On student projects on MB software engineering in mechanical engineering field

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Laulasmaa, 28-29 october 2013

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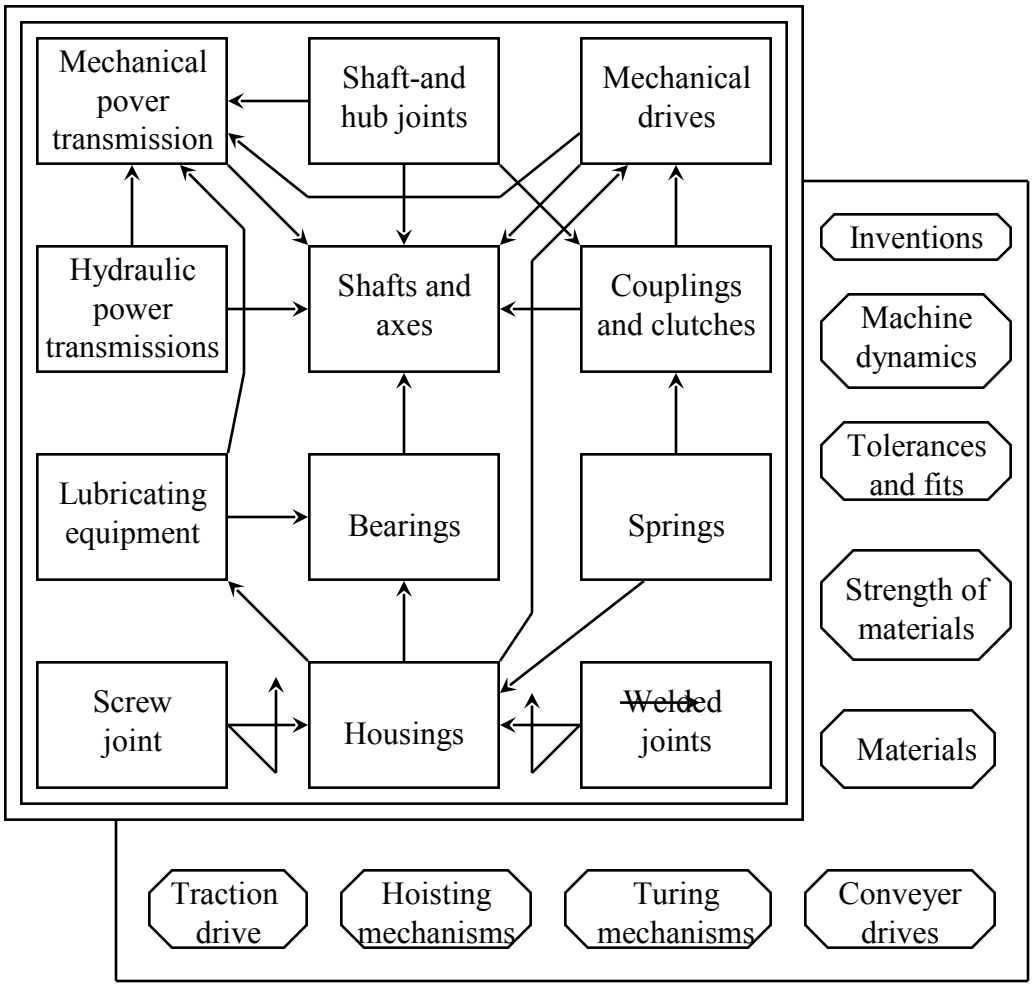
I Overview of PRIZ - family systems

System	Computer	Year	Additional-components
SMP	Minsk-22	1973	
PRIZ-32	Minsk-32	1975	
PRIZ ES	ES (IBM-360/370)	1978	DB
MIS	ES	1981	
	ELBRUS-I		
	SM		
	BESM-6		
MicroPRIZ	Apple II	1982	
-- “ --	Labtam 3000	1984	ES
-- “ --	IBM PC	1985	ES
ExpertPRIZ	IBM PC	1987	ES, DB
NUT	Labtam-Kronos	1988	
	SUN		
	NEXT		
	IBM PC(Linux)		
C-PRIZ	IBM PC		ES
WExpPRIZ	IBM PC	1991	
Cocovila	IBM PC (Linux)	2004	
	(Windows)		

II Software development using MBSE environments



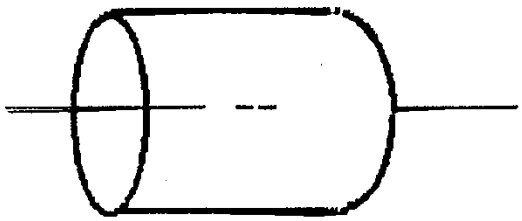
III Developing software packages. (ExpertPRIZ)

Creating software packages. Stages

1. Compiling a technical task.
   Analysis of tasks
2. Preparation of a list of concepts
3. Programming of concepts
4. Developing expert KB-s
5. Programming of input-output interface
6. Creating and filling data bases.
7. Testing the typical problems using ExpertPRIZ interface.
8. Developing *run-time* version of the package
9. Compiling package documentation
10. Testing the run-version of the program packages in industry, i.e. the programmers' group together with the engineers solves the possible maximal number of practical problems.
11. Package accept

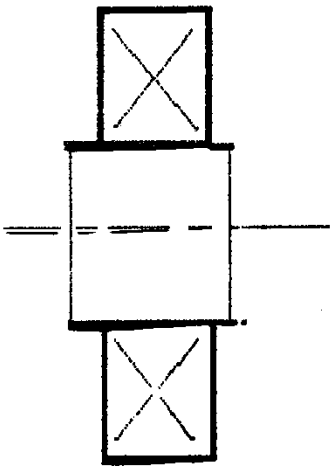
Concepts for designing shafts

neck

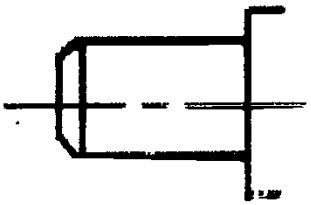


key

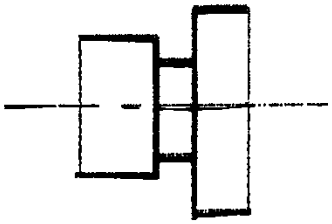
bearing



console tip



shoulder



The Examples of Developing and Using Knowledge Bases

```
* CONSOLE
  eltype text
  material text
  eltype='CONS'
  geom (eltype l d)
* diameter ?
  d^3=t/0.2*tau)
* moment ?
  t=9550*1000*p/n
* tau ?
  tau=0.003*sgmb
* mass ?
  m=l*d^2*pi*0.00785/4000
* DB operation for sgmb ?
  rel1 tab file='steels' row=mater column='SGMB' res=sgmb
* DB operation for l ?
  Rel2 tab file='legths' row=d column='lenth' res=1
  pi=3.14


* NECK
...

* BEARING
...
```

The stored concepts can further be used similarly to classes in object-oriented programming languages, creating objects of those classes in the problem descriptions. The following is a shaft description:

```
!mn y
C! CONSOLE p=6.5 n=3000 material='40X'
K1 KEY ds=C1.dn ls=C1.l
S1 STEPCR d1=C1.d
N3 NECK2 l=20 D=N2.d
B3 BEARING ds=N3.d
…
pict(C1.geom,K1.geom,S1.geom,…,)
com pict
!rp dshaft pict
```

XPERT DESIGN OF REDUCTOR SHAFTS

CONSOLE TIP	COGWHEELS	BEARINGS	?	RESULT
Yes	3 Cogwheels	Ball bearings	STYPE1	END
Yes	3 Cogwheels	Roller bearings	STYPE2	END
No	3 Cogwheels	Ball bearings	-	#SHAFT1.EXP

*1 IS THE SHAT TO BE DESIGNED WITH CONSOLE?
*2 THE SHAFT TO BE DESIGNED IS WITH …
*3 THE BEARINGS OF THE SHAFT ARE ...

XPERT DESIGN OF REDUCTOR SHAFTS

CONSOLE	?	NECK1	?	BEARINGS	?	NECK2	?	
Yes	CONS1	Yes	NECK1	Roller bearings	RBEAR1	Yes	NECK2	
Yes	CONS1	Yes	NECK1	Ball bearings	BBEAR1	Yes	NECK2	
Yes	CONS1	Yes	NECK1	Don't have	-	No	-	...
No	-	Yes	NECK1	Roller bearings	RBEAR1	Yes	NECK2	
No	-	Yes	NECK1	Ball bearings	BBEAR1	Yes	NECK2	

*1 IS THE SHAT TO BE DESIGNED WITH CONSOLE?
*IS THE NEXT ELEMENT NECK?
*THE NECK HAS …

...

n	t	key selection table			
	b	h	lmin	lmax	k
12	-	-	-	-	-
17	5	5	10	56	2.3
22	6	6	14	70	2.6
30	8	7	18	90	3.0
38	-	-	-	-	-
44	-	-	-	-	-

Dialog with EKB

Problem model

Console?
Yes

NECK1?
Yes

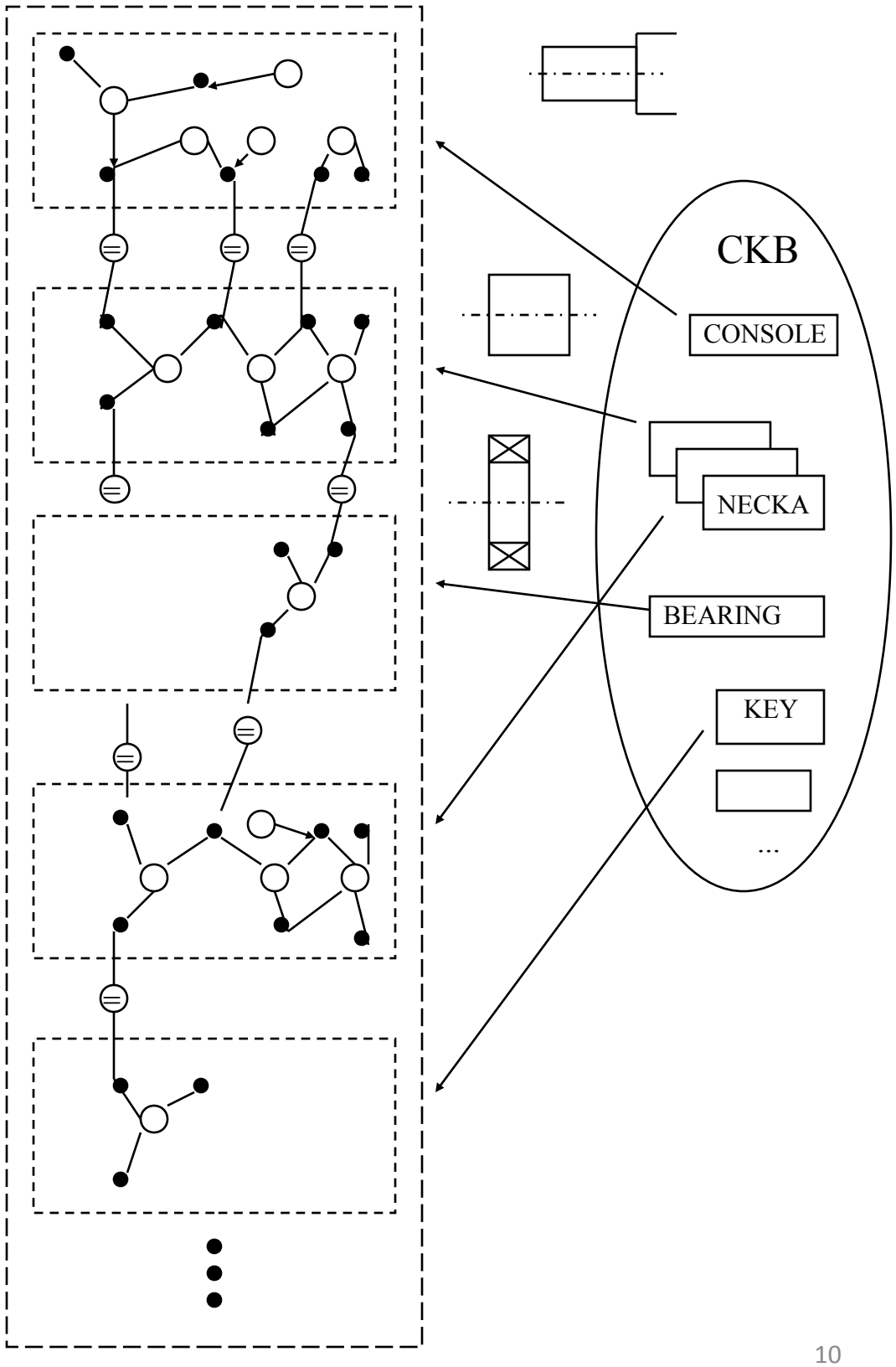
BEARING1?
Yes

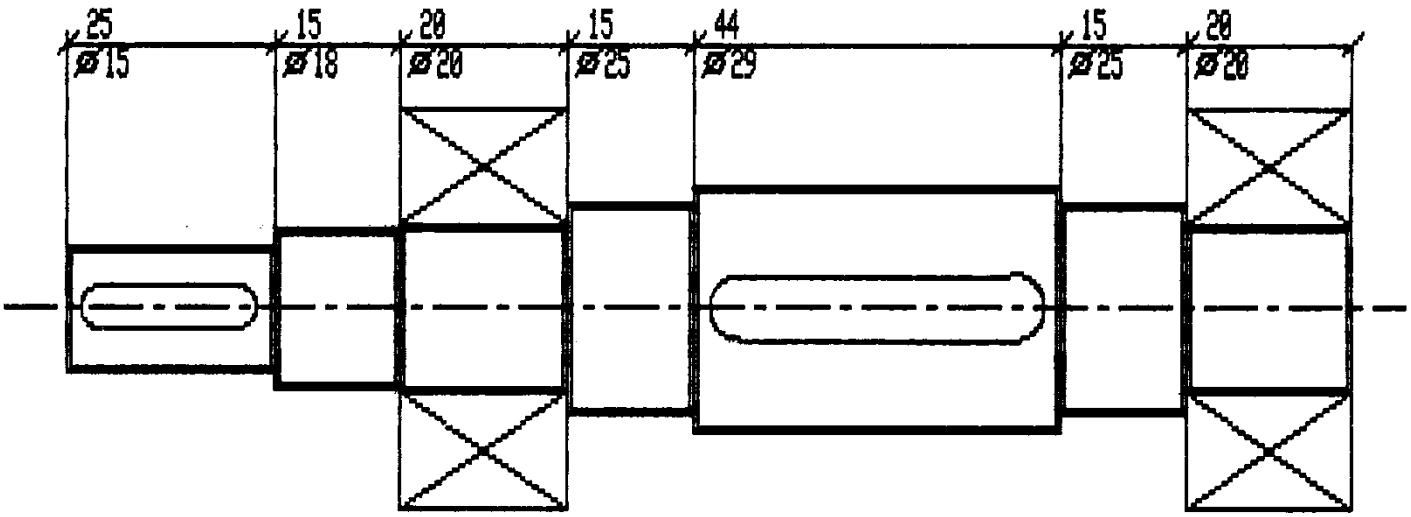
NECK2?
No

NECK3?
Yes

KEY1
Yes

...

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Developing software for civil engineering

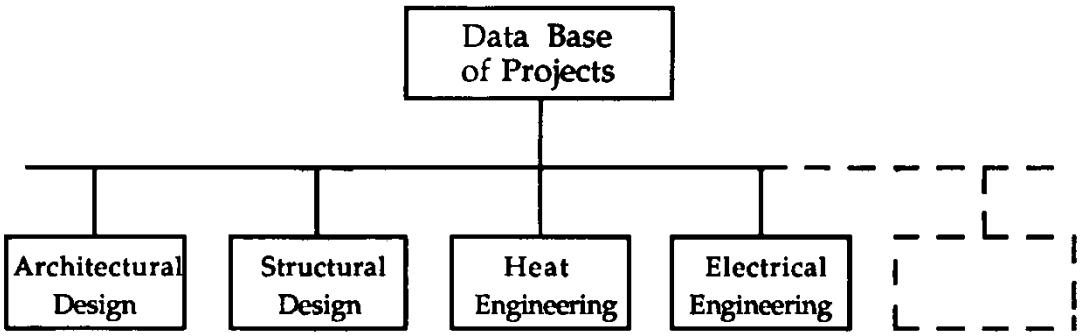


Figure 5. The components of CAD in civil engineering

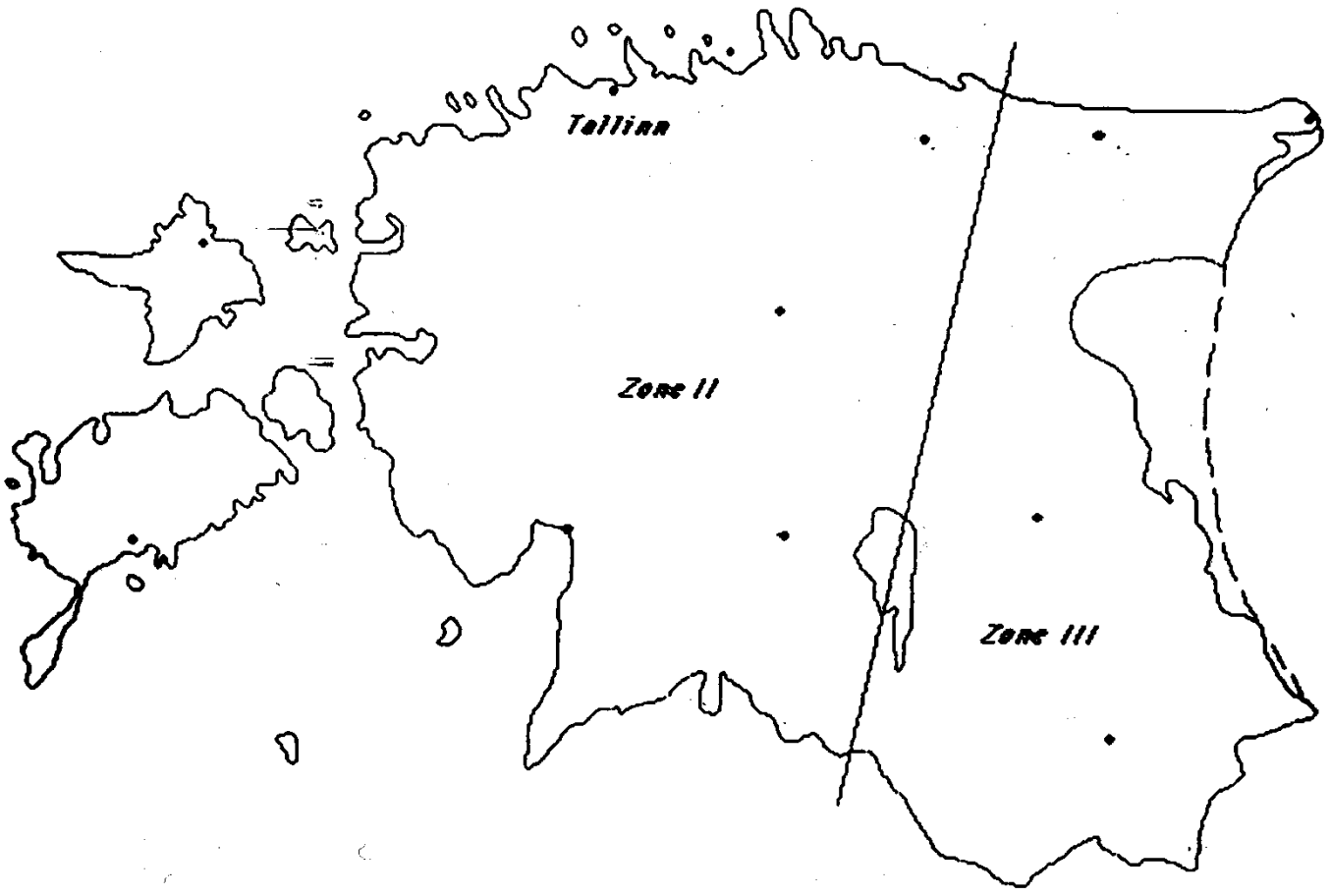


Figure 2. Estonian snowcover

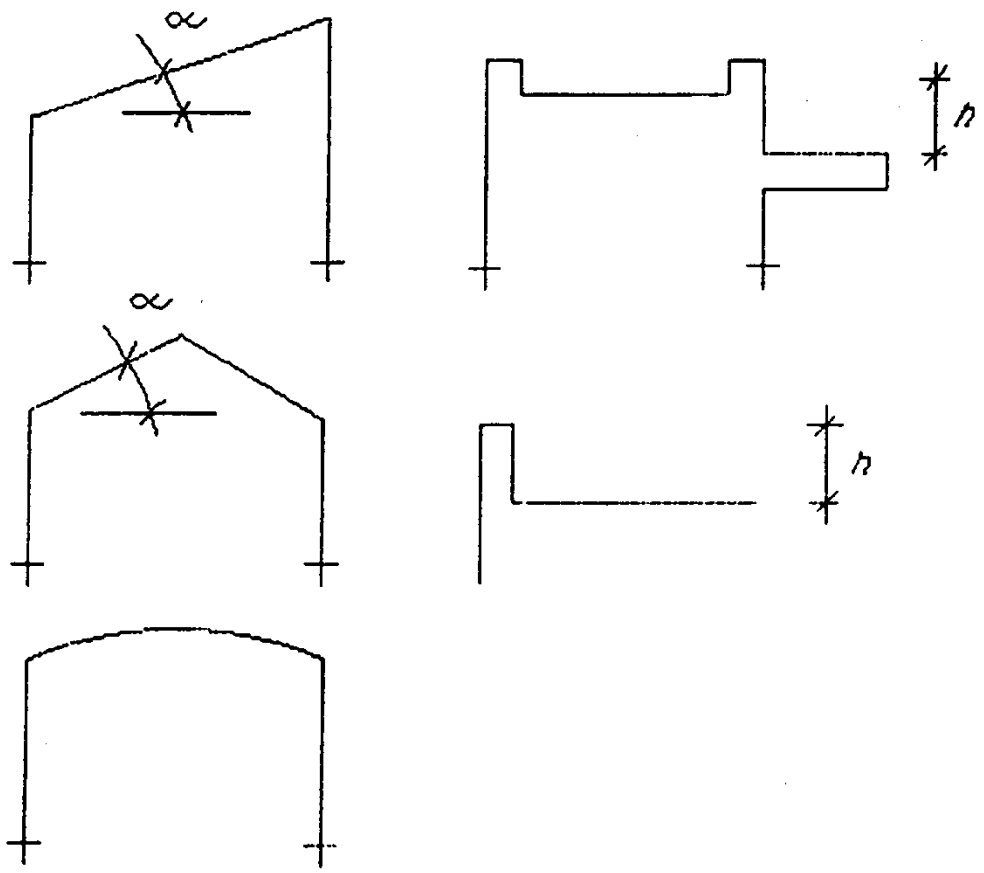
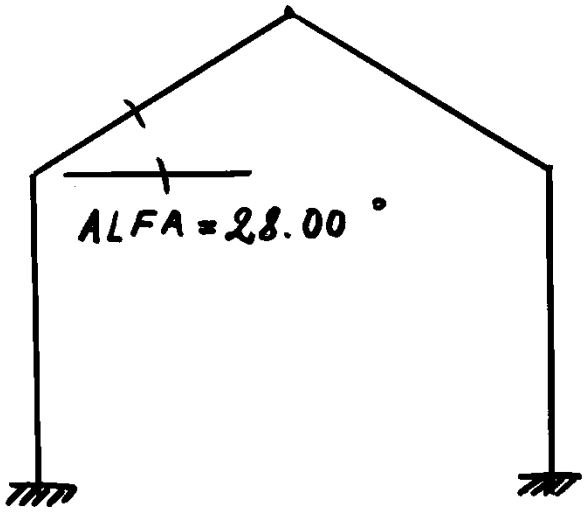


Figure 3. Shapes of roofs



S = 0.700 kPa
Sa = 1.000 kPa

S1 = 0.490 kPa
Sa1 = 0.700 kPa

S2 = 0.910 kPa
Sa2 = 1.300 kPa

IV Developing software package. (NUT)

Using Conceptual Programming Environments for Modelling CAD and Technical Systems

The approach to program development used here is called conceptual programming because essentially it is the usage of concepts in programming.

New concepts are defined and used to specify problem conditions, i.e. to give specifications from which programs can be built, then the computer is relied on to get the program ready and run it.

Such activities can be divided into two separate stages: one is *the specification of concepts* and the other *the specification of a problem* in the terms of knowledge of given concepts.

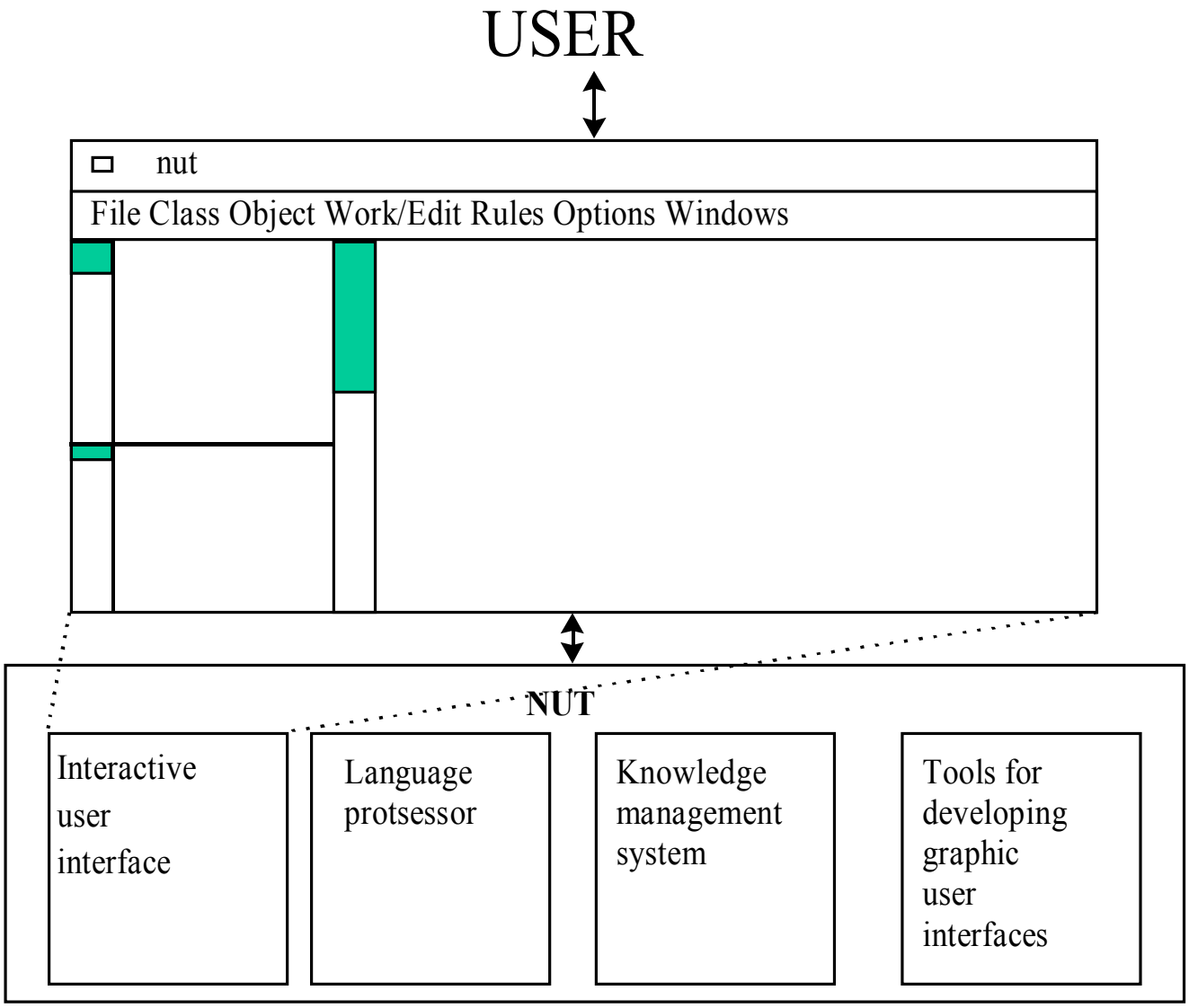


Figure 1. The NUT system

Model Levels

Models can be built and satisfying solutions can be generated at different levels.

Model levels show the concrete software features and functions involved.

Designer- Modelling process Environment Modeller

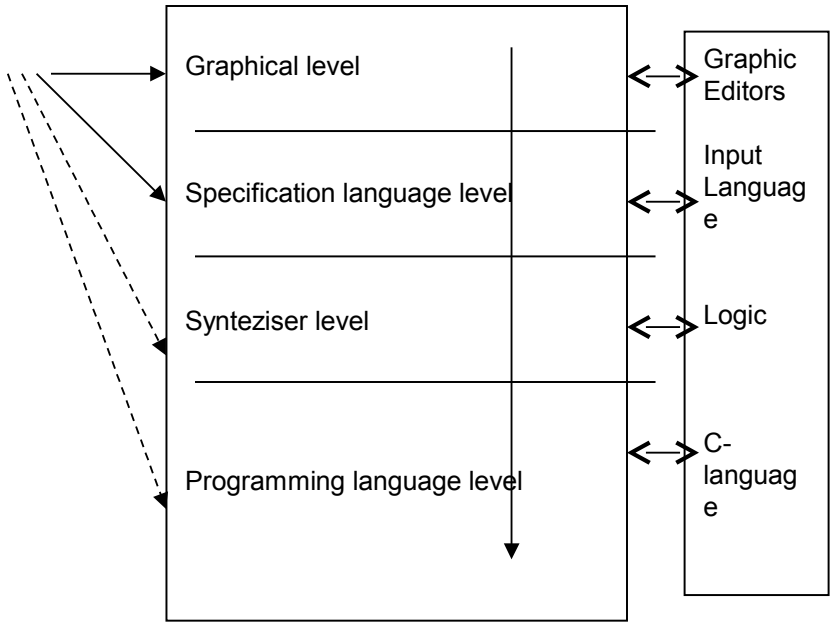


Figure 2. Main structure of the modelling environment

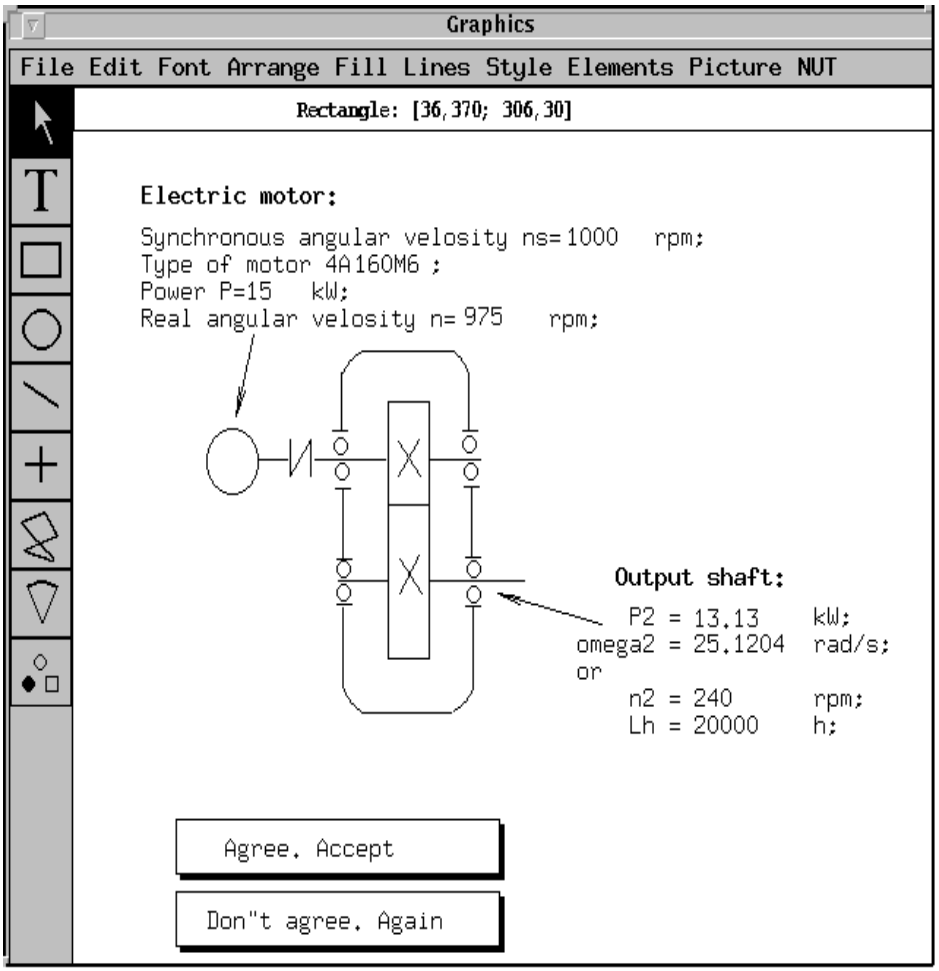


Figure 3. A typical graphical modelling fragment

Graphics

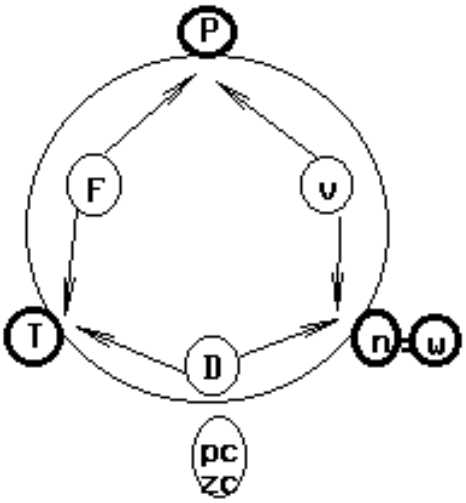
File Edit Font Arrange Fill Lines Style Elements Picture

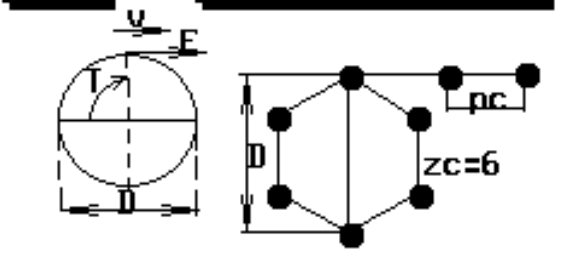
The main parameters of working shaft are:

1.Power	P[kW]	
2.Torque	T[N*m]	
3.Force	F[N]	
4.Diameter	D[mm]	
5.Rotation speed	n[rpm]	
6.Angular velocity	w[rad/s]	
7.Peripheral velocity	v[m/s]	
8.Pitch lenght	pc[mm]	
9.Teeth number	zc	

CLEAR

compute missing values





You may insert P and n
or P and w
or P and T
or T and n
or T and w

NEXT

QUIT

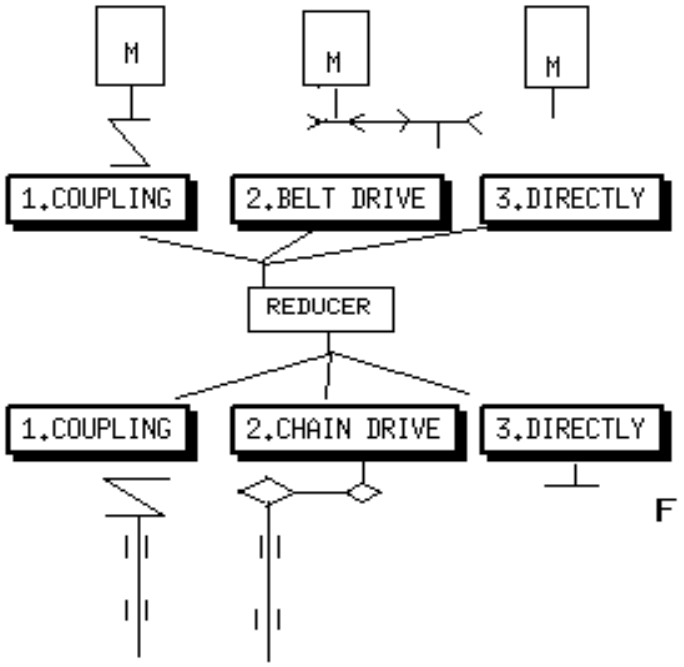
Graphics

File Edit Font Arrange Fill Lines Style Elements Picture

KINEMATIC DIAGRAM

POWER TRANSMISSION FLOW DIAGRAM

The torque is transmitted from motor to the input shaft or a reducer gear through a coupling or a belt drive or directly (motor-reducer). The torque from the output shaft is transmitted to the shaft of the production machine through a coupling or a chain drive or directly.



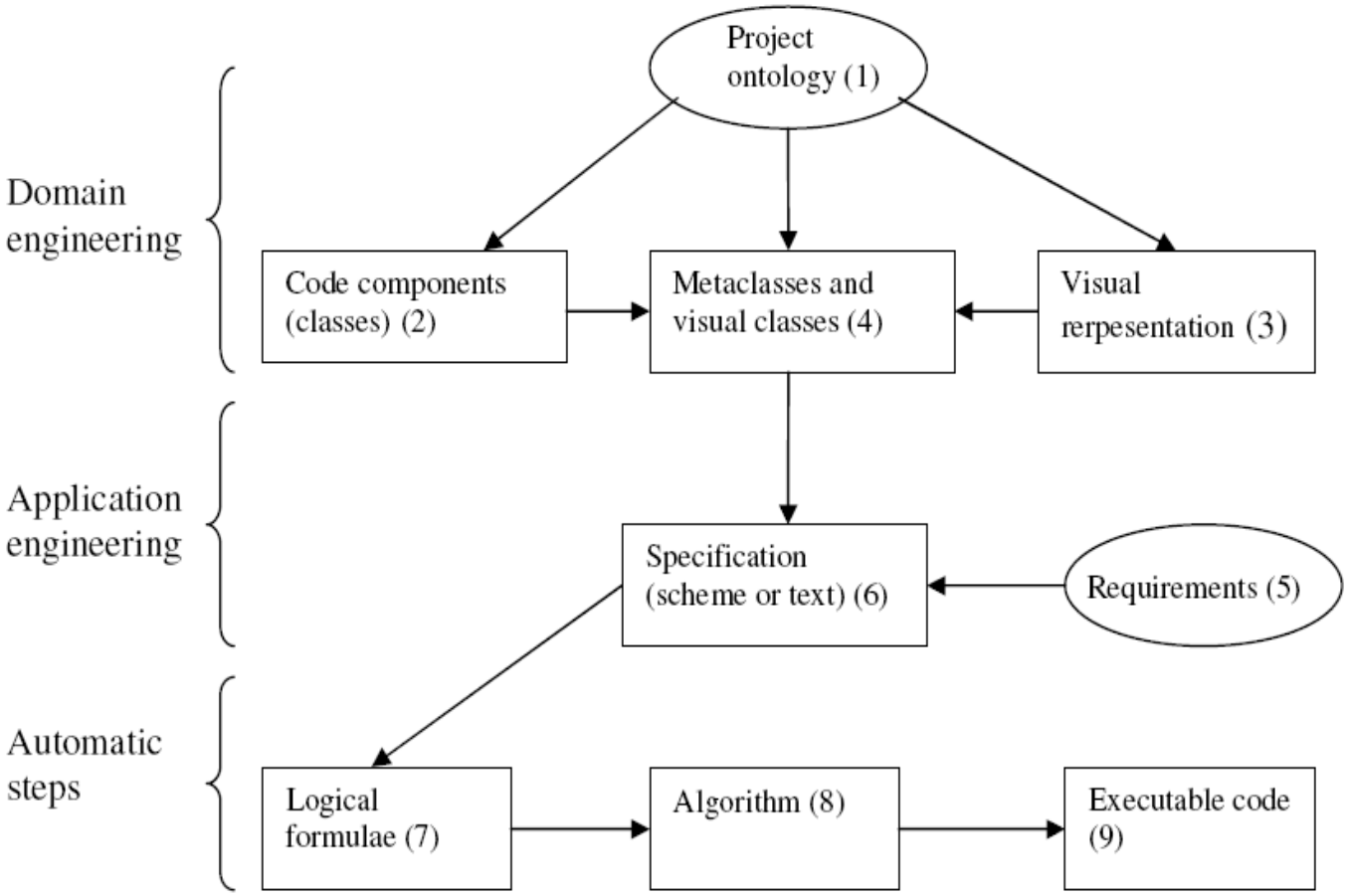
Do you have asyncrone or syncrone motor?

ASYNCRONE MOTOR

SYNCRONE MOTOR

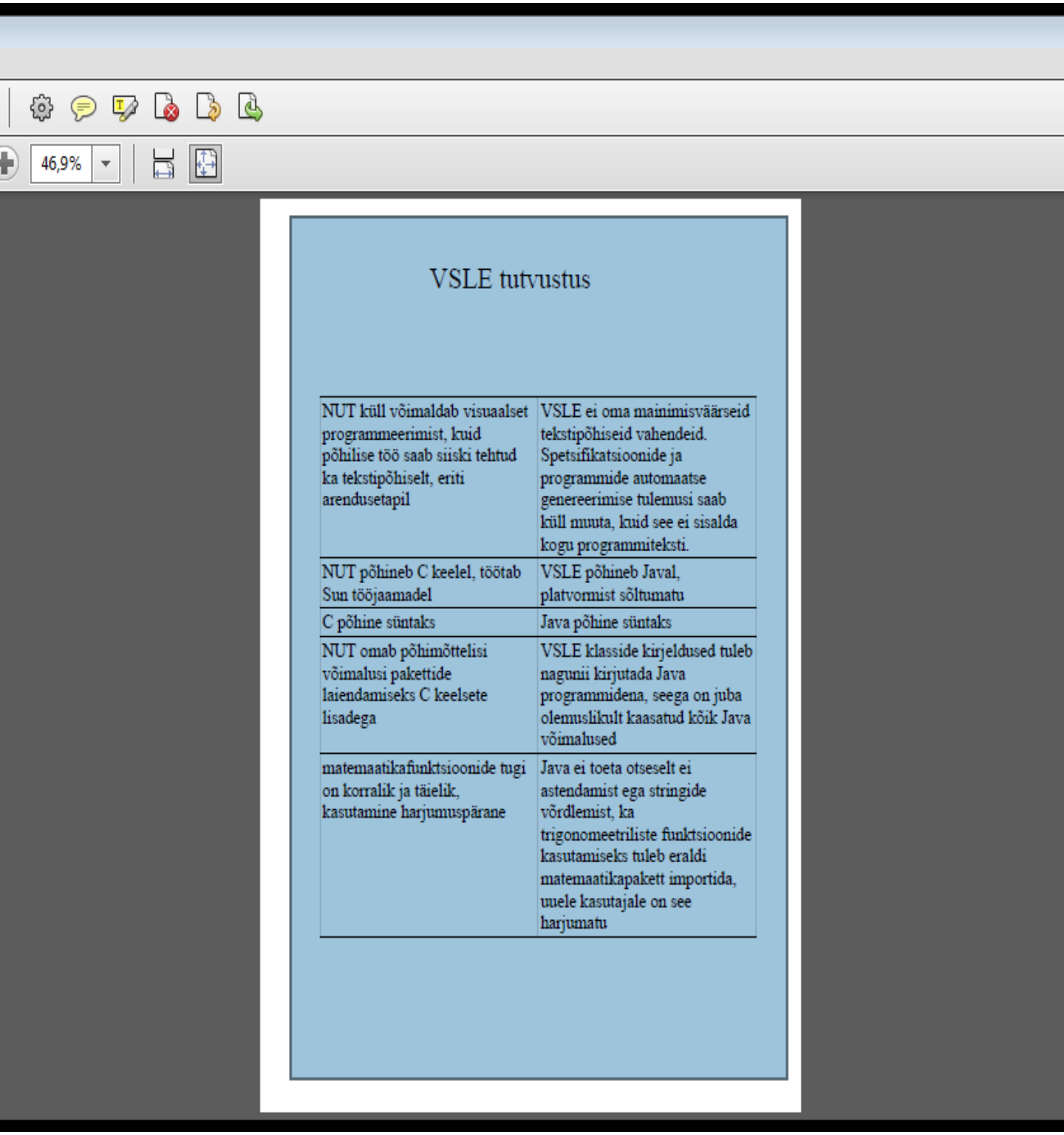
PREVIOUS PAGE NEXT QUIT

V Developing software package. (CoCoViLa)



CAD package for belt-transmission design in VSLE

Urmas Lipso
2004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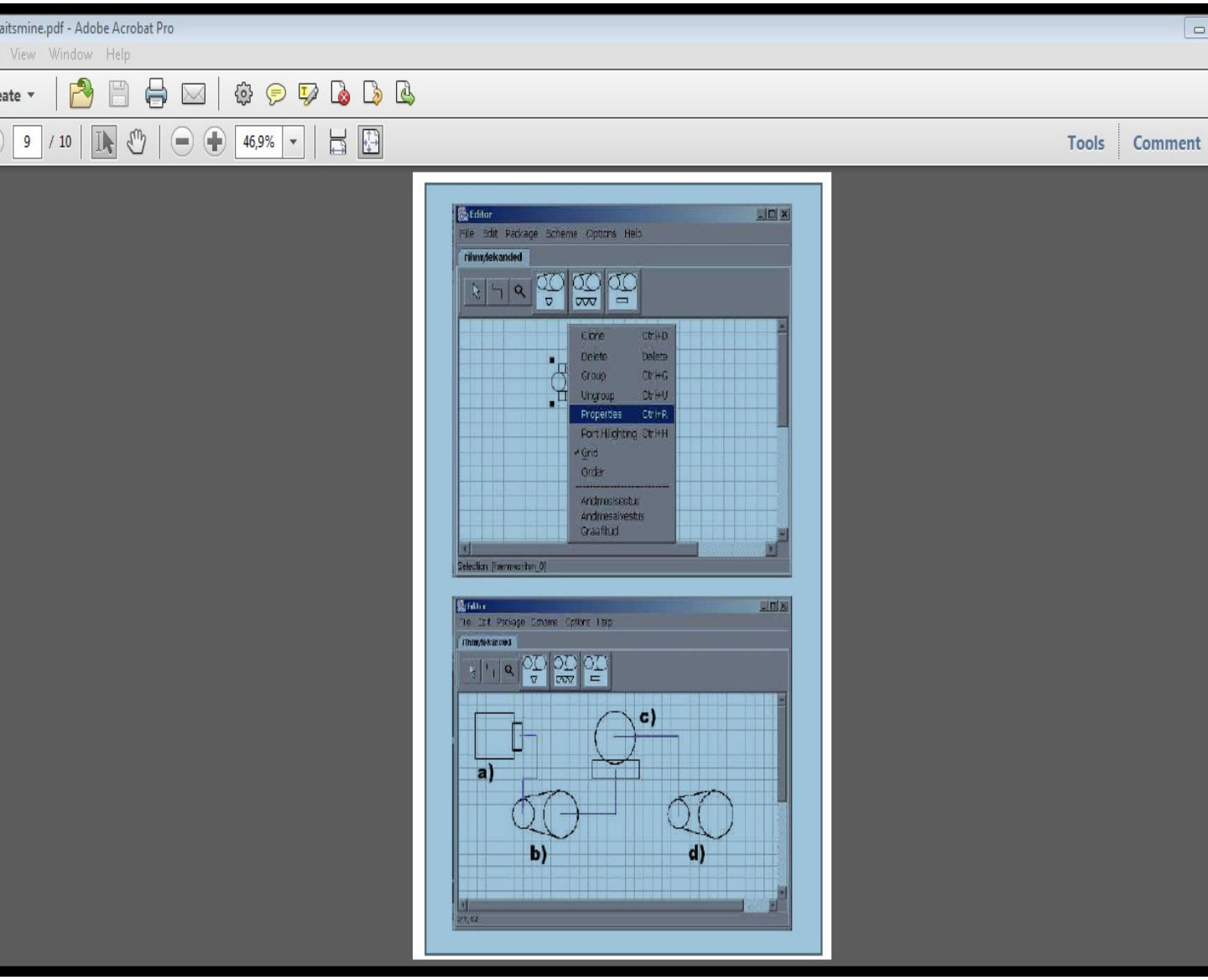
VSLE tutvustus
NUT küll võimaldab visuaalset programmeerimist, kuid põhilise töö saab siiski tehtud ka tekstipõhiselt, eriti arendusetapil
VSLE ei oma mainimisväärseid tekstipõhiseid vahendeid. Spetsifikatsioonide ja programmide automaatse genereerimise tulemusi saab küll muuta, kuid see ei sisalda kogu programmiteksti.
NUT põhineb C keelel, töötab Sun tööjaamadel
VSLE põhineb Javal, platvormist sõltumatu
C põhine süntaks
Java põhine süntaks
NUT omab põhimõttelisi võimalusi pakettide laiendamiseks C keelsete lisadega
VSLE klasside kirjeldused tuleb nagunii kirjutada Java programmidena, seega on juba olemuslikult kaasatud kõik Java võimalused
matemaatikafunktsioonide tugi on korralik ja täielik, kasutamine harjumuspärane
Java ei toeta otseselt ei astendamist ega stringide võrdlemist, ka trigonomeetriliste funktsioonide kasutamiseks tuleb eraldi matemaatikapakett importida, uuele kasutajale on see harjumatu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Group Ctrl+G
Ungroup Ctrl+U
Properties Ctrl+R
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Grid
Order
a)
b)
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d)

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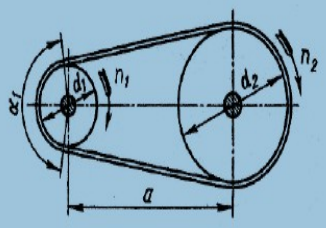
Rihmülekanded

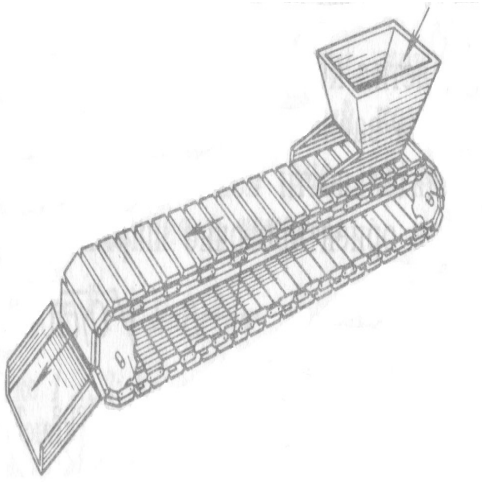


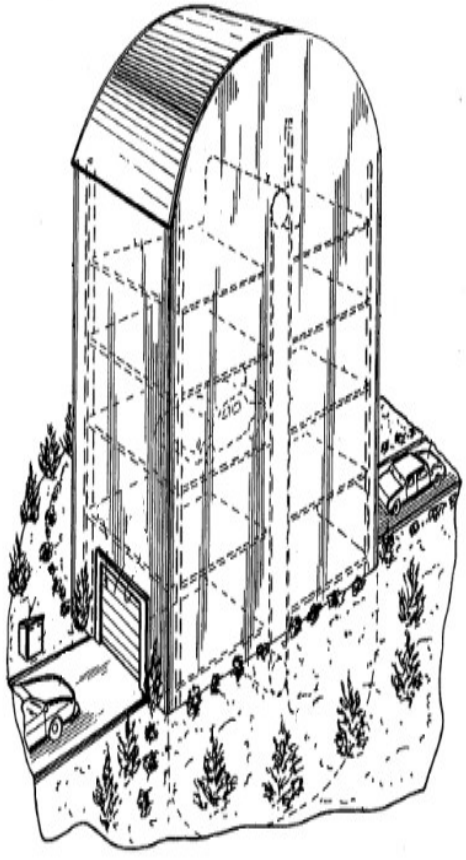
CAD package for chain conveyors design in CoCoViLa environment

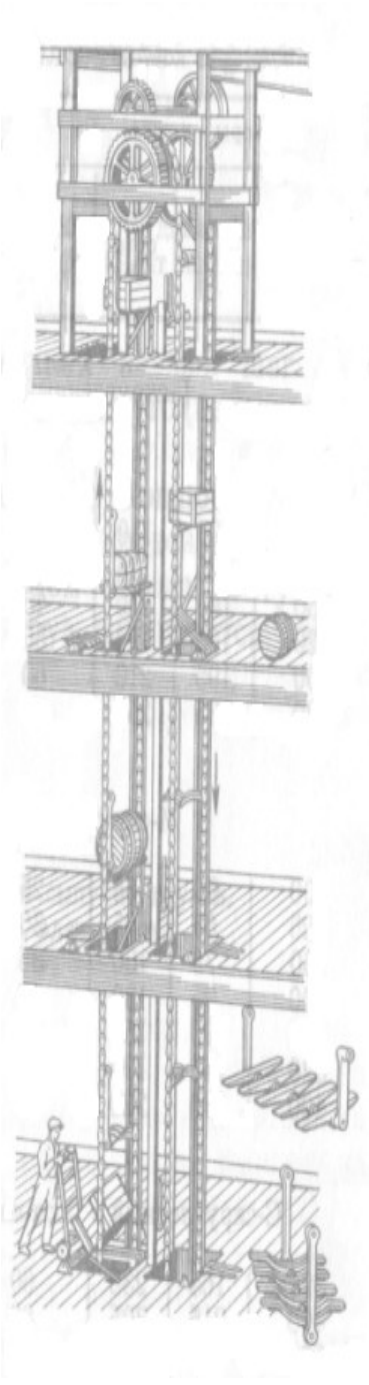
Toomas Matsalu

2007

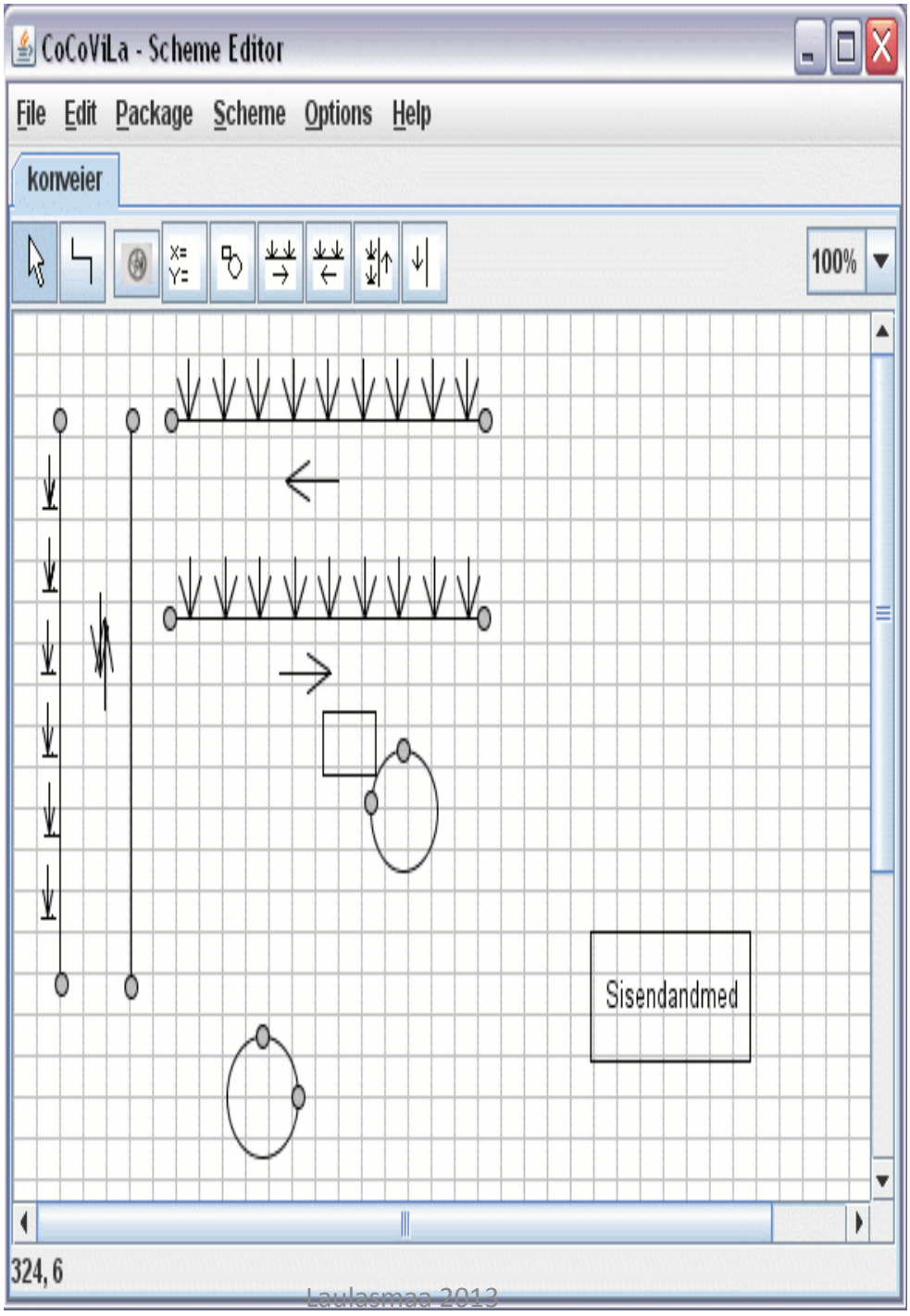
Chain conveyors



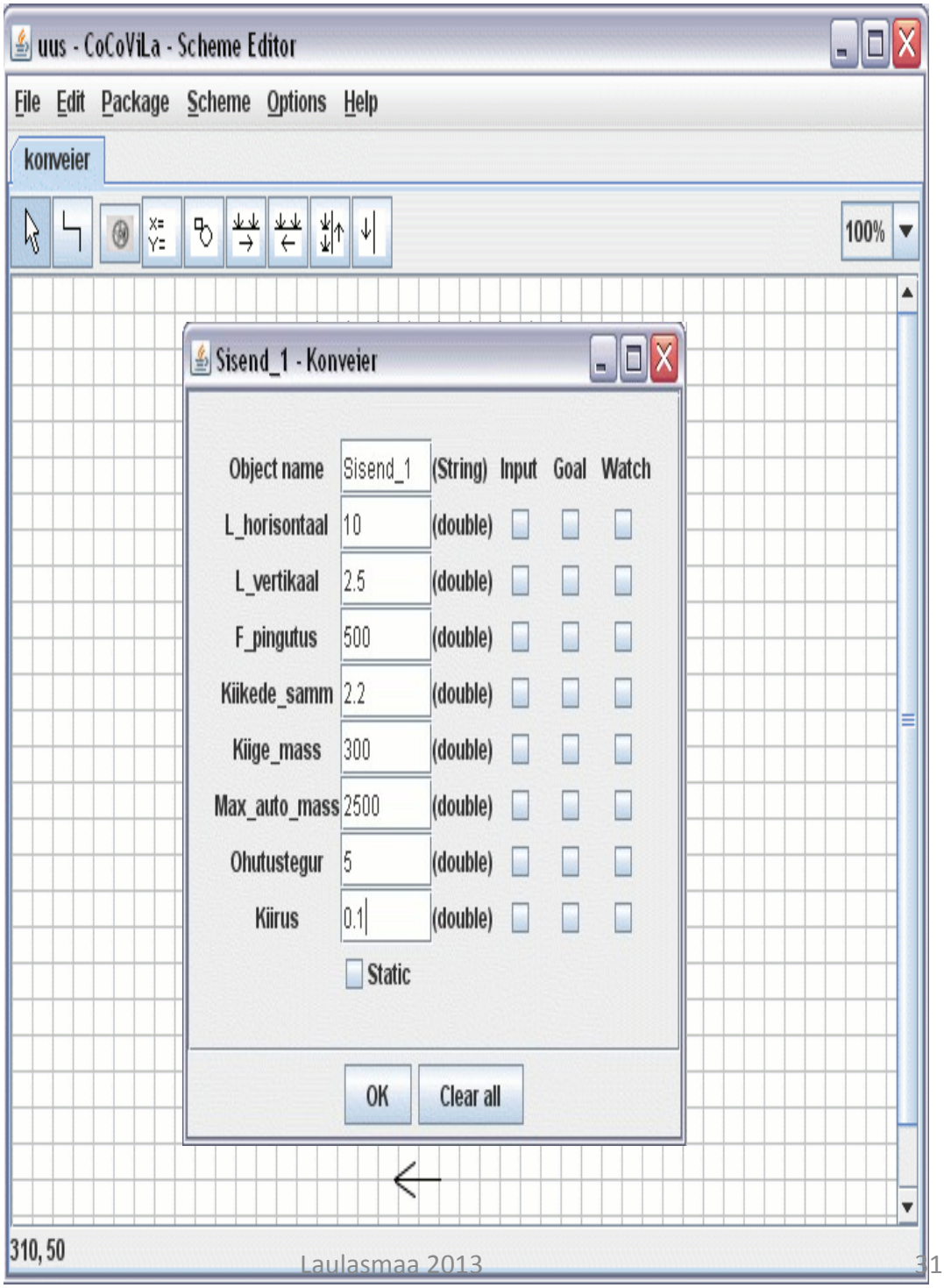




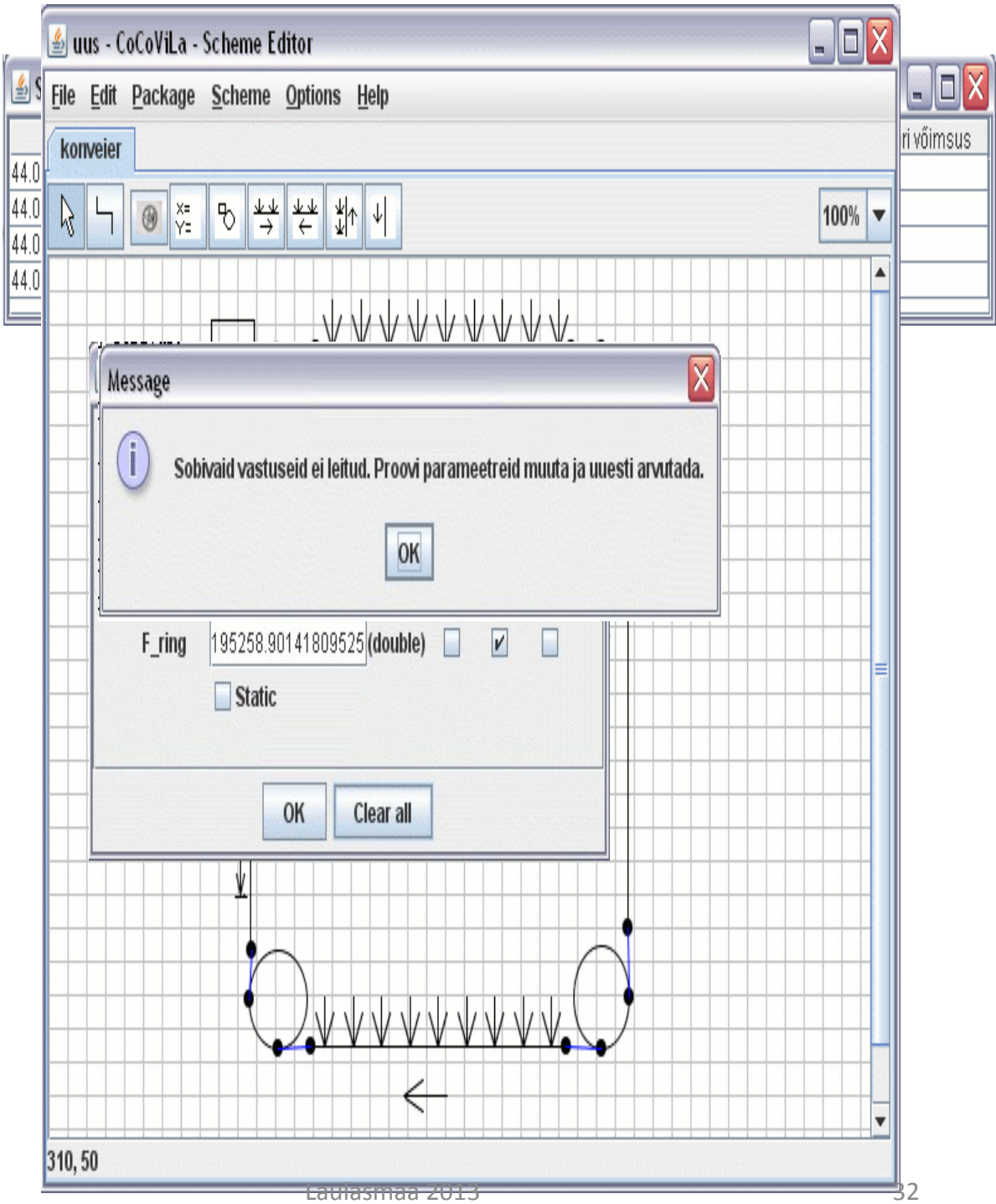
Chain conveyors elements



Schema of car parking area



Design results



Kokkuvõte

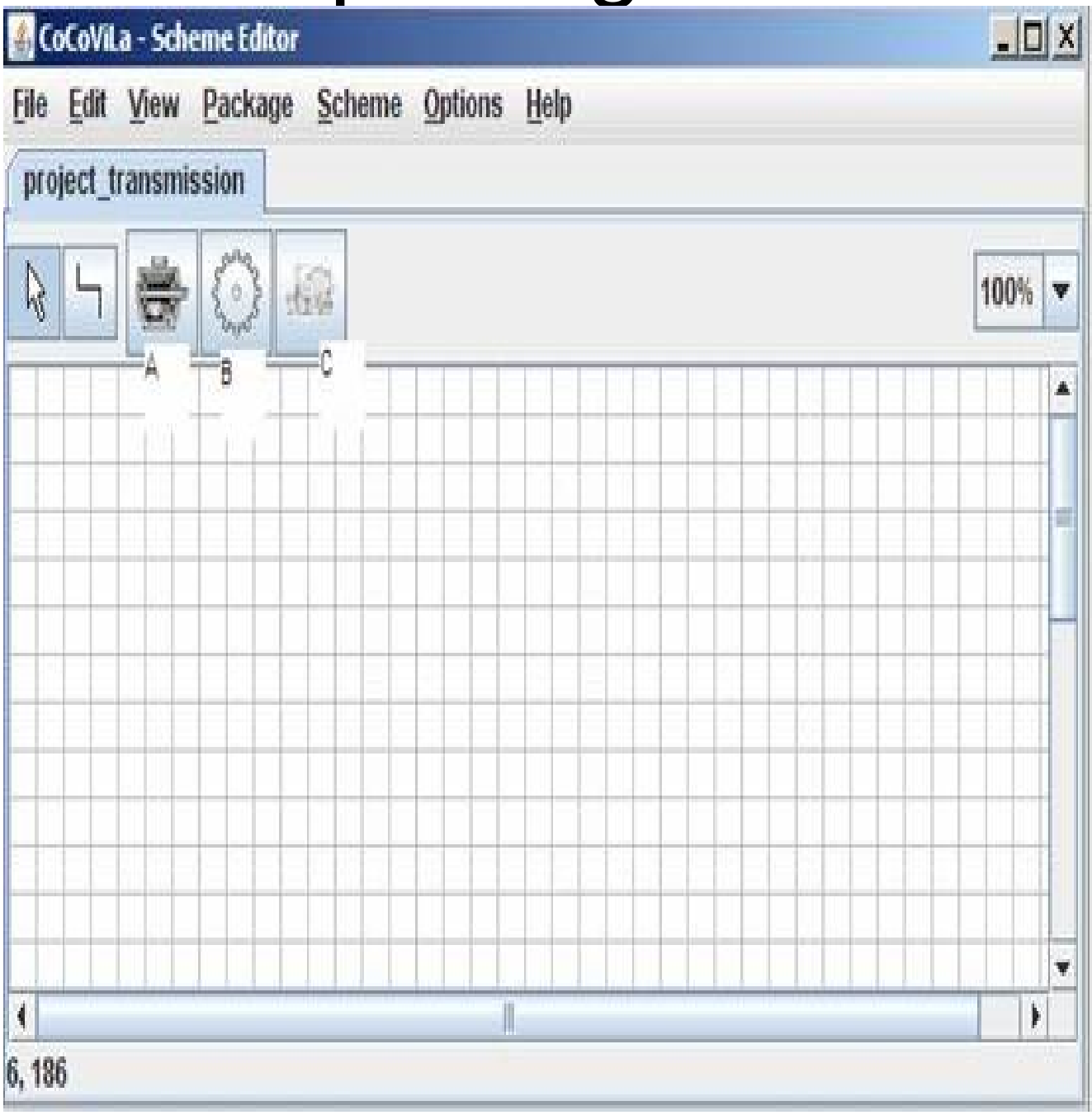
- CoCoViLa on sobiv vahend antud tüüpi ülesannete lahendamiseks.
- Loodud lahendus annab võimaluse mugavalt muuta projekteeritava konveieri parameetreid ja näha tehtud muutuste mõju.
- Antud pakett võib leida reaalset kasutust Tallinna Tehnikakõrgkooli territooriumile rajatava autoparkla projekteerimisel.
- Paketti on võimalik edasi arendada CoCoViLa võimaluste lisandudes.

Conceptual design of gear transmissions in CoCoViLa environment

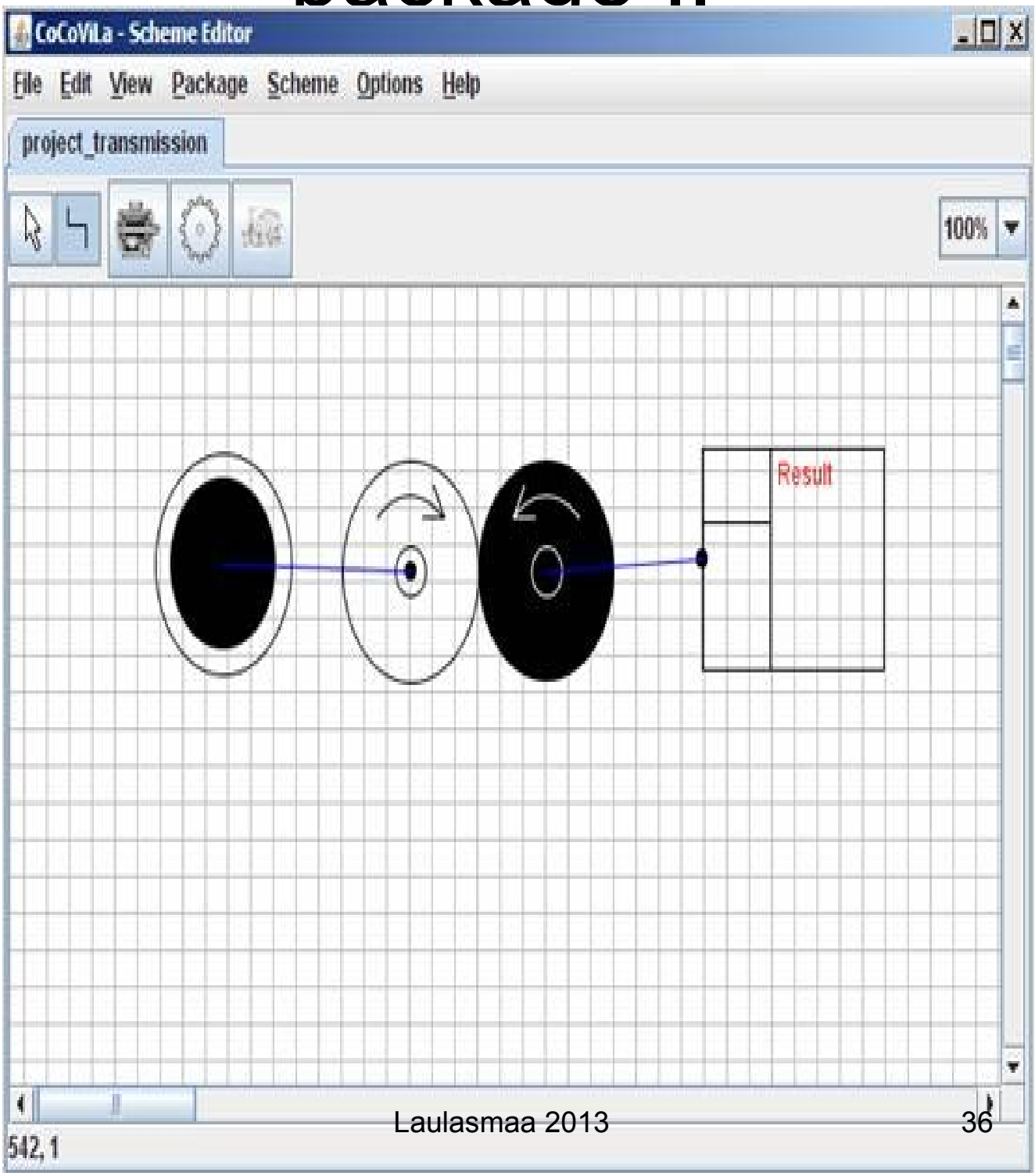
Merje Viil

2008

Introduction to program package I



Introduction to program package II



Introduction to program package III

Tulemus:

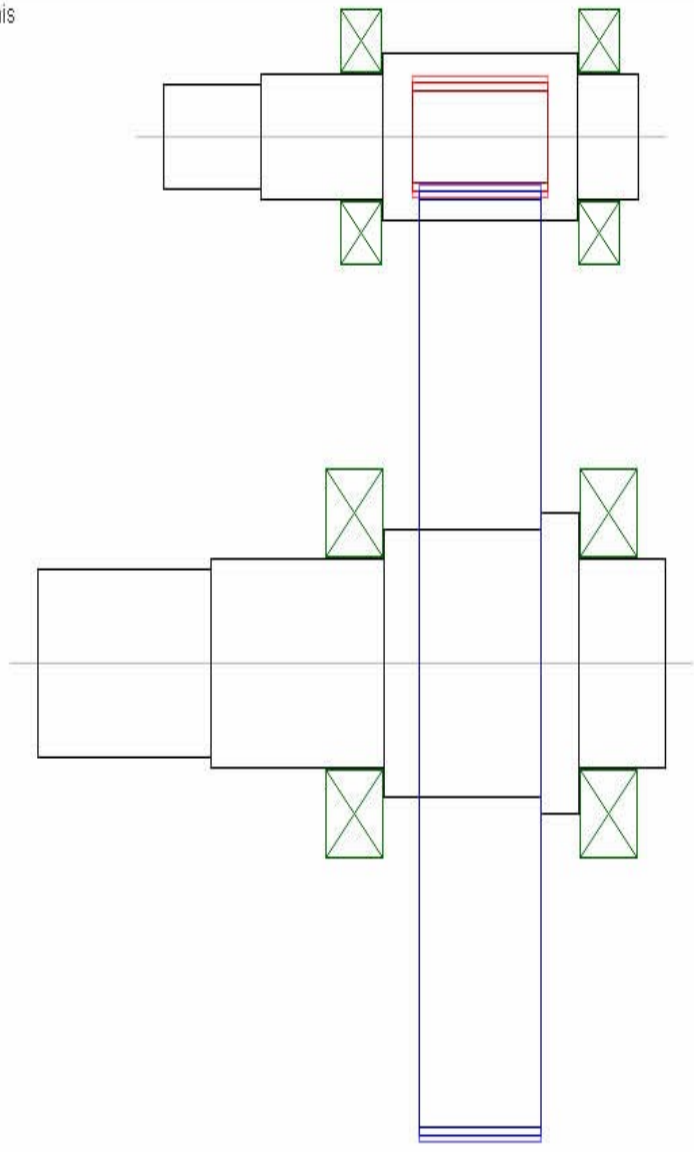
Sisestatud andmed:
Ajamiväljund võimsus P2 = 7.0 Kw
Ajamiväljund pöörded n2 = 250.0 p/min
Süsteemi optimismitegur g = 0.6
Ülekandearv u = 6.0
Terase mark: C45_P

Arvutustulemused:
Leitud mootor:
Mootori tüüp: 4AM132S4 (1455 p/min)
Mootori võimsus P_el = 7.5 Kw
Mootori pöörded n_el = 1455.0 p/min

Võllide parameetrid:
Veetav võll:
d1 = 25.0 mm
l1 = 36.0 mm
d_lg1 = 30.0 mm
l_k1 = 45.0 mm
d_lo = 40.0 mm
l_lo = 72.0 mm
Vedav võll:
d2 = 45.0 mm
l2 = 64.0 mm
d_lg2 = 50.0 mm
l_k2 = 64.0 mm
d_ist = 64.0 mm
l_ist = 72.0 mm
d_krae = 72.0 mm
l_krae = 14.0 mm

Hammasrataste parameetrid:
Veetav hammasratas:
T1 = 47.0 mm
b1 = 50.0 mm
z_1 = 25.0
D1 = 26.0 mm
Da1 = 29.0 mm
Df1 = 22.4 mm
Vedav hammasratas:
T2 = 269.0 mm
b2 = 45.0 mm
z_2 = 150.0
D2 = 226.0 mm
Da2 = 229.0 mm
Df2 = 222.4 mm

Joonis



Kokkuvõte

- Tarkvarasüsteem CoCoViLa on efektiivne vahend mitmesuguste rakenduspakettide koostamiseks
- CoCoViLa keskkonnas töötavad rakenduspaketid võimaldavad arvutusprotsessi tunduvalt kiirendada ja lihtsustada
- Konstruktor võib korduvate arvutuste abil saavutada ülekande optimaalsed parameetrid
- Tänu Java toele on võimalik täpseid ja dünaamilisi graafilisi jooniseid esitada

Tarkvarasüsteem CoCoViLa eelised NUTi ees

- Sõltumatus platvormile tänu Java tehnoloogiale
- Kaasaegne tehnoloogia ja suuremad võimalused
- Graafika esitamise oluliselt paremad võimalused
- CoCoViLa võimaldab lahendada mahukamaid ülesandeid kui NUT
- Küberneetika Instituudi plaan järk-järgult üle minna CoCoViLa'le

Magistritöö tulemused

1. Magistritöös andsin ülevaate tänapäevase masinprojekteerimise olemusest ja tarkvarasüsteemidest NUT ja CoCoViLa

2. Koostasin hammasülekannete projekteerimise tarkvara ja projekteerimispaketi dokumentatsiooni

3. Lahendasin näiteülesandeid ja koostasin kokkuvõtte tööst

Abstract

Model based software engineering (MBSE) has been a research topic a long period in the Institute of Cybernetics at TUT.
At the same time our students have used MBSE environments for software developing in large numbers of master thesis.

Firstly, an overview of PRIZ - family systems is presented.
Secondly, the principles of software development using MBSE environments are given.
Thirdly, a row of developed software package (in ExpertPRIZ, in NUT and in CoCoViLa) is presented.