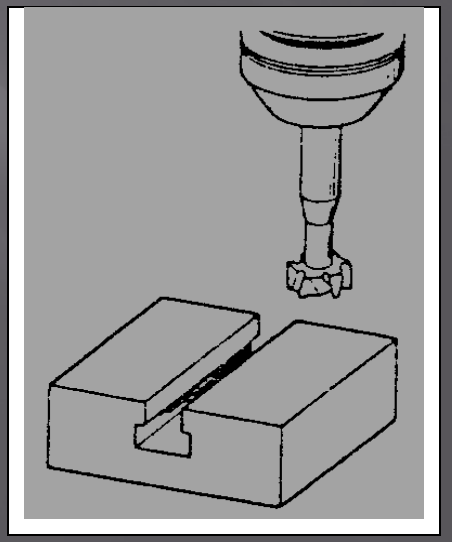




Pengefraisan muka



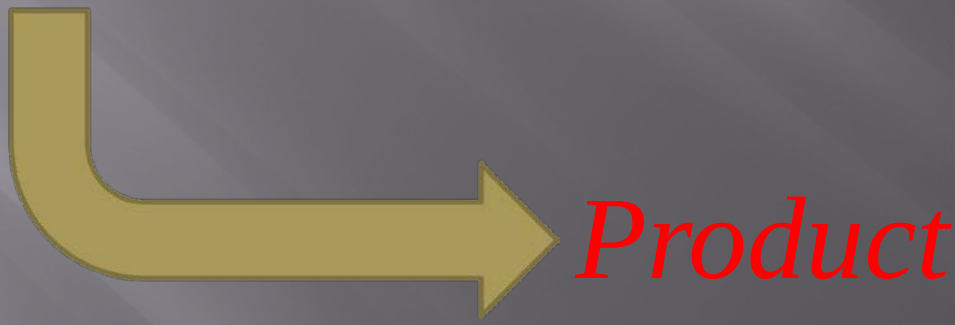
Pengefraisan alur



Pengefraisan alur **T**

TRANSFER PROGRAM KE MESIN

Transfer program ke mesin NC berarti memindahkan dari file NCC ke mesin. Suatu metode perpindahan program ini disebut Direct Numerical Control (DNC). Komputer dengan file NCC dihubungkan ke pengontrol dari mesin dengan RS -232 Connection



Connection Cable Interface

Ethernet Connecting

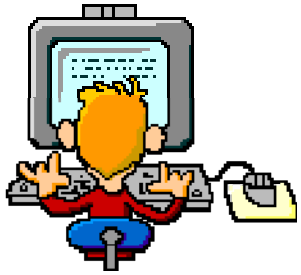
Ethernet adalah teknologi area lokal, dengan jaringan yang beroperasi secara tradisional dalam satu gedung, dengan menghubungkan perangkat-perangkat di dekatnya

Example : CAD/CAM Softwares

MasterCAM

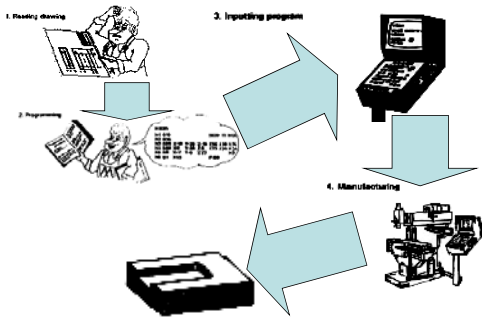
- Didirikan pada tahun 1984.
- MasterCAM adalah paket perangkat lunak CAD / CAM yang terintegrasi.
- Oleh MasterCAM kita dapat menciptakan geometri dan menyiapkan detail teknik, alat bantu grafis-jalan, dan kode NC.

Programming Systems



Programming for Positioning

From the drawing to the workpiece



PROSEDUR Pemrograman CNC

- Gambar Rencana (Design)
- Mesin dan Tools
- Raw Material
- Programer/Operator
- Program CNC

Koordinat System & Word Adresses

- No.Program
- G-code
- M-code
- T, D, F, K, etc

Ketelitian s/d 0,01 mm

Hardware Configuration of an NC Machine Tool

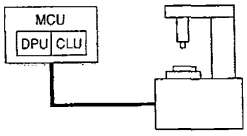
- DPU reads the part program, decodes it, processes the information and passes it to the CLU
- CLU convert the information to control signals and drives the mechanism, receives feedback (about position and velocity) and instructs DPU to read new instructions

Axis of a machine tool is defined as a path along which relative motion between the cutting tool and the workpiece occurs and a machine can have more than one axis.

Hardware Configuration of an NC Machine Tool

A typical NC machine tool contains the Machine Control Unit (MCU) and the machine tool itself.

The MCU includes
- the Data Processing Unit (DPU) and
- the Control Loop Unit (CLU)



Programming Format

Prosedur Pemrograman

Standard : **ISO = International Standart Organisation**
EIA = Electronics Industries Association

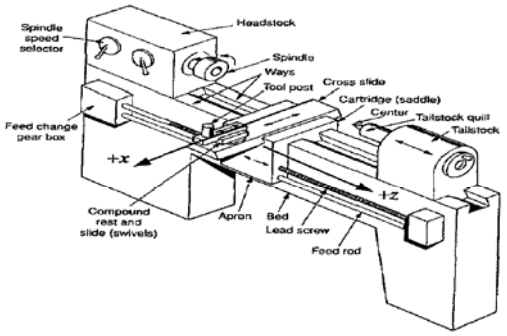
Kompilasi menggunakan kode-kode yang diidentifikasi dengan huruf/kunci-kunci (keys) yang melaksanakan fungsi tertentu didalam system kontrol

I. Coordinate System

Main 3 Axes forming a right-hand coordinate system, by convention z axis moves the cutting tool away from the workpiece, in details:

The z axis, parallel to the spindle for rotating workpiece, and parallel to the machine tool axis for rotating tool, as a milling, drilling, or boring machine

The x axis, in the direction of the tool movement for the first case, and points to the right when some-one is facing the machine.



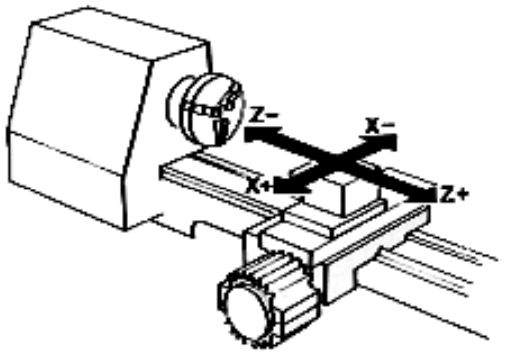


Fig. 4 The main axes of a lathe or turning center. (Enco Maier Corp)

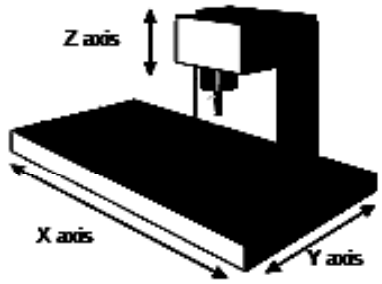
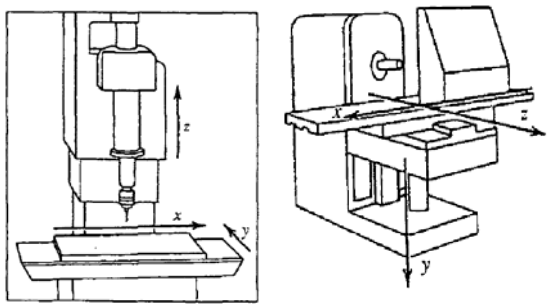


Fig. 5 The main axes of a vertical machining center. (Denford Inc.)



Datum/Titik Acuan/Titik Reference/Titik Nol

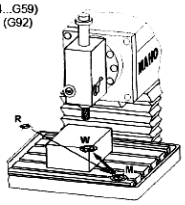
Adalah titik acuan program untuk arah gerak geser yang settingnya dilakukan melalui titik nol yang dihubungkan secara dimensional

Datum Point

Datum Program (Operator) **: Titik seting yang dilakukan oleh programer sesuai dengan keinginan dan identitasnya dengan angka numerik nol**

Datum Mesin Fixed Zero (Pabrik) **: Titik seting posisi untuk geseran mesin yang berinteraksi dan identitasnya didalam dengan angka numerik nol didalam kontrol**

Stored zero shifts (G54...G59)
Programmed zero shift (G92)

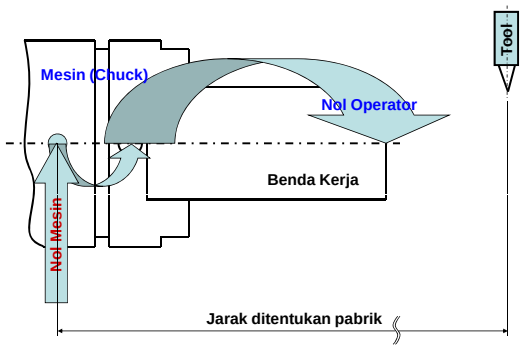


R = Reference point (maximum travel of machine)
M = Machine zero point (X0,Y0,Z0) of machine coordinate system.
W = Part zero point workpiece coordinate system.

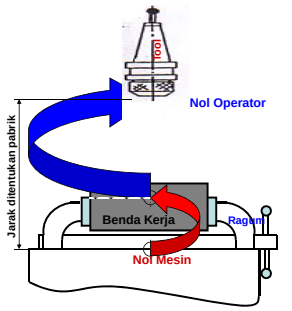
Under G54 ... G59 the actual machine coordinates of part zero are stored in the stored zero offsets memory and activated in the part program.

Under G92 the actual machine coordinates are inserted and used on the G92 line of the part program.

Fig. 19 The relationship between the part zero and the machine system of coordinates. (Deckel Maho, Inc.)

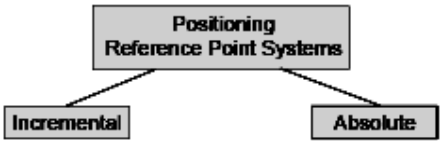


Turning Machine



Milling Machine

Datum/Titik Acuan/Titik Reference/Titik Nol



Data Posisi

Absolut : **Titik nol yang tetap dimana seluruh gerakan yang dilakukan baik oleh benda kerja maupun mesin**

Inkremental : **Titik nol yang bergeser yang mengikuti arah gerakan pahat atau titik nol berada diujung mata pahat**

CNC MACHINE CODING

THE CARTESIAN COORDINATE SYSTEM:
This is the measurement system the CNC control uses to relay motion movement to the desired axis(s). Think of it as the "timeline" we all learned about in 2nd grade math class.

G-CODES:
G-Codes are preparatory functions and the main source (backbone) to CNC programming. G-Codes can be used (but are not limited to) rapid and linear movements (G0 & G1) or in "canned cycles".

M-CODES:
M-Codes are miscellaneous commands (coolant on/off, spindle on/off, or clockwise/counterclockwise tailstock forward/reverse, end of program. etc.)

F-CODES:
F-Codes usually represent feed rates. (ie. F.008 or F 2.3)

S-CODES:
S-Codes usually represent spindle speeds. (ie. S3000 max or S600 sfm)

Group	Code	Function
01	G00	Rapid positioning
01	G01	Linear interpolation
01	G02	Circular interpolation clockwise (CW)
01	G03	Circular interpolation counterclockwise (CCW)
06	G20*	Inch input (in.)
06	G21*	Metric input (mm)
	G24	Radius programming (**)
00	G28	Return to reference point
00	G29	Return from reference point
	G32	Thread cutting (**)
07	G40	Cutter compensation cancel
07	G41	Cutter compensation left
07	G42	Cutter compensation right
08	G43	Tool length compensation positive (+) direction
08	G44	Tool length compensation minus (-) direction
08	G49	Tool length compensation cancel
	G84	Canned turning cycle (**)
03	G90	Absolute programming
03	G91	Incremental programming

(*) - on some machines and controls, these may be G70 (inch) and G71 (metric)

(**) - refers only to CNC lathes and turning centers.

Fig. 14 Some of the most common G-codes used in CNC programming.

Program Structures

BEFORE ONE CAN LEARN TO PROGRAM ONE MUST KNOW THE MACHINE CONTROLS AND ALL THEIR FUNCTIONS.

BEFORE YOU TACKLE ANY PROGRAMMING TASK, READ ALL MANUALS AND PROGRAMMING GUIDES.

KNOW WHAT CONTROL AND SERIES YOUR WORKING WITH.

When creating CNC programs it's important to keep in mind the functionality of the processes being created. By this I mean keeping things consistent through out the program. For example, when to turn on and off your coolant, what value to use as your clearance point, and so on... doing this will give your programs a nice visual flow. Who knows? You may not be the only one who has to edit it!

Understanding the CNC program:

The CNC Program is made up from ***"BLOCKS"*** of information.

An example of a Block: N10, N20, N30 *N20 G1 X3.0 Z-1.0 F.01*

Each block contains one or more ***"WORDS".***

It contains the Words: N20, *G1, X3.0, Z--1.0 F.01*

A word is generally an ***"ADDRESS"*** followed by a "VALUE".

The Addresses N, G, X, Z, and F are used with the Values: *20, 1, 3.0, -1.0 and .01*

Syntax of Part Programming

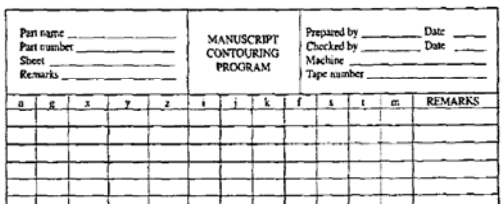
Formats for the commands arranged to form a block:

- Fixed sequential format
- Block address format
- Tab sequential format
- Word address format
  - For example: N040 G00 X0 Y0 Z300 T01 M06

N: identifier number, G: preparatory commands,
X,Y and Z: coordinates along the x, y and z axis
T: the tool number and M: miscellaneous commands

Manual Part Programming

Part program manuscript



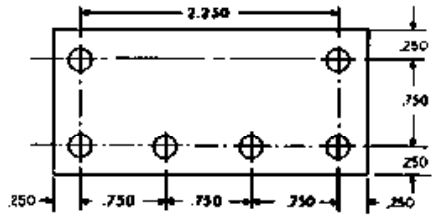


Fig. 6 A workpiece dimensioned for the incremental system mode. (Ikan Corporation)

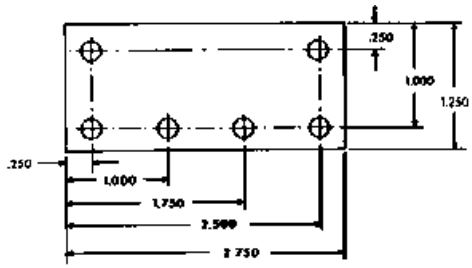


Fig. 7 A workpiece dimensioned to the absolute system mode. Note: All dimensions are given from a known point of reference. (Ikan Corporation)

Programing System

Point-to-Point or Continuous Path

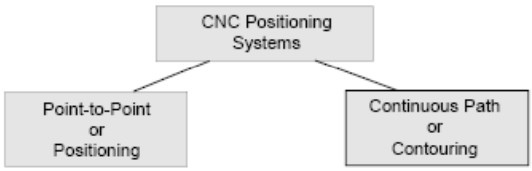


Fig. 8 Types of CNC positioning systems (Kelmar Associates)

Point-to-Point

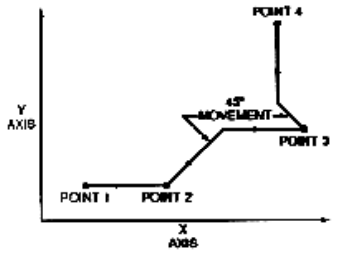


Fig. 9 The path followed by point-to-point positioning to reach various programmed points (machining locations) on the XY axis. (Kelmar Associates)

Programming Format

1. Word Address Format

2. Codes

- G-codes (preparatory functions),
- M codes (miscellaneous functions)
- Other codes such as F, S, D, and T are used for machine functions such as feed, speed, cutter diameter offset, tool number, etc.

Continuous Path (Contouring)

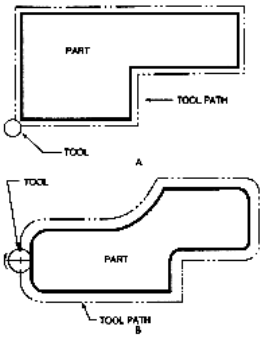
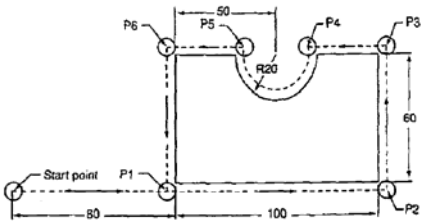
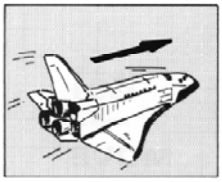


Fig. 10 Types of contour machining (A) Simple contour, (B) complex contour (Allen Bradley)

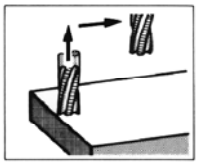
Manual Part Programming Example:



G - Code

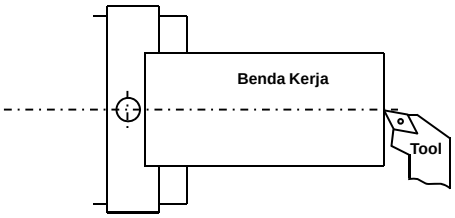


G00 : RAPID TRAVERSE

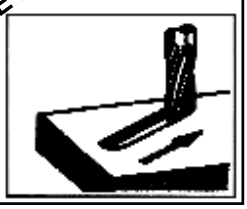


Turning

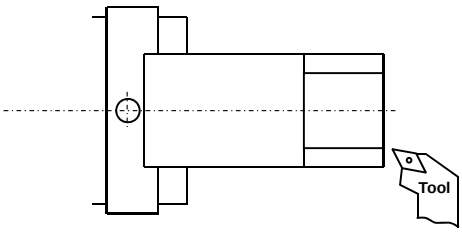
G00 = *Interpolasi Lurus gerak cepat tanpa beban (F = 0)*

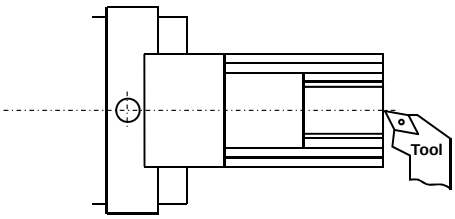


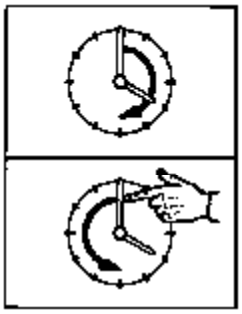
G01 : LINEAR INTERPOLATION (STRAIGHT LINE MOVEMENT)



G01 = *Interpolasi Lurus gerak Terkendali dengan beban (F = ?)*





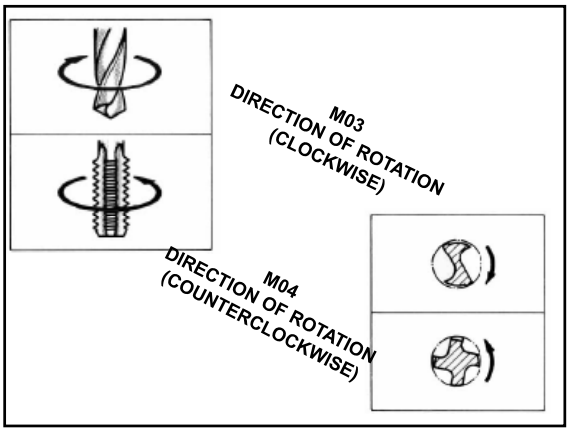


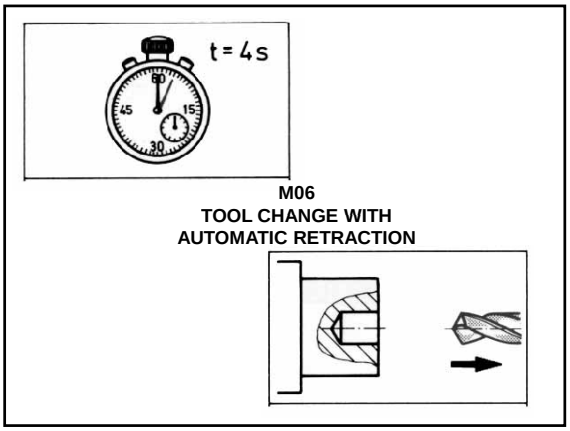
G02
CIRCULAR INTERPOLATION
(CLOCKWISE)

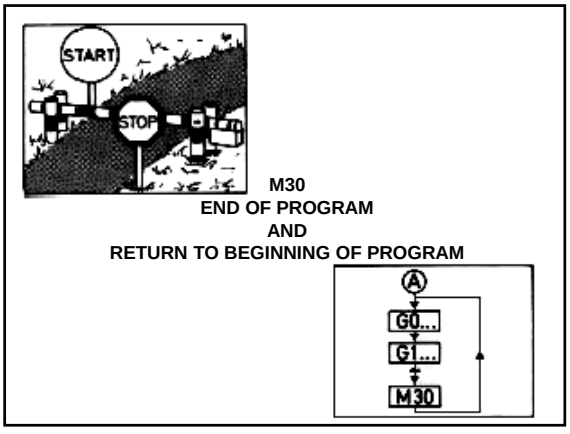
G03
CIRCULAR INTERPOLATION
(COUNTERCLOCKWISE

M - Code

M or miscellaneous codes are used to either turn ON or OFF different functions which control certain machine tool perations, Fig. 15.


M03
DIRECTION OF ROTATION
(CLOCKWISE)
M04
DIRECTION OF ROTATION
(COUNTERCLOCKWISE)


t = 4 s
M06
TOOL CHANGE WITH
AUTOMATIC RETRACTION


START
STOP
M30
END OF PROGRAM
AND
RETURN TO BEGINNING OF PROGRAM
A
G0...
G1...
M30

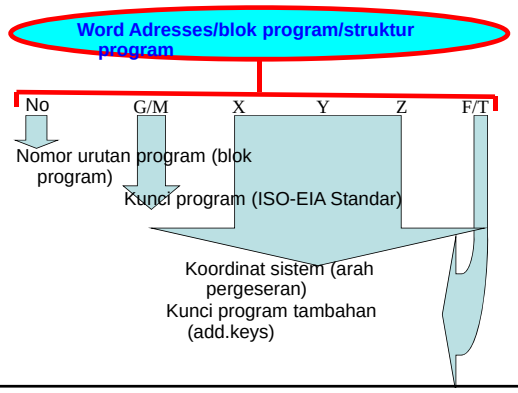
Code	Function
M00	Program stop
M02	End of program
M03	Spindle start (forward CW)
M04	Spindle start (reverse CCW)
M05	Spindle stop
M06	Tool change
M08	Coolant on
M09	Coolant off
M10	Chuck - clamping (**)
M11	Chuck - unclamping (**)
M12	Tailstock spindle out (**)
M13	Tailstock spindle in (**)
M17	Toolpost rotation normal (**)
M18	Toolpost rotation reverse (**)
M30	End of tape and rewind
M98	Transfer to subprogram
M99	End of subprogram

(**) - refers only to CNC lathes and turning centers.

Fig. 16 Some of the most common M-codes used in CNC programming.

No.	M-key	Fungsi Gerakan		
		EMCO CNC	Mesin lain 1	Mesin lain 2
01	M00	Penghentian program	Idem	Idem
02	M01	-	Penghentian bebas	Idem
03	M02	-	Akhir program	Idem
04	M03	Spindel on, searah jarum jam	Idem	Idem
05	M04	Spindel on, berlawanan jarum jam	Idem	Idem
06	M05	Spindel off	Idem	Idem
07	M06	Penggantian tool	Idem	Idem
08	M08	Pendingin hidup	Idem	Idem
09	M09	Pendingin mati	Idem	Idem
10	M17	Akhir sub program (kembali ke progr. Pokok)	-	-
11	M30	Akhir program	Idem	Idem

Contoh Pemrograman



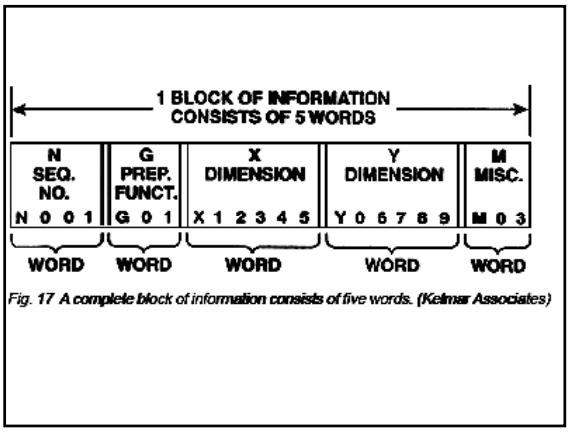
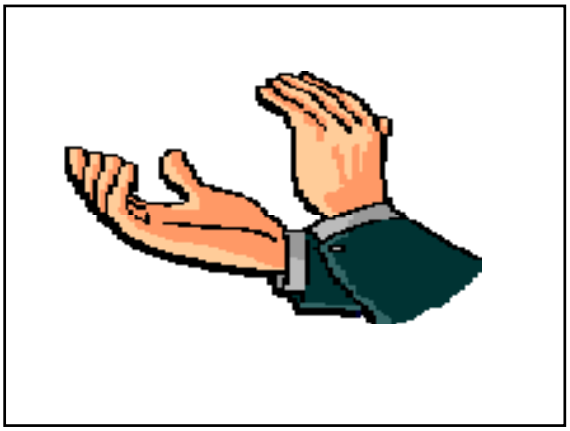


Fig. 17 A complete block of information consists of five words. (Kelmar Associates)



Pemrograman NC (Numerical Control)

Teknologi Proses Produksi/Proses Permesinan

Perkembangan Teknologi Proses Produksi/Proses Permesinan

Mesin Perkakas Konvensional

Hasil riset

- Demi penghematan ***Biaya***
- serta untuk mencapai ***hasil optimum***

❖ berbagai ***Universitas*** terkemuka di dunia
CIRP : *International Institution for Production Engineering Research*
❖ ***Industri***
PCM : Pacific Conference on Manufacturing

MESIN PERKAKAS NC

Bubut (turning),
freis (milling),
gurdi (drilling),
koter (boring),
gerinda (grinding).
Alat Potong (Flame Cutting).

Pemrograman NC (Numerical Control)

Produksi Komponen (Proses Permesinan) :

Produksi Tinggi (Massal) dan Waktu Pendek dan Ekonomis, Presisi

Abad 18

Jhon Wilkinson ⇨ Mesin Metal Cutting Boring

Mesin Hydraulic Tracer Controlled Copy

1943

Milling

Turning

Pertama ***: Mesin Kontrol dg Komputer (ENIAC)***
(Electronic Numerical Integrated and Controller)

Ukuran besar
Produksi terbatas

USAF (United State Air Force) ⇨ Komponen Pesawat ⇦ **Mesin Konvensional**

By : Metal Cutting Industries

Butuh Banyak & Presisi

Jhon Parson & MIT ⇨ ***Mesin Pergeseran otomatis (NC)***
Produksi Massal & Rumit

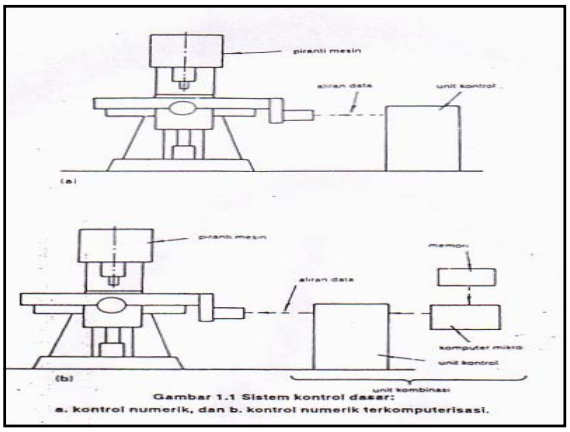
1976

Mesin CNC/Microprocessor Programe

History Continued

NC Machine : *kontrol gerakan mesin menggunakan intruksi oleh seri bilangan dan dikendalikan oleh sistim kontrol elektronika*

CNC Machine : *kontrol gerakan mesin menggunakan intruksi oleh seri bilangan dan dikendalikan oleh komputer internal dan pemrograman via memory*



Gambar 1.1 Sistem kontrol dasar:
a. kontrol numerik, dan b. kontrol numerik terkomputerisasi.

Aplikasi CNC

1. Metal Cutting
2. Wood Working
3. Welding
4. Flame Cutting
5. Metal Boring
6. etc Manufacturing Product

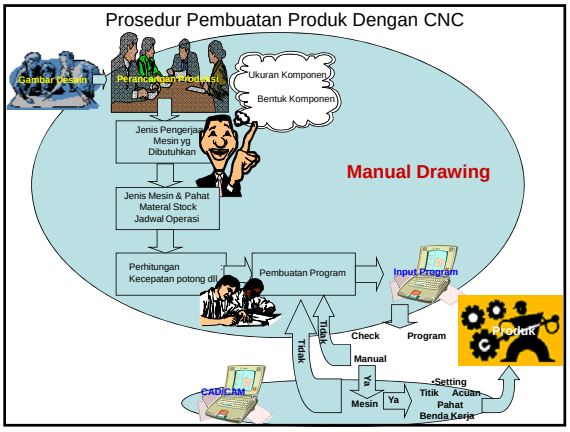
Keuntungan CNC

1. Laju Produksi Tinggi dan Cepat untuk waktu yang sama
2. Produk Seragam
3. Reject berkurang
4. Operator sedikit
5. Bentuk rumit komplek mudah dikerjakan
6. Presisi
7. Dokumentasi program (Baik)
8. Mampu bekerja berjam-jam setiap hari Tanpa harus dibawah pengawasan operator

Kekurangan CNC

1. Investasin awal mahal
2. Tenaga ahli programer
3. Sensitifitas komponen alat tinggi
4. Perawatan tinggi

Prosedur Pembuatan Produk Dengan CNC



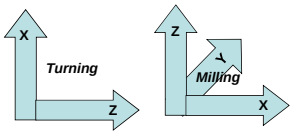
Sistim Persumbuan CNC (Arah Pergeseran)

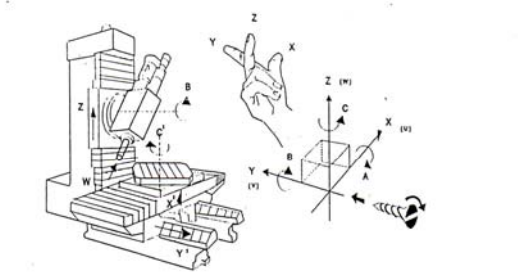
Pahat
Ragum (Catok)
Spindel (Chuck)

Turning : Gerakan mesin (tool/pahat) geseran secara linier dan benda kerja berputar

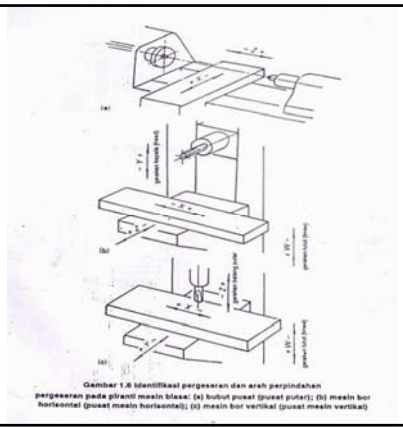
Milling : Gerakan mesin (tool/pahat) berputar dan benda kerja geseran secara linier

Sumbu Koordinat : (X, Y, Z) yang berpedoman pada sumbu putar



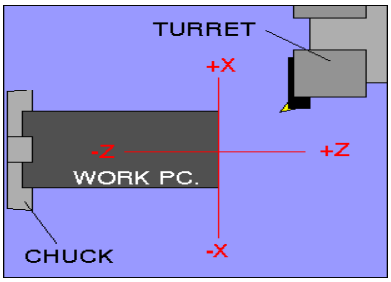


Gambar 12.2 Mesin freis spindel vertikal, 5 sumbu (X',Y',Z,B,C'). Sumbu W merupakan sumbu sejajarnya sumbu Z yang dioperasikan bergantian dengan sumbu Z.

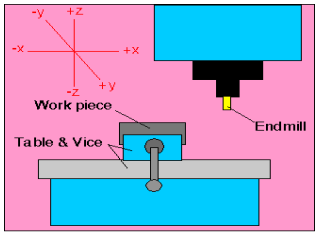


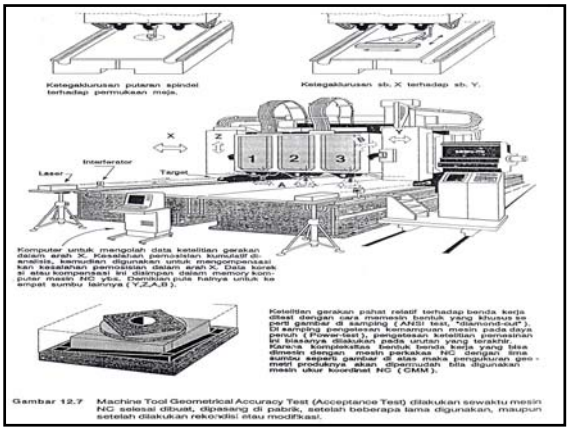
Gambar 1.6 Identifikasi pergeseran dan arah perpindahan pergeseran pada pfranti mesin biasa: (a) bubut pusat (pusat putar); (b) mesin bor horisontal (pusat mesin horisontal); (c) mesin bor vertikal (pusat mesin vertikal)

Lathes are almost all the same when it comes to the Cartesian Coordinate System. The *"Z" axis runs through the center of the chuck, work pc. And tailstock.*
The "X" axis runs from the back of the machine, to the front of the machine.

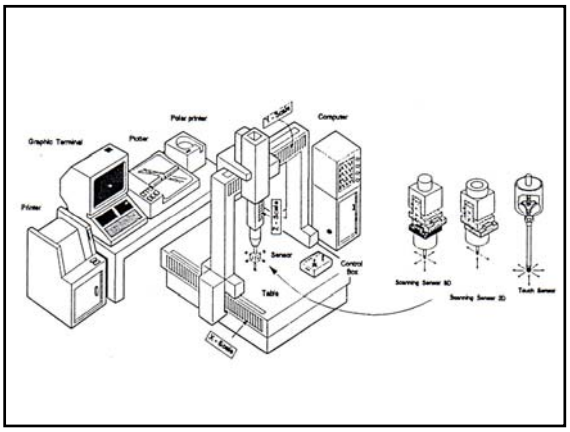


Milling Machines are a little different, *The "Z" axis runs up and down.*
The "X" axis runs from the left of the machine, to the right of the machine.
The "Y axis runs from the front of the machine, to the back of the Machine.

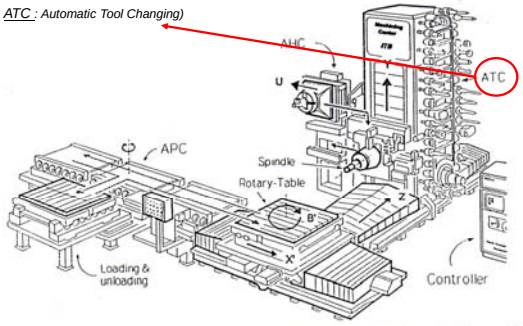




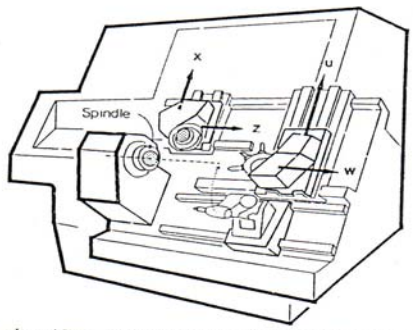
Gambar 12.7 Machine Tool Geometrical Accuracy Test (Acceptance Test) dilakukan sewaktu mesin NC selesai dibuat, dipasang di pabrik, setelah beberapa lama digunakan, maupun setelah dilakukan rekondisi atau modifikasi.



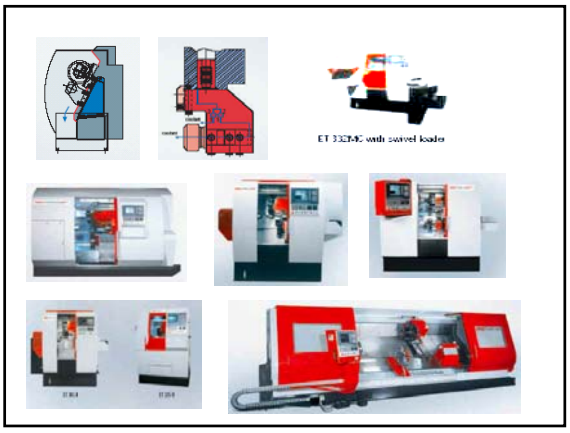
ATC : Automatic Tool Changing)



Gambar 12.4 Machining Center 4 Axes (X',Y,Z,B') additional axis U yang dilengkapi dengan ATC, AHC, dan APC. Mesin menjadi sangat fleksibel dan produktif.

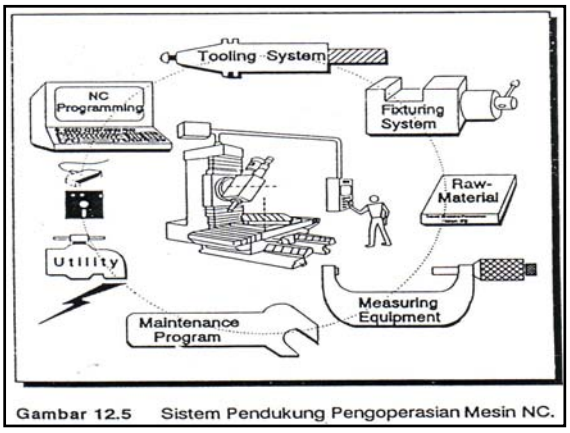


Gambar 12.3 Mesin bubut NC dengan sumbu 2x2 (X,Z dan U,W). Dengan mesin ini dapat dilakukan pembubutan luar dan dalam serentak.


ET 332MC with swivel loader


ET 332MC with bar loader
ET 465MC with gantry loader


ET 365 with tailstock



Gambar 12.5 Sistem Pendukung Pengoperasian Mesin NC.

Production Machine

Contoh Jenis Merek

PRISMA

- East German system built between 1969 and 1974
- Highly touted by Milacron's chiet marketer
- Visited by Nevins and Whitney April,1976
- Porous partly machined parts on the floor
- Almost no raw castings at the input Stacks of finished parts at the output
- General Mgr: "What do you think?"
- Nevins: "Very impressive. Do you plan to make any more?"
- G.M. "No!"

Yamazaki Mazak

- Built lights-out factory in mid 1980s to make its products (machine tools) – visited by Whitney in 1991
- Addressed tool proliferation with "given tool method"
- Addressed system complexity by breaking up factory into many simple cells having identical tasks, identical machines, and identical tool sets

Yamazaki Mazak (Cont.)

- Addressed reliability, in part, by reducing cutter depth and speed at night, eliminating tool breakage, the main failure preventing lights-out operation
- "American customers want 120-tool capacity in their tool carousels – ha ha. Japanese companies are happy with 60".
- Some of this documented by the late Prof Jai Jaikumar of HBS in cases on Yamazaki

Fanuc

- Originally a motor company
- Built NC machine in 1956!
- Developed NC technology in 1960s and 70s
- Started building robots in the 1970s
- Applied robot controllers to simple CNC machines in late 1970s with low cost bubble memory and simple graphical controls for programming and simulating and monitoring operations

Fanuc (Cont.)

- Drove US NC controls makers (GE, Honeywell, A-B) out of the market
- Addressed needs of small manufacturers and simple machines for the first time
- Fanuc is still important in the controller and robot markets