

KOMPUTEROWE WSPOMAGANIE TECHNOLOGII WYTWARZANIA ODLEWÓW



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- Dane 2D/3D
- Rysunki 2D
- Narzucone metody kontroli jakości
- Specyfikacja warunków odbioru

- Rysunki (geometria numeryczna 3D)
- Obliczenia technologiczne
- Obliczenia ciężaru
- Definicje parametrów użytkowych

- Symulacja procesów:
 - ◆ Wypełniania
 - ◆ Krzepnięcia
 - ◆ Powstawania naprężeń
 - ◆ Obróbki cieplnej
- Obliczenia symulacyjne wytrzymałościowe

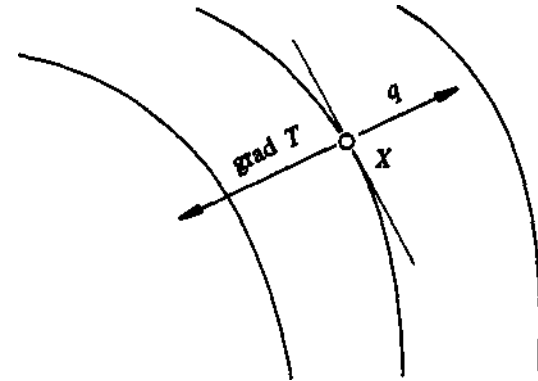
- Wykonanie modeli
- Kontrola wymiarowa i skanowanie
- Obróbka mechaniczna
- Spawanie
- Obróbka wykańczająca

I – interface'y geometrii CAD

Matematyczny opis krzepnięcia i stygnięcia odlewu

Prawo Fouriera

$$q(X, Y, Z, \tau) = -\lambda \text{ grad}T(X, Y, Z, \tau)$$



Równanie Fouriera – Kirchhoffa:

$$c_p \rho \frac{\partial T}{\partial \tau} = \text{div}(\lambda \cdot \text{grad}T) + q_v, \frac{W}{m^3}$$

$$q_v = L \frac{\partial f_s}{\partial \tau}$$

c_p - ciepło właściwe; $\frac{J}{kg \cdot K}$ λ - współczynnik przewodzenia ciepła; $\frac{W}{m \cdot K}$

ρ - gęstość; $\frac{kg}{m^3}$ L - utajone ciepło krystalizacji; $\frac{J}{m^3}$

Model makro

$$\text{dla } \frac{\partial f_s}{\partial \tau} = \frac{df_s}{dT} \cdot \frac{\partial T}{\partial \tau} \quad \longrightarrow \quad c_p \rho \frac{\partial T}{\partial \tau} = \text{div}(\lambda \cdot \text{grad}T) + L \frac{df_s}{dT} \frac{\partial T}{\partial \tau}$$

$c_v = c_p \rho$

$$\left(c_v - L \frac{df_s}{dT} \right) \frac{\partial T}{\partial \tau} = \text{div}(\lambda \cdot \text{grad}T)$$

$$f_s(T) = \frac{T_L - T}{T_L - T_s}$$



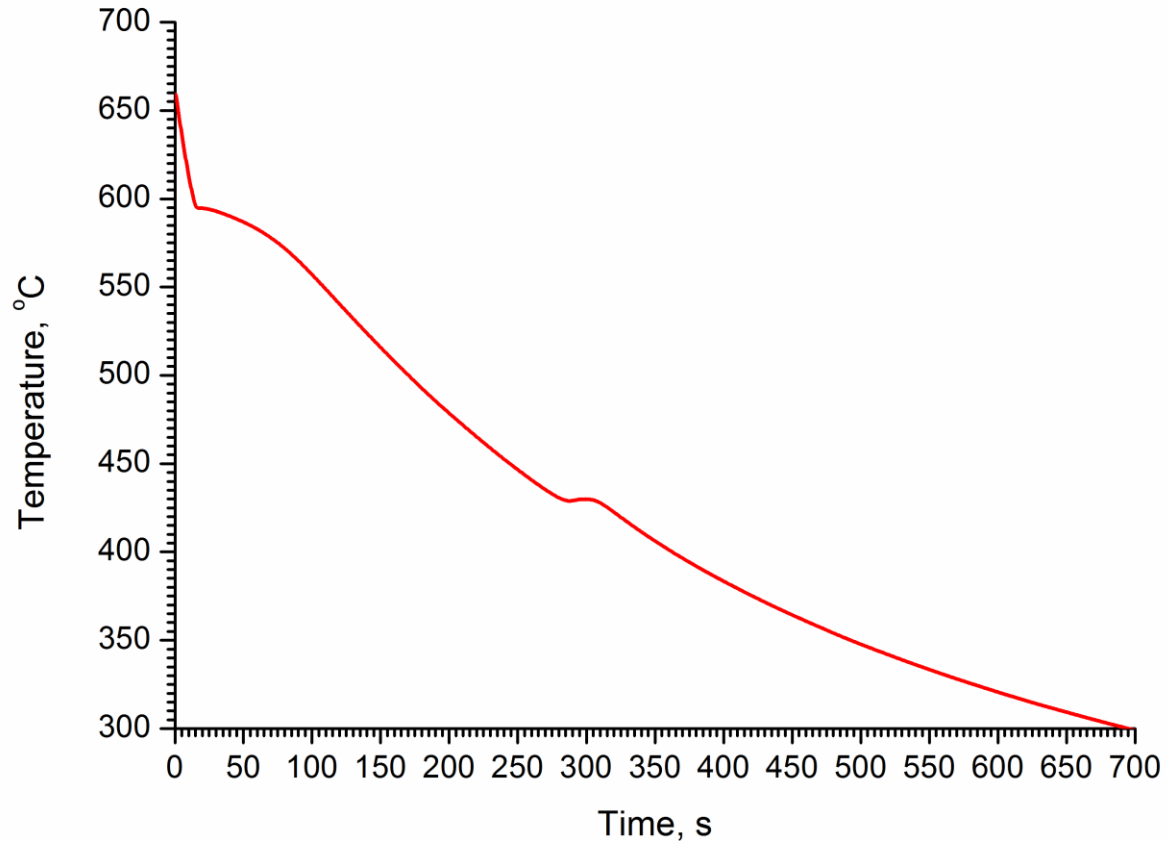
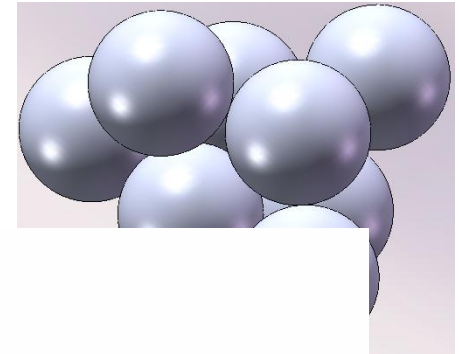
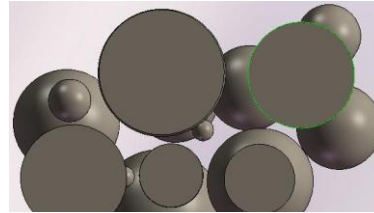
$$\frac{df_s}{dT} = \frac{-1}{T_L - T_s}$$

$$\left(c_v + L \frac{1}{T_L - T_s} \right) \frac{\partial T}{\partial \tau} = \text{div}(\lambda \cdot \text{grad}T)$$

Model mikro – ciepło krystalizacji zależy od szybkości zarodkowania i szybkości wzrostu fazy stałej

$$f_s(T, \Delta T, N_V \dots)$$

$$f_s = \sum_{i=1}^{n+1} \frac{4}{3} \pi R_i^3 N v_i$$



$$\frac{\partial f_s}{\partial \tau} = \sum_{i=1}^n 4 \lambda$$

λ

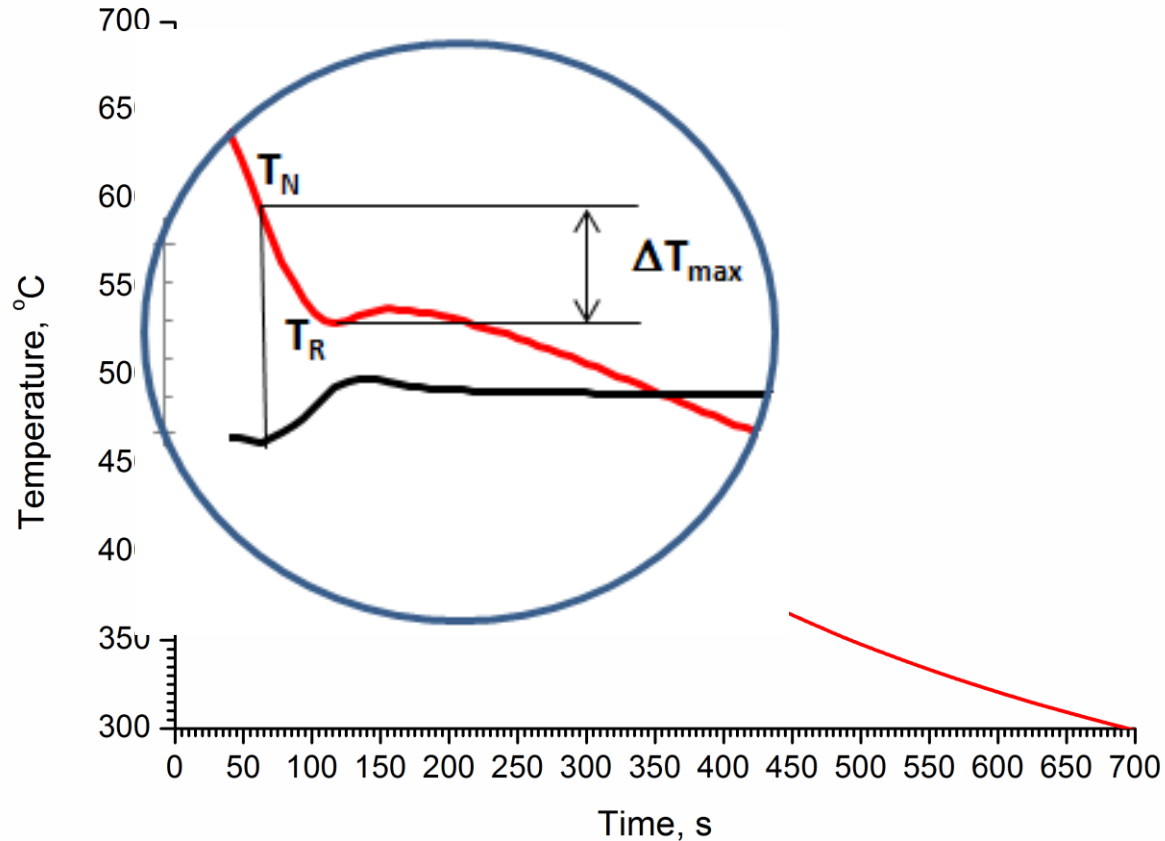
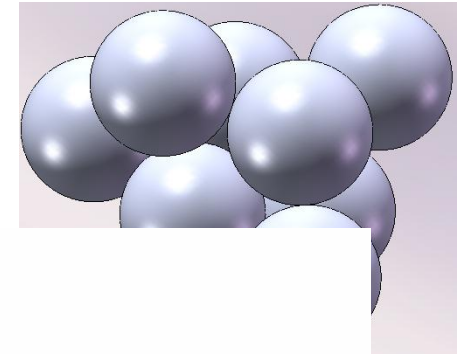
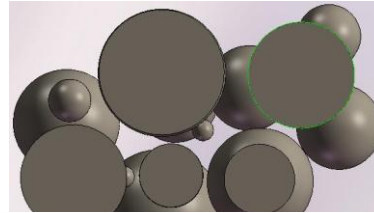
$$\Delta T = \Delta T$$



Model mikro – ciepło krystalizacji zależy od szybkości zarodkowania i szybkości wzrostu fazy stałej

$$f_s(T, \Delta T, N_V \dots)$$

$$f_s = \sum_{i=1}^{n+1} \frac{4}{3} \pi R_i^3 N v_i$$




$$\frac{\partial f_s}{\partial \tau} = \sum_{i=1}^n 4 \lambda_i$$

λ

$$\Delta T = \Delta T$$

Warunki jednoznaczności

$$c_p \rho \frac{\partial T}{\partial \tau} = \text{div}(\lambda \cdot \text{grad} T) + q_V$$

1. Warunki geometryczne.
2. Warunki fizyczne. 
3. Warunki początkowe.
4. Warunki brzegowe.

$$c_p \rho \frac{\partial T}{\partial \tau} = \lambda \nabla^2 T + q_V$$

a) warunek brzegowy I rodzaju,

$$T(X, t) = T_1(X, t)$$

b) warunek brzegowy II rodzaju,

$$-\lambda \circ \text{grad} T(X, t) = q_n(X, t)$$

c) warunek brzegowy III rodzaju,

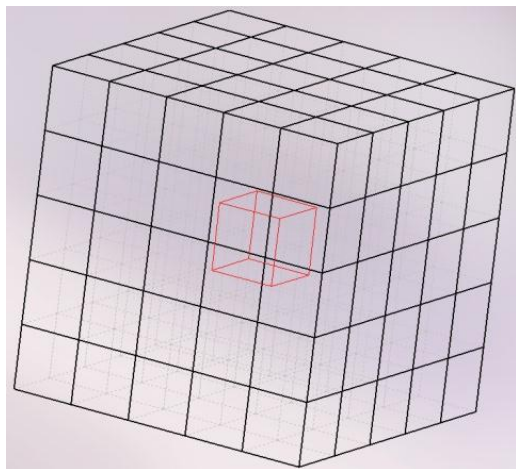
$$q = \alpha(T - T^\infty)$$

d) warunek brzegowy IV rodzaju.

$$-\lambda_1 \circ \text{grad} T_1(X, t) = -\lambda_2 \circ \text{grad} T_2(X, t)$$

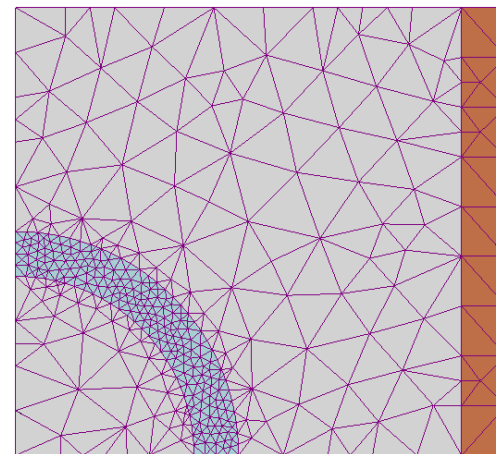
Metody dyskretyzacji obszaru

MRS

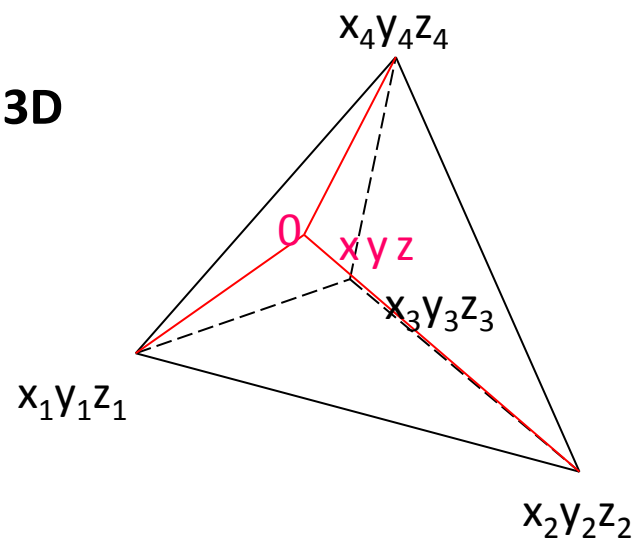


MES

2D



3D



Pochodna względem czasu – schemat Eulera

Definicja pochodnej:

$$F(\tau) \approx \frac{T^{n+1} - T^n}{\Delta\tau}$$

Wzór Taylora:

$$T(\tau + \Delta\tau) = T(\tau) + \Delta\tau \frac{dT(\tau)}{d\tau} + \frac{(\Delta\tau)^2}{2} \frac{d^2T(\tau)}{d\tau^2} + \frac{(\Delta\tau)^3}{6} \frac{d^3T(\tau)}{d\tau^3} + o(\Delta\tau^4)$$

Jawny schemat Eulera

oznaczmy

$$T(\tau + \Delta\tau) = T^{n+1} \approx T^n + \Delta\tau \frac{dT(\tau)}{d\tau}$$

$$\frac{dT(\tau)}{d\tau} = F(\tau)$$

$$T^{n+1} = T^n + \Delta\tau \cdot F(\tau)$$

Pochodna przestrzenna

$$\frac{dT(\mathbf{x}, \tau)}{d\tau} = a \frac{\partial^2 T(\mathbf{x}, \tau)}{\partial x^2}$$

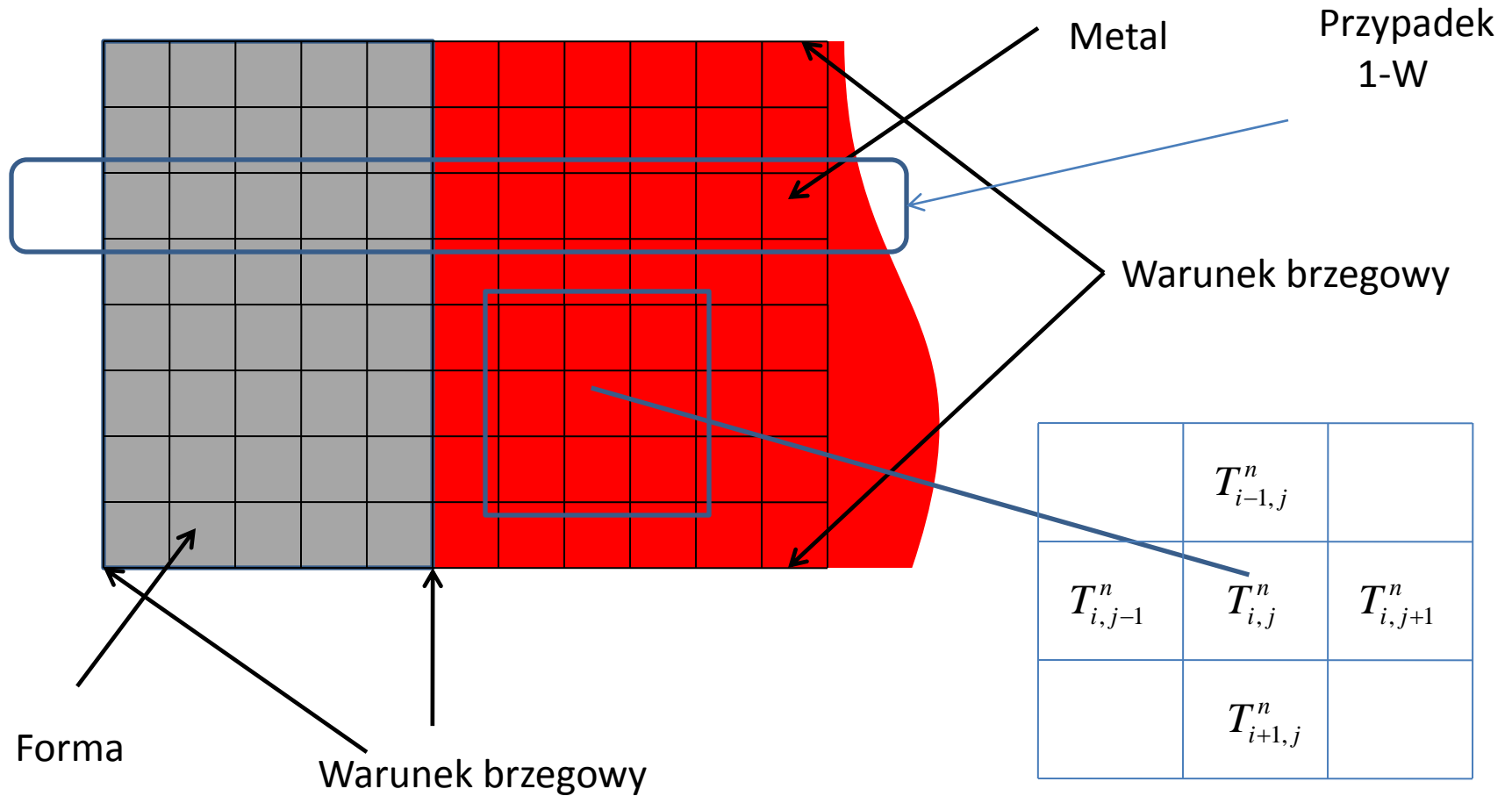
$$\begin{cases} T(x + \Delta x) = T(x) + \Delta x \frac{dT(x)}{dx} + \frac{(\Delta x)^2}{2} \frac{d^2T(x)}{dx^2} + o((\Delta x)^3) \\ T(x - \Delta x) = T(x) - \Delta x \frac{dT(x)}{dx} + \frac{(\Delta x)^2}{2} \frac{d^2T(x)}{dx^2} + o((\Delta x)^3) \end{cases}$$

$$T(x + \Delta x) + T(x - \Delta x) = 2 \cdot T(x) + (\Delta x)^2 \frac{d^2T(x)}{dx^2} + o((\Delta x)^3)$$

Metoda Różnic Skończonych (Finite Difference Method)

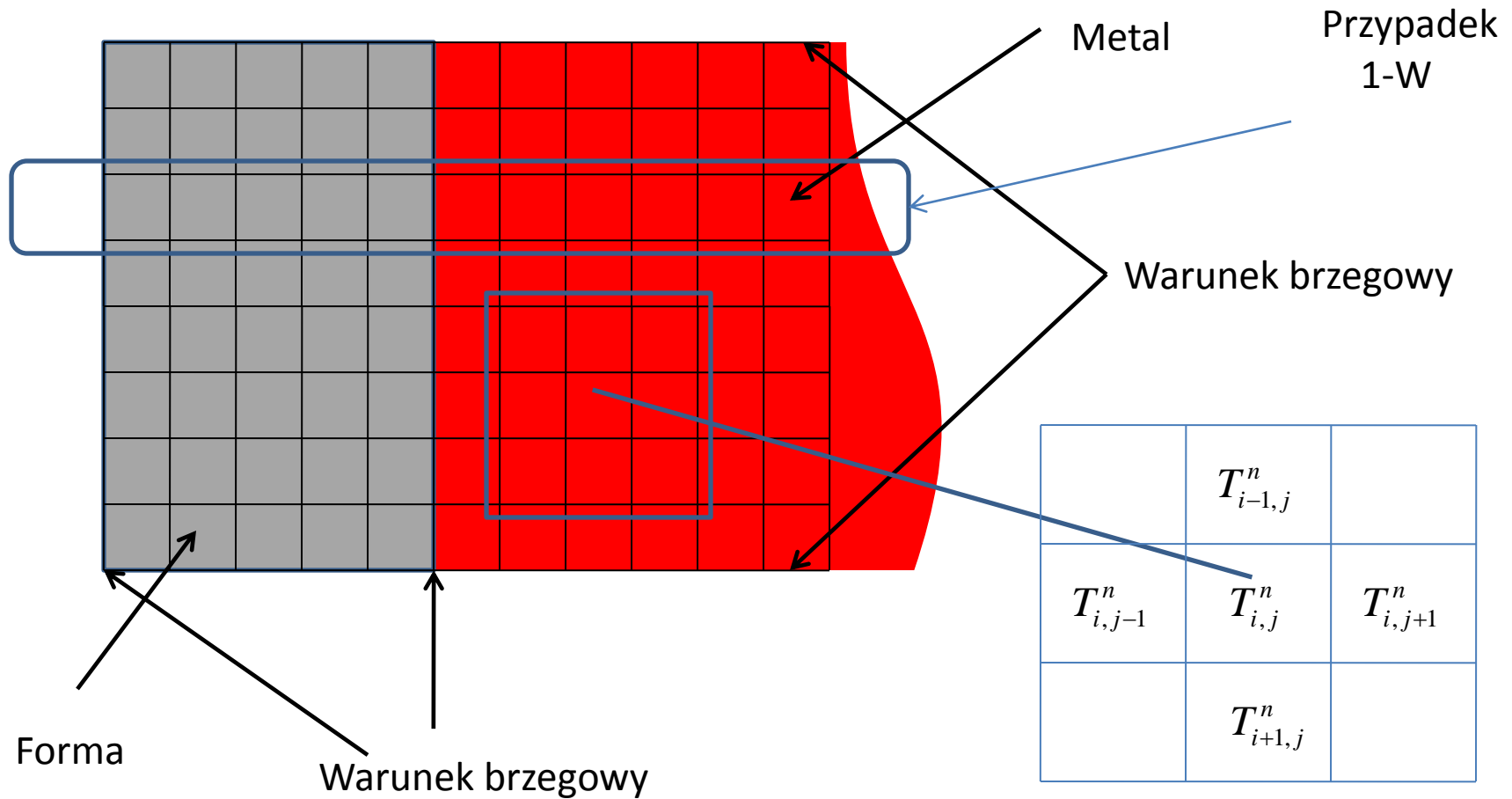
$$\frac{d^2T(x)}{dx^2} \approx \frac{T(x + \Delta x) - 2 \cdot T(x) + T(x - \Delta x)}{(\Delta x)^2}$$

Pochodna przestrzenna – siatka różnicowa



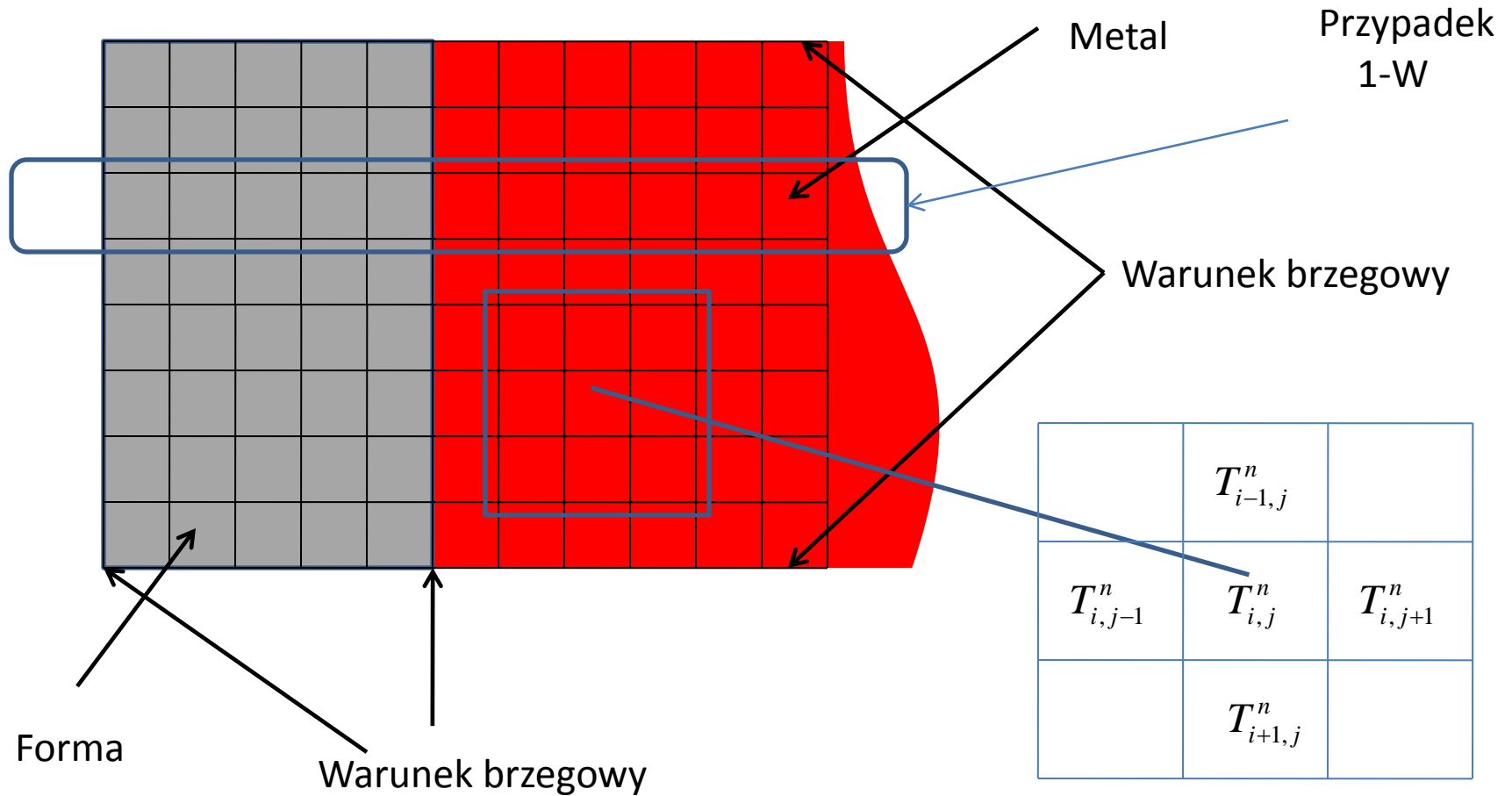
$$\frac{d^2 T(x, y)}{dx^2} \approx \frac{T_{i-1} - 2 \cdot T_i + T_{i+1}}{(h)^2}$$

Pochodna przestrzenna – siatka różnicowa



$$\frac{d^2T(x, y)}{dx^2} + \frac{d^2T(x, y)}{dy^2} \approx \frac{T_{i,j-1} + T_{i-1,j} - 4 \cdot T_{i,j} + T_{i+1,j} + T_{i,j+1}}{(h)^2}$$

Pochodna przestrzenna – siatka różnicowa



$$\frac{d^2T(x, y, z)}{dx^2} + \frac{d^2T(x, y, z)}{dy^2} + \frac{d^2T(x, y, z)}{dz^2} \approx \frac{T_{i,j-1,k} + T_{i-1,j,k} + T_{i,j,k-1} - 6 \cdot T_{i,j,k} + T_{i+1,j} + T_{i,j+1} + T_{i,j,k+1}}{(h)^2}$$

Metoda różnic skończonych

$$\frac{dT(\mathbf{x}, \tau)}{d\tau} = a \frac{\partial^2 T(\mathbf{x}, \tau)}{\partial x^2}$$

$$\frac{dT}{d\tau} \approx \frac{T^{n+1}(x) - T^n(x)}{\Delta\tau}$$

$$\frac{d^2T(x)}{dx^2} \approx \frac{T^n(x + \Delta x) - 2 \cdot T^n(x) + T^n(x - \Delta x)}{(\Delta x)^2}$$

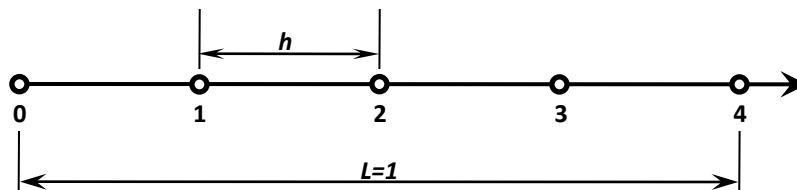


$$\tilde{T}^{n+1} \Big|_{x=x_i} \approx \tilde{T}^n \Big|_{x=x_i} + a \left(T^n \Big|_{x=x_i} \right) \frac{\Delta\tau}{\Delta x^2} \left(T^n \Big|_{x=x_i+\Delta x} - 2T^n \Big|_{x=x_i} + T^n \Big|_{x=x_i-\Delta x} \right)$$

$$\Delta\tau = \tau_{k+1} - \tau_k$$

Zadanie

Znaleźć przybliżone rozwiązanie równania $d^2T/dx^2+100=0$ z warunkami: $T(0)=0$ oraz $T(L)=0$, metodą różnic skończonych dla płyty.



$$(T_0 - 2T_1 + T_2)/h^2 + 100 = 0$$

$$T_0 = 0$$

$$T_0 - 2T_1 + T_2 = -6,25$$

$$T_1 - 2T_2 + T_3 = -6,25$$

$$T_2 - 2T_3 + T_4 = -6,25$$

$$T_4 = 0$$

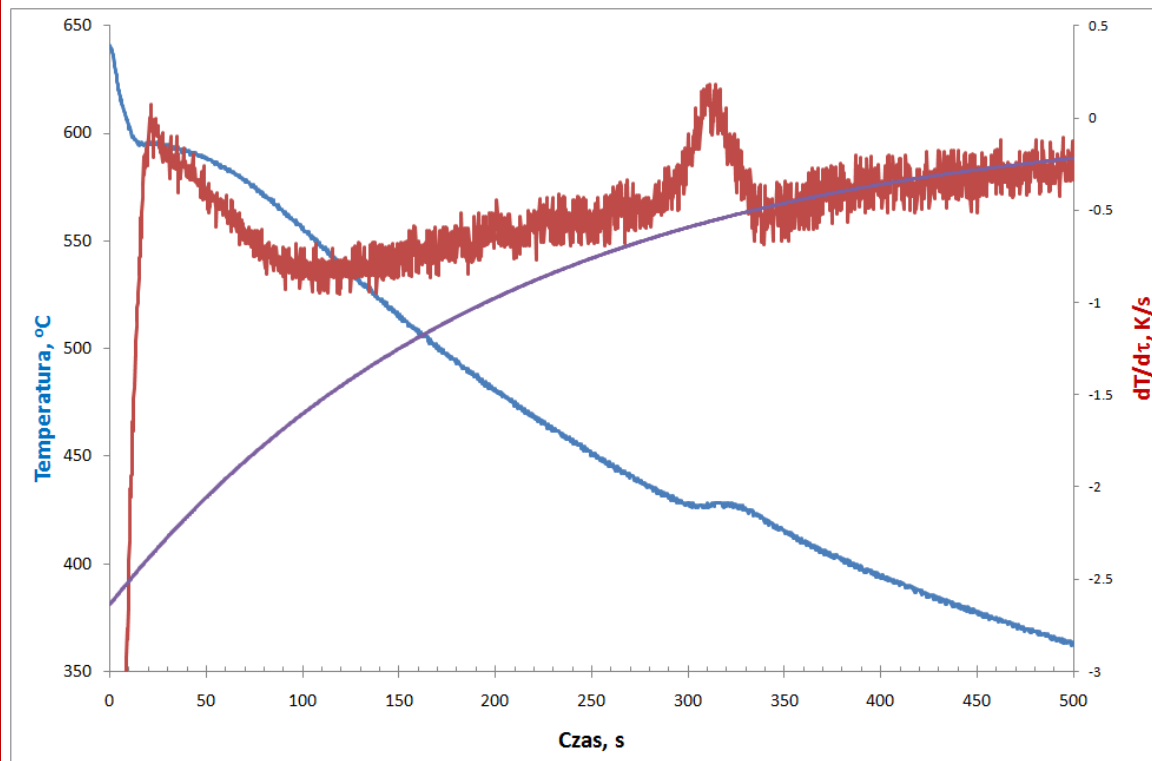
$$T_0 = T_4 = 0, T_1 = T_3 = 9,375, T_2 = 12,5$$

Pochodna przestrzenna

Którą metodę wybrać ?

Oprócz przywołanych MRS i MES istnieje jeszcze kilka metod przybliżania pochodnej przestrzennej. Odpowiedź na postawione w temacie pytanie jest zatem bardzo trudna.

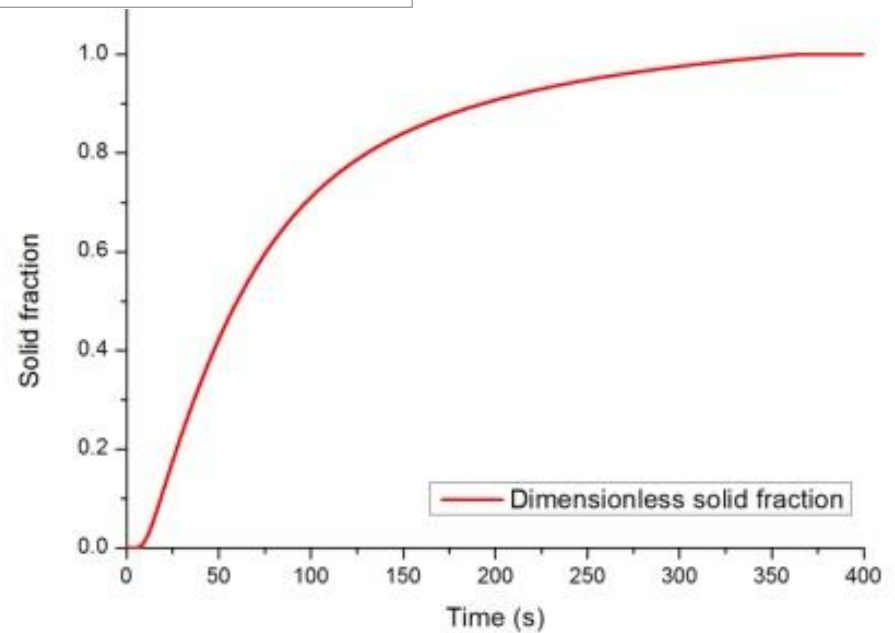
MRS		MES	
Zalety	Wady	Zalety	Wady
<ul style="list-style-type: none"> - prosty algorytm - siatkę można wygenerować bardzo szybko - wiele wad można usunąć po prostu przez zagęszczenie siatki 	<ul style="list-style-type: none"> - stosunkowo niska dokładność obliczeń - kubiczna siatka słabo odwzorowuje owalne kształty - zagęszczanie siatki powoduje znaczne wydłużenie czasu obliczeń 	<ul style="list-style-type: none"> - dowolne elementy pozwalają dokładnie odwzorować owale - duża dokładność obliczeń - obliczenia trwają krócej, ze względu na mniejszą ilość elementów siatki 	<ul style="list-style-type: none"> - bardzo skomplikowany algorytm - ciężko jest dopasować siatkę – automatyczne generatory wymagają poprawy



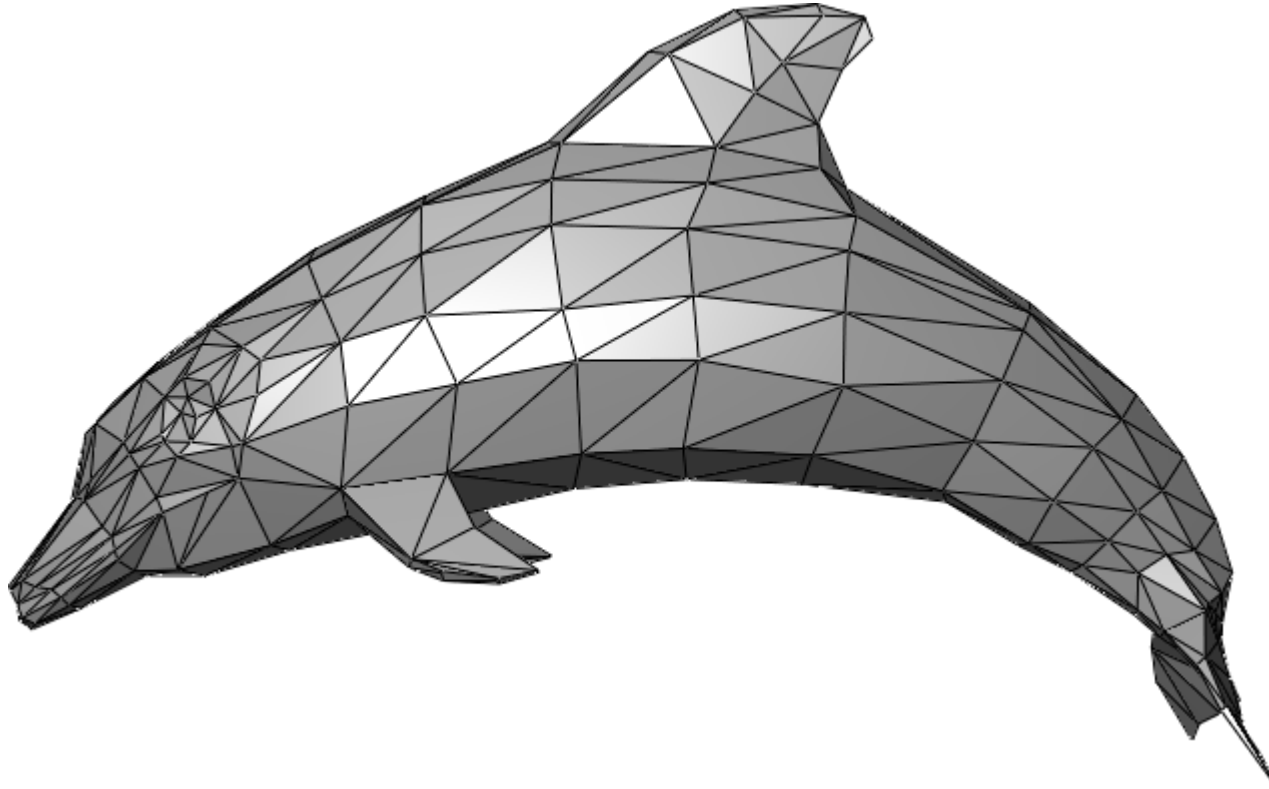
$$V \cdot c \cdot \rho \cdot \frac{dT}{d\tau} = -\alpha \cdot (T - T_{ot}) \cdot F$$

$$\frac{dT}{d\tau} = -\frac{\alpha}{M \cdot c \cdot \rho} \cdot (T_0 - T_{ot}) \cdot \exp\left(-\frac{\alpha}{M \cdot c \cdot \rho} \cdot \tau\right)$$

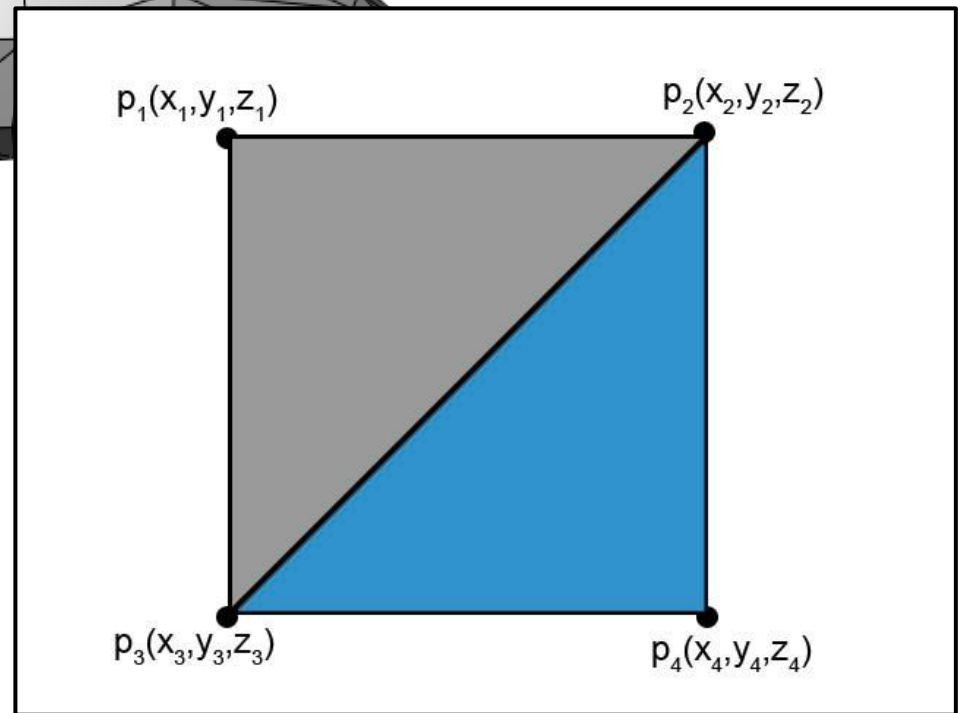
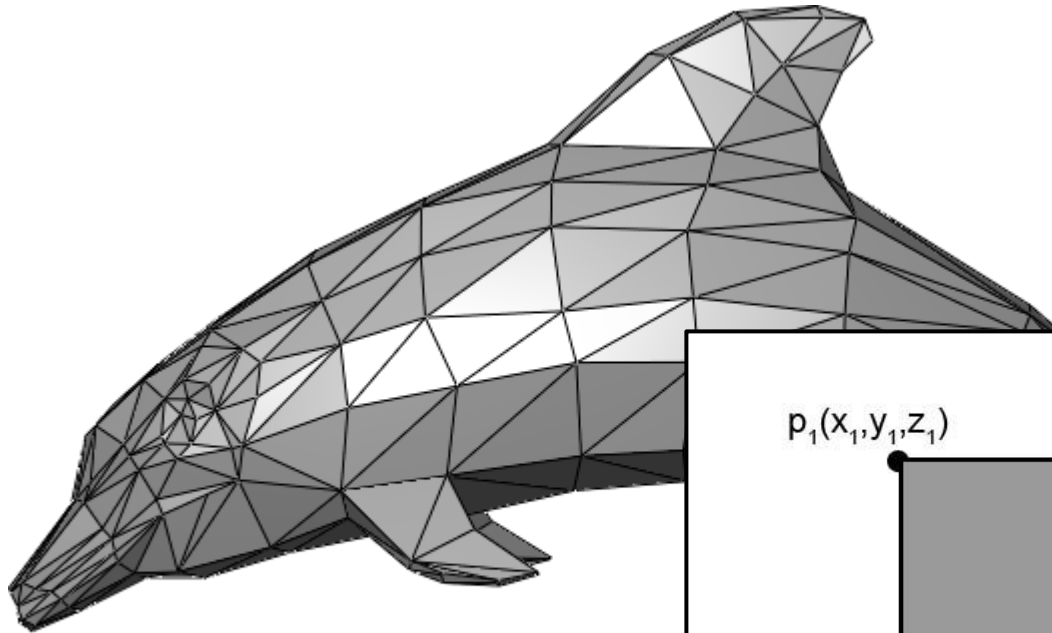
$$Z_0 = A \cdot \exp(B \cdot \tau)$$



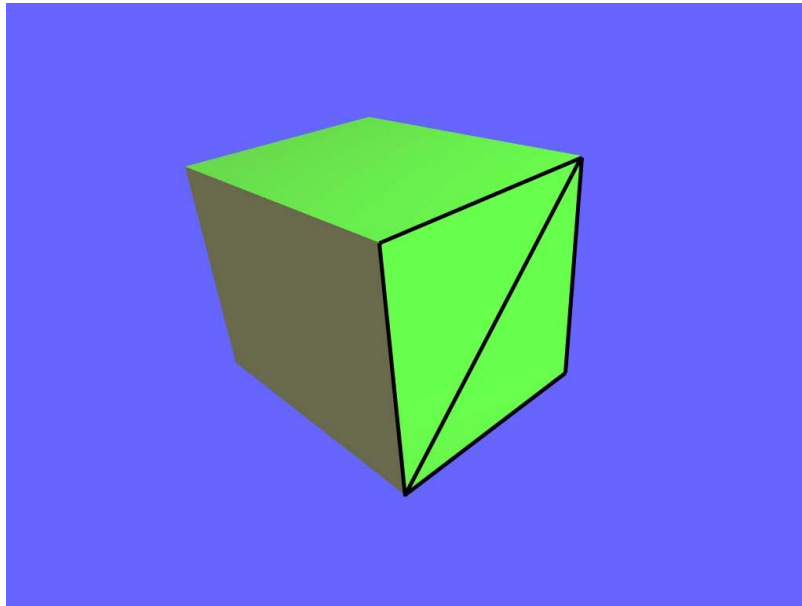
Reprezentacja wirtualnych brył przy pomocy trójkątów



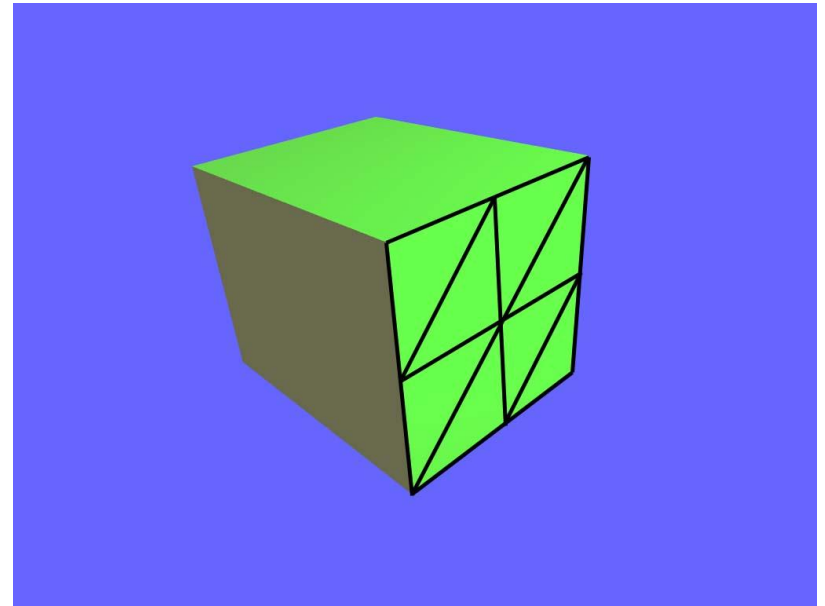
Reprezentacja wirtualnych brył przy pomocy trójkątów



Różne sposoby reprezentacji tego samego obiektu

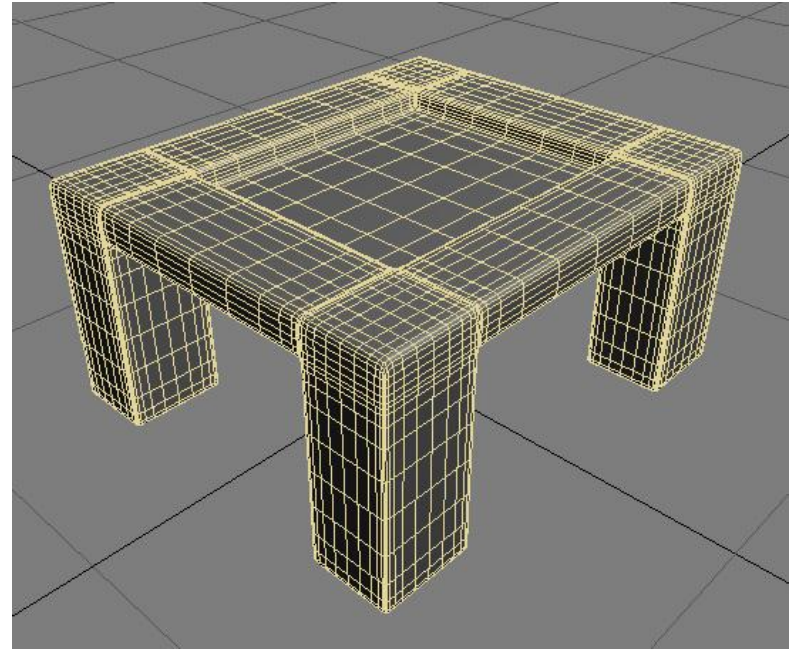
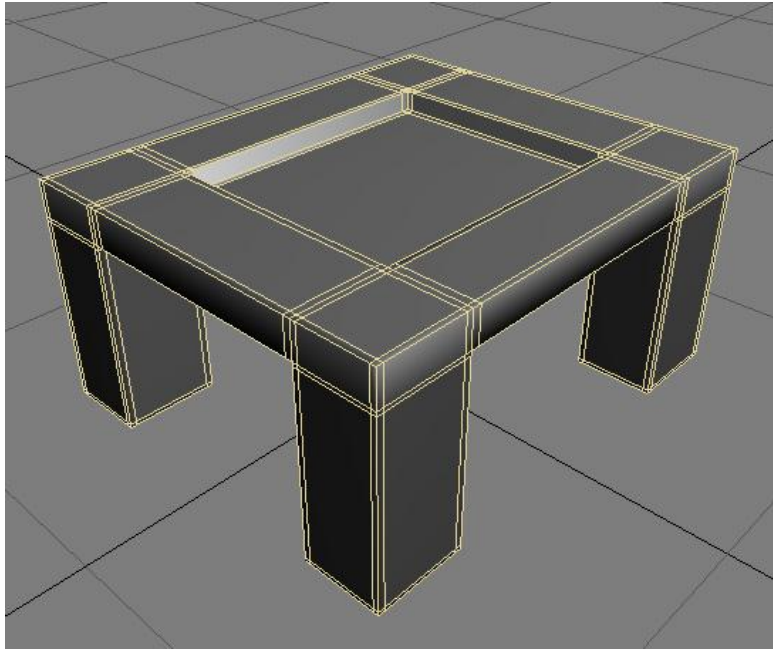


a) 12 trójkątów



a) 48 trójkątów

Różne sposoby reprezentacji tego samego obiektu c.d.



Plik *.STL

Format STL (“StereoLithography”) to jeden z najpopularniejszych formatów plików służących do przechowywania wirtualnych brył 3D.

W pliku przechowywane są współrzędne wierzchołków poszczególnych trójkątów stanowiących elementy budulcowe bryły.

Pliki STL występują w dwóch odmianach:

- **tekstowej**
- **binarnej**

Budowa tekstowego pliku *.STL

solid *name*

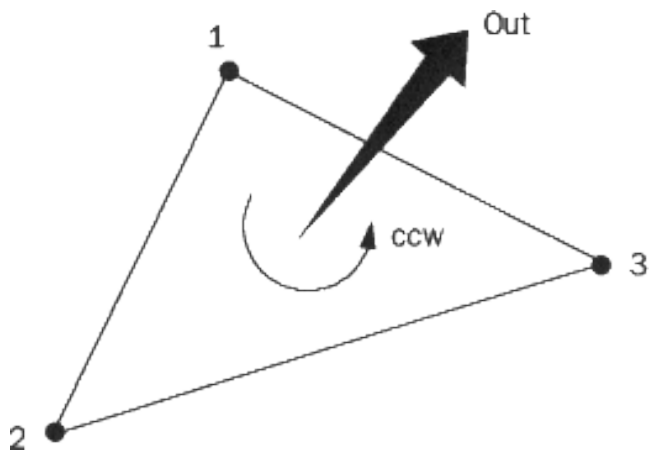
facet normal n_i n_j n_k
outer loop
vertex $v1_x$ $v1_y$ $v1_z$
vertex $v2_x$ $v2_y$ $v2_z$
vertex $v3_x$ $v3_y$ $v3_z$
endloop
endfacet

endsolid *name*

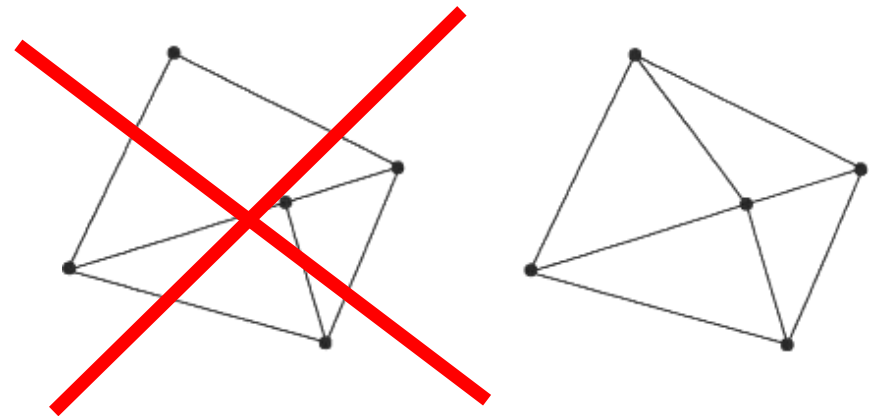
Budowa binarnego pliku *.STL

Bytes	Data type	Description
80	ASCII	Header. No data significance.
4	unsigned long integer	Number of facets in file
4	float	i for normal
4	float	j
4	float	k
4	float	x for vertex 1
4	float	y
4	float	z
4	float	x for vertex 2
4	float	y
4	float	z
4	float	x for vertex 3
4	float	y
4	float	z
2	unsigned integer	Attribute byte count

Definiowanie wierzchołków trójkątów



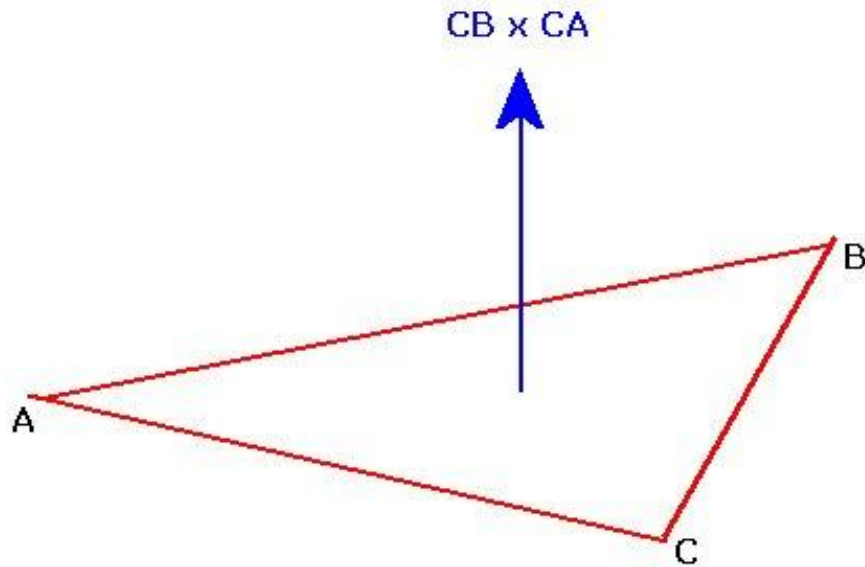
Kolejność wierzchołków



Zasada Vertex-to-vertex

Wektor normalny

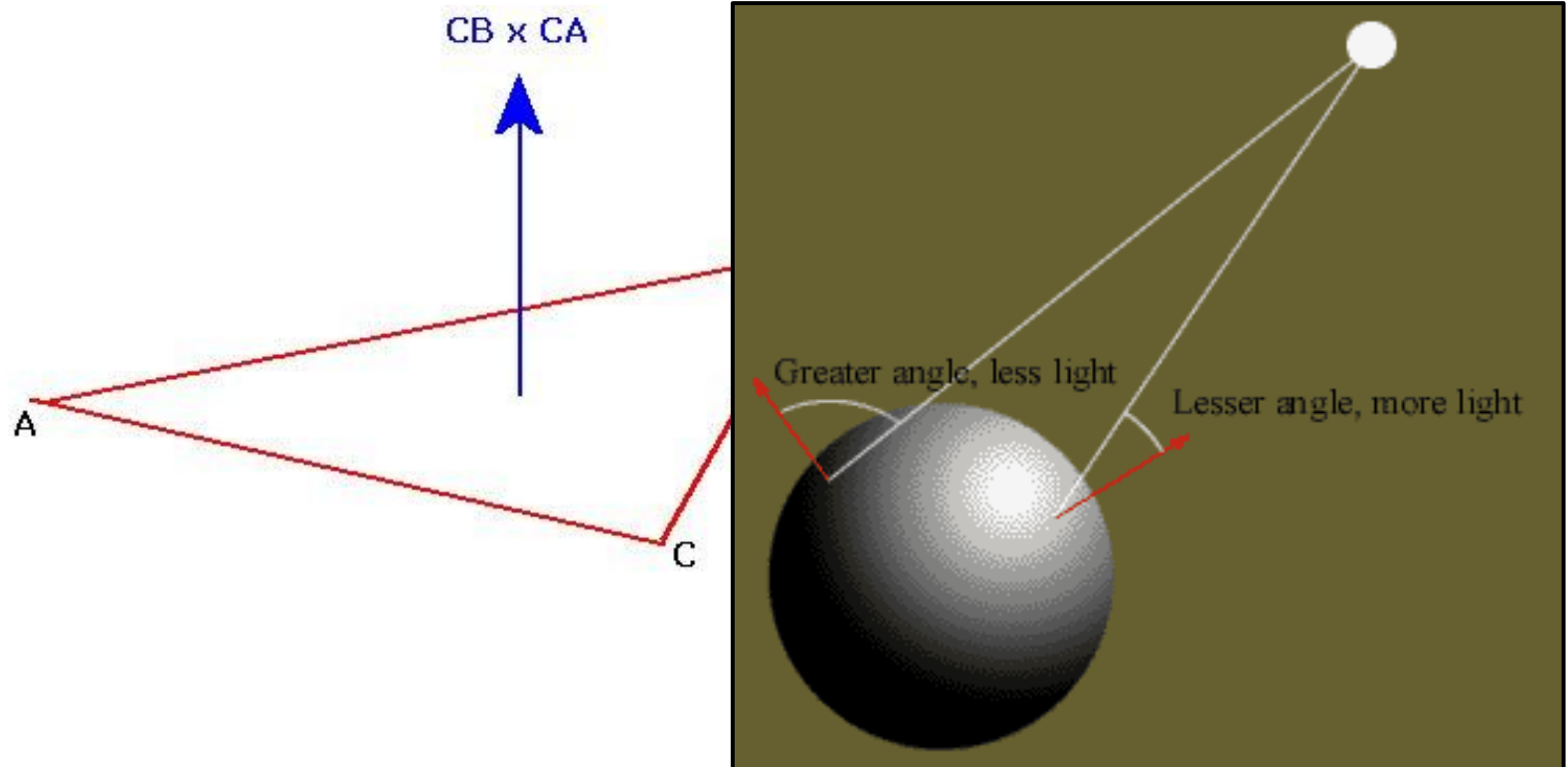
Wektor normalny – jednostkowy wektor prostopadły do powierzchni trójkąta skierowany od środka bryły na zewnątrz



Sposób obliczenia oświetlenia dla wirtualnych obiektów 3D

Wektor normalny

Wektor normalny – jednostkowy wektor prostopadły do powierzchni trójkąta skierowany od środka bryły na zewnątrz



Sposób obliczenia oświetlenia dla wirtualnych obiektów 3D

Wygładzanie (Smooth Shading)

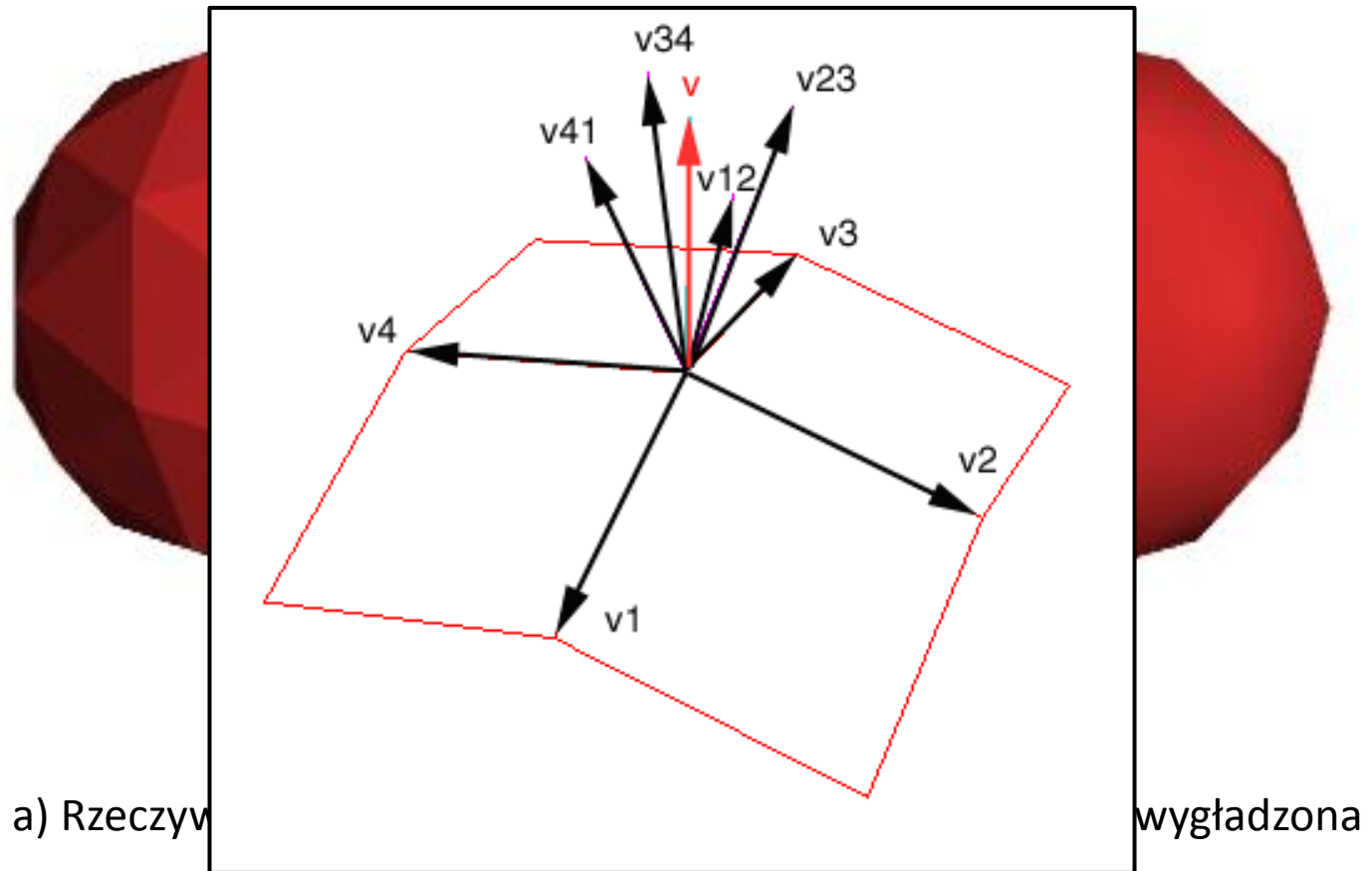


a) Rzeczywista siatka bryły



b) Siatka „sztucznie” wygładzona

Wygładzanie (Smooth Shading)



Obliczenie uśrednionego wektora normalnego dla
każdego z wierzchołków bryły

MAGMASOFT

project	preprocessor	enmeshment	simulation	postprocessor	database	info	help
---------	--------------	------------	------------	---------------	----------	------	------

```
$Connection MAGMASOFT/MAGMAprj closed ...  
$Open connection to `MAGMApre` ...  
$Initialize MAGMASOFT/MAGMATng_post ...
```



MAGMASOFT

project	preprocessor	enmeshment	simulation	postprocessor	database	info	help
---------	--------------	------------	------------	---------------	----------	------	------

open project
create project
create version

delete results
delete version / project
rename project

project info

1: GT13_CASING_Lower_Part / version_04
2: trojnik_zabrze_1 / version_01
3: trojnik_zabrze_1 / version_10
4: trojnik_zabrze_1 / version_09
5: trojnik_zabrze_1 / version_08

exit MAGMASOFT

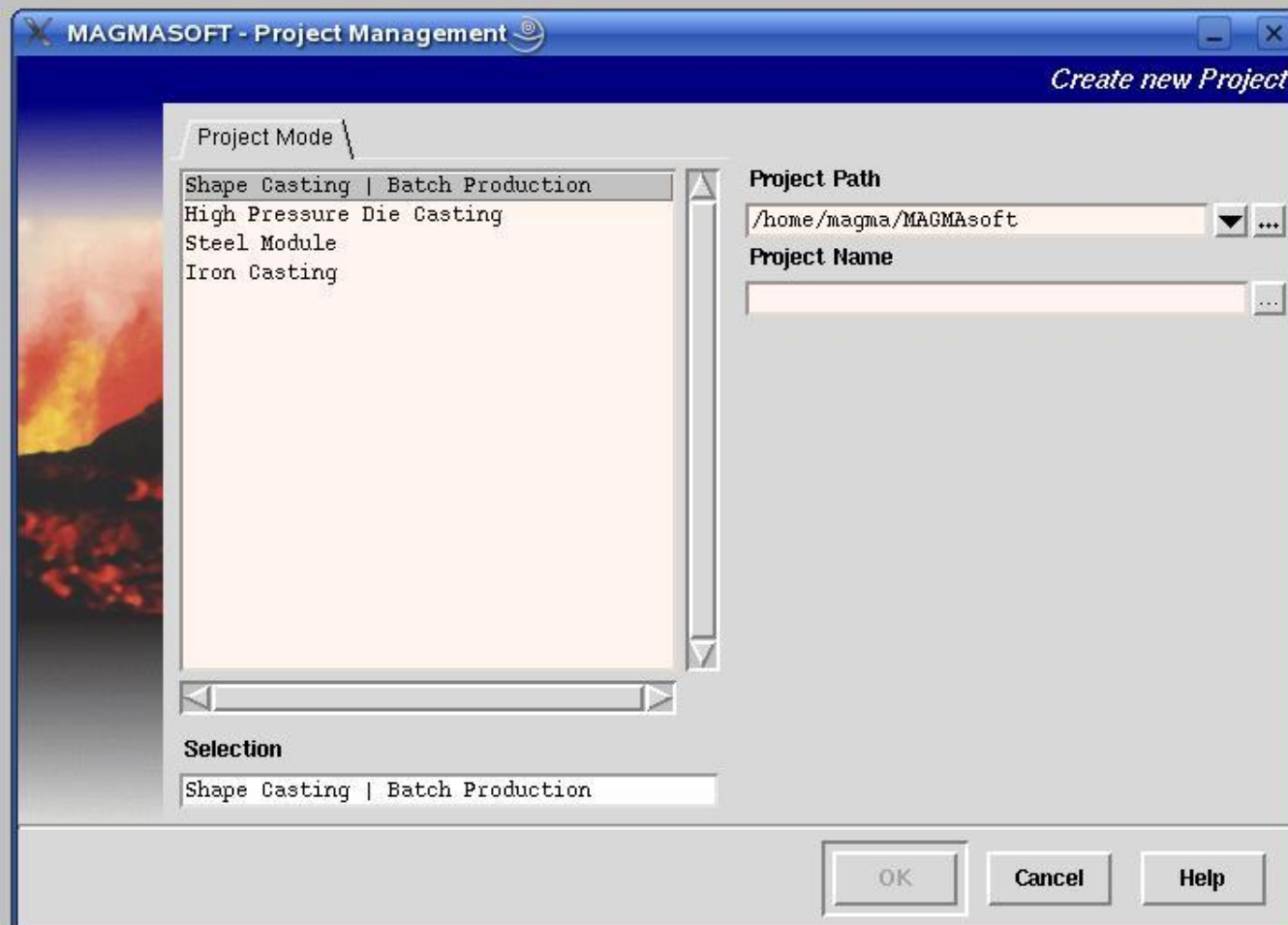
```
$Connection MAGMASOFT/MAGMAprj closed ...  
$Open connection to `MAGMApre` ...  
$Initialize MAGMASOFT/MAGMATng_post ...
```



MAGMASOFT

project | preprocessor | enmeshment | simulation | postprocessor | database | info

help

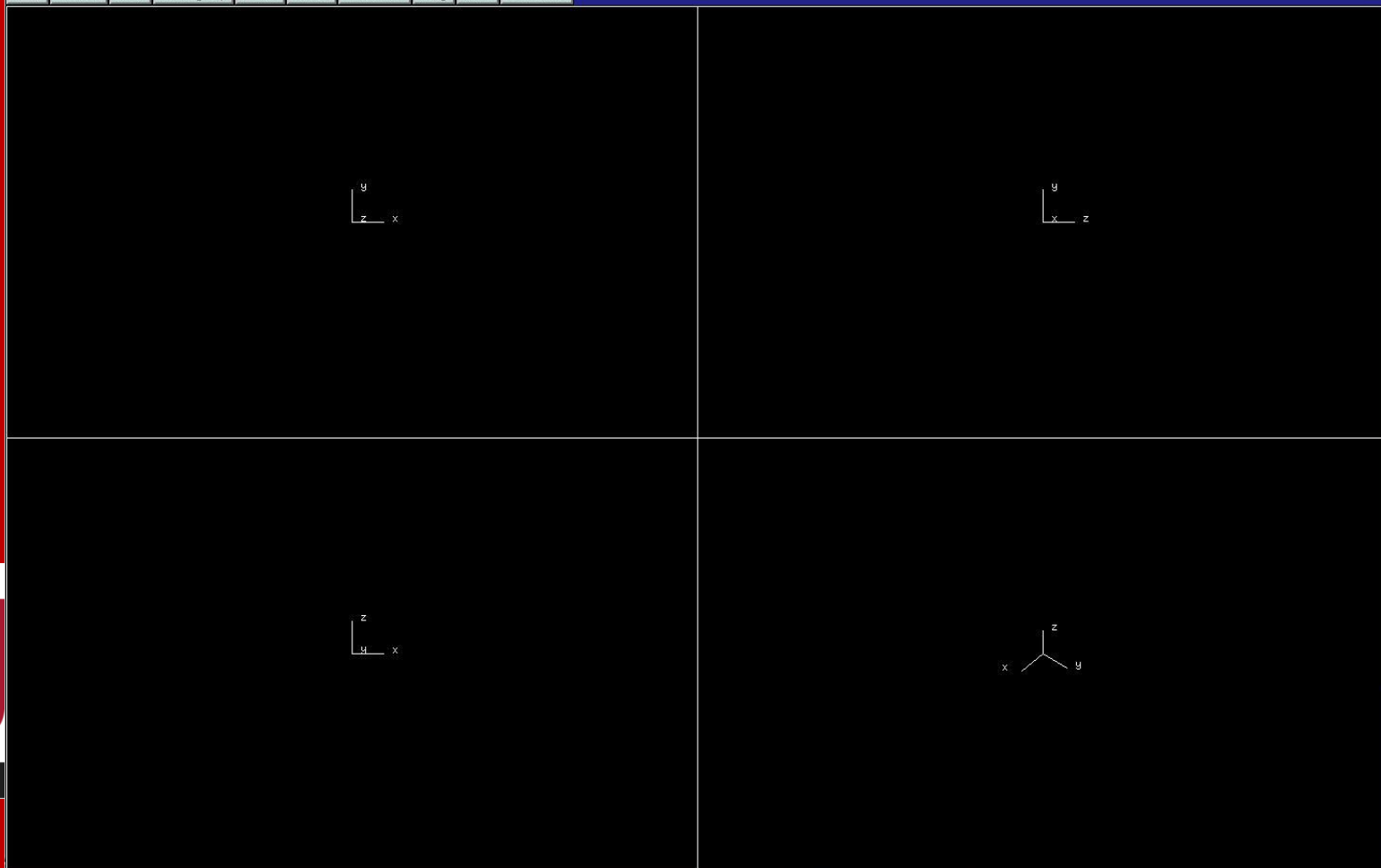


```
-- GEO v1.4.0 [( 13/11/07/16/14/22 )] --  
-- OLDGEO v1.1 [( 13/11/07/16/14/36 )] --  
-- DB v2.5.0 [( 13/11/07/16/12/49 )] --  
-- DATA v1.11 [( 14/02/08/21/24/33 )] --
```

MAGMASOFT

project preprocessor enmeshment simulation postprocessor database info help

File Select Edit Redisplay Reset Color Material Help Info Database



Navigation and tool icons: Undo Point, Zoom, Material, Views, Uni + Gri, Ctrl Point, Ang + Acc, Edit, Sweep, Revol, Special, Steel, MAT GR +, MAT ID +, CHANGE MAT, CAST, CORE, SANDM, INSU, CHILL, PERMM, COOL, USER 1, USER 2, INLET, NECK, FEEDER, BOUND, CUTBOX, FILTER, GATING, INGATE, PBASIN, MALLOW.

View: 3 MM
 X: 395.950
 Y: -447.537
 Z: -15.644
 Material: 1 / 1
 Sheet: 0
 Angle: 360.000
 Accuracy: 16
 Zoom: OUT
 H1 mode: OFF
 Solids: 0
 MagmaKIP0: magna

preprocessor (v.4.2) waiting for input ...

```
$open connection to magma.ple ...
$Initialize MAGMASOFT/MAGMATng_post ...
```



MAGMASOFT

project | preprocessor | enmeshment | simulation | postprocessor | database | info | help

MAGMASOFT <2>

mesh generation

mesh generation

- method
- accuracy
- wall thickness
- element size
- options
- core generation
- mesh for solver 5

accuracy (standard)

x-direction : 3

y-direction : 3

z-direction : 3

accuracy (advanced)

x-direction : 3

y-direction : 3

z-direction : 3

dismiss | calculate | generate | help

```
$Initialize MAGMASOFT/MAGMAPrj ...  
$Connection MAGMASOFT/MAGMAPrj closed ...  
$Open connection to `MAGMAPre' ...
```

MAGMASOFT

project

preprocessor

enmeshment

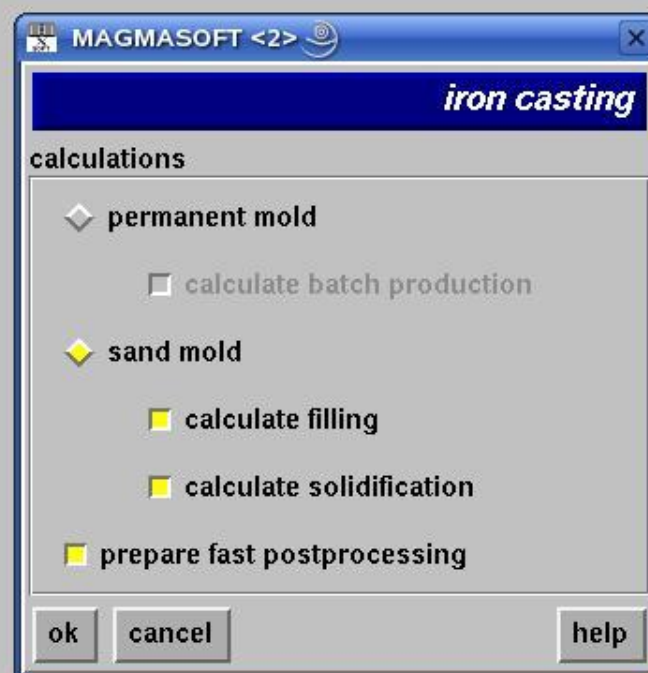
simulation

postprocessor

database

info

help



```
$Initialize MAGMASOFT/MAGMAprj ...  
$Connection MAGMASOFT/MAGMAprj closed ...  
$Initialize MAGMASOFT/MAGMActrl ...
```

MAGMASOFT

project | preprocessor | enmeshment | simulation | postprocessor | database | info | help

MAGMASOFT <2>

material definitions

selection

material : T-initial : [°C]

database : T-liquidus : [°C]

file name : T-solidus : [°C]

list

[+] material class	database/file name	initial temp
[-] material group - id	database/file name	initial temp
[+] Cast Alloy	project/GGG40MOHRA	1340.00
[+] Sand Mold	magma/FURAN	20.00
[+] Chill	magma/STEEL	20.00

ok | prev | cancel | select data | expand | hide | parameters | help

```
$Initialize MAGMASOFT/MAGMActrl ...
$Connection MAGMASOFT/MAGMActrl closed ...
$Initialize MAGMASOFT/MAGMAmat ...
```


MAGMASOFT

project | preprocessor | enmeshment | simulation | postprocessor | database | info | help

MAGMASOFT <2>

heat transfer definitions

selection

boundary : Cast Alloy , Sand Mold

database : magma

file name : TempIron group : temperature dependent

list

[+] material class	, material class	database/file name
[-] material group	- id, material group	- id database/file name
[+] Cast Alloy	, Sand Mold	magma/TempIron
[+] Cast Alloy	, Chill	magma/C1000.0
[+] Sand Mold	, Chill	magma/C1000.0

ok | prev | cancel | select data | expand | hide | parameters | help

```
$Initialize MAGMASOFT/MAGMAmat ...  
$Connection MAGMASOFT/MAGMAmat closed ...  
$Initialize MAGMASOFT/MAGMAhtc ...
```

MAGMASOFT

project | preprocessor | enmeshment | simulation | postprocessor | database | info | help

MAGMASOFT <2>

options

Pressurize	<input type="checkbox"/> yes	<input checked="" type="checkbox"/> no	parameters...
Sand Permeability	<input checked="" type="checkbox"/> yes	<input type="checkbox"/> no	
Venting	<input checked="" type="checkbox"/> yes	<input type="checkbox"/> no	
Ladle	<input type="checkbox"/> yes	<input checked="" type="checkbox"/> no	parameters...
Plug	<input type="checkbox"/> yes	<input checked="" type="checkbox"/> no	parameters...
Die Coating	<input type="checkbox"/> yes	<input type="checkbox"/> no	parameters...
Shake Out	<input type="checkbox"/> yes	<input checked="" type="checkbox"/> no	parameters...
Quenching	<input type="checkbox"/> yes	<input checked="" type="checkbox"/> no	parameters...

ok | prev | cancel | reset | help

```
$Initialize MAGMASOFT/MAGMAhtc ...  
$Connection MAGMASOFT/MAGMAhtc closed ...  
$Initialize MAGMASOFT/MAGMAoptions ...
```

MAGMASOFT

project | preprocessor | enmeshment | simulation | postprocessor | database | info | help

MAGMASOFT <2>

filling definitions

use solver :

filling depends on :

filling time : [s]

fill direction x : []

fill direction y : []

fill direction z : []

filter definitions :

calculate erosion : yes no

storing data :

ok | prev | cancel | help

```
$Initialize MAGMASOFT/MAGMAoptions ...  
$Saving MAGMASOFT/MAGMAoptions ...  
$Initialize MAGMASOFT/MAGMAfill ...
```


MAGMASOFT

project | preprocessor | enmeshment | simulation | postprocessor | database | info | help

MAGMASOFT <2>

filling definitions

use solver :

filling depends on :

filling time : [s]

MAGMASOFT <3>

storing data definitions

select result groups data list

time

percent

percent		
0.000	[%]	
0.500	[%]	
1.000	[%]	
1.500	[%]	
2.000	[%]	
2.500	[%]	
3.000	[%]	
3.500	[%]	
4.000	[%]	
4.500	[%]	
5.000	[%]	

input data

\$I
 \$\$
 \$INITIALIZE MAGMASOFT / MAGMABUILD ...

MAGMASOFT

project | preprocessor | enmeshment | simulation | postprocessor | database | info | help

MAGMASOFT <2>

solidification definitions

temperature from filling : yes no

use solver :

stop simulation :

stop value : [°C]

calculate feeding : yes no

feeding effectivity : d [%]

criterion temperature #1 : d [°C]

criterion temperature #2 : d [°C]

sand burn : yes no

critical temperature : d [°C]

top off feeders :

storing data :

ok | prev | cancel | help

```
$Initialize MAGMASOFT/MAGMAfill ...  
$Connection MAGMASOFT/MAGMAfill closed ...  
$Initialize MAGMASOFT/MAGMASolid ...
```

MAGMASOFT

project | preprocessor | enmeshment | simulation | postprocessor | database | info | help

MAGMASOFT <2>

iron casting

inoculation method :

treatment yield : [%]

mold dilatation :

graphite precipitation :

consider water content :

extended feeding :

ok prev cancel help

```
$Initialize MAGMASOFT/MAGMASolid ...  
$Connection MAGMASOFT/MAGMASolid closed ...  
$Initialize MAGMASOFT/MAGMAmicro ...
```

fast postprocessing preparation

result preparation

- filling temperature filling entrapped air filling pressure filling velocity
- fill criteria (material trace, air entrapment)
- solidification criteria (fill, solid)
- x-ray range, show all above: d [°C]
- fraction liquid
- x-ray range, show all above: d [%]
- fraction solid
- x-ray range, show all below: d [%]
- stress
- add on mesh (interpolated)
- unprepared results only

- new conversion

conversion preparation

- | | | |
|--|------------------------------------|--------|
| total amount of available memory (in MB) | <input type="text" value="60"/> | [MB] |
| maximum volume size for subtracts
(default is calculated from the available memory) | <input type="text" value="10000"/> | |
| maximum number of facets per volume
(default is calculated from the available memory) | <input type="text" value="25000"/> | |
| polygon reduction | <input type="text" value="None"/> | |

MAGMASOFT

project

preprocessor

enmeshment

simulation

postprocessor

database

info

help

MAGMASOFT <2>

online job simulation control

percentage online curves

simulation [%]

temperature [°C]

time [s]

simulation info

dismiss prev start restart stop dump read help

\$ initialize MAGMASOFT / MAGMAS.DIM ...

MAGMASOFT

preprocessor

enmeshment

simulation

postprocessor

database

info

help

MAGMApost Project: GT13_CASING_Lower_Part Directory: /home/magma/MAGMASoft/ALSTOM/GT13_CASING_Lower_Part/v04/

MAGMApost

Quit

Help

3D-Results

3D-Mesh

C-Curves

Fill Tracer

Solid Tracer

Help on Trace



Reading geometry ...
done

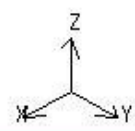
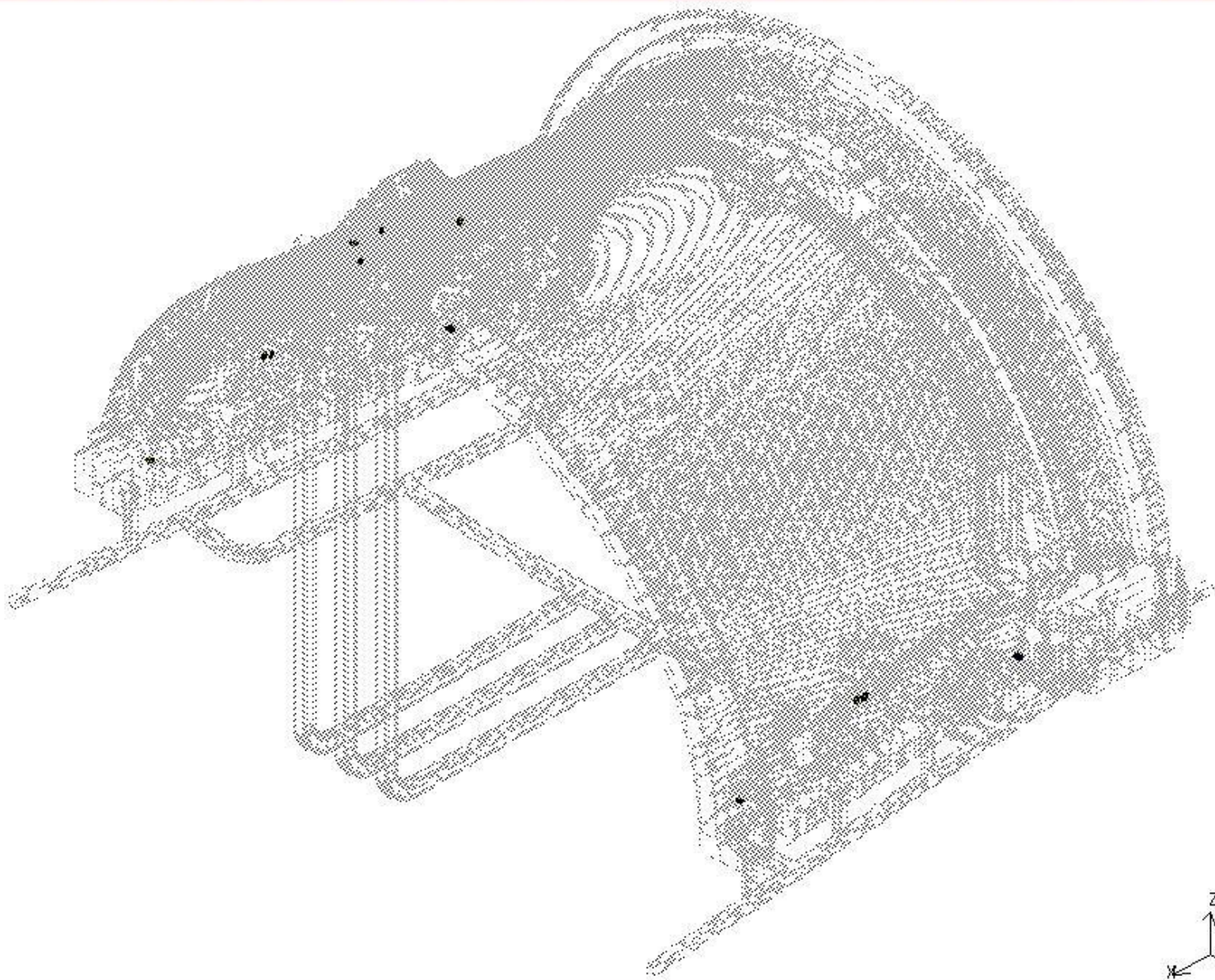
Information

Print



MAGMApost

- Return
- Help
- Settings
- User Scale
- Viewpoint
- Clipping
- Previous
- Same
- Next



Stop

Project: GT13_CASING_Lower_Part
Version: v04
Number of elements: 26760960

Information
■ Connection over edge: Total of 20
■ Blocked cells: Total of 0

Print



Project View Support

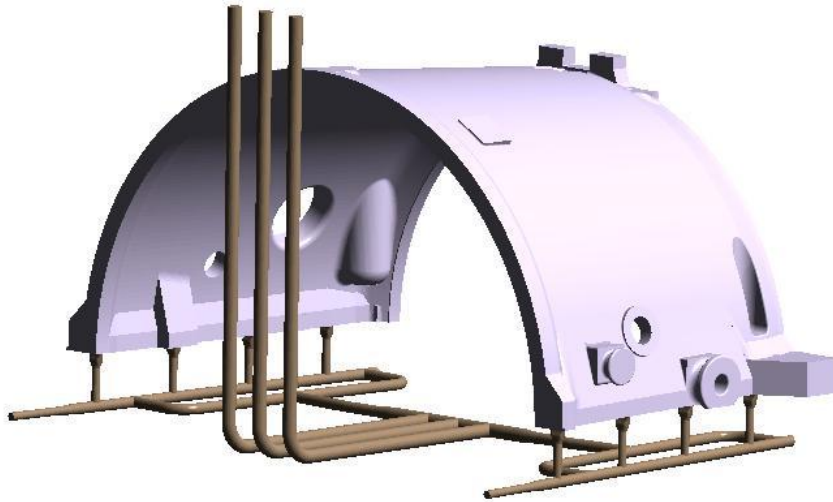
Help

Curves XYZ Scr β Vec Slice X-Ray Vector Dist Anim

Material Scales Rotate Images Views Light

Results X-Ray Clipping Animation Distortion ProcRot
Curves Vector Slicing Tracer Print Mesh

Project: GT13_CASING_Lower_Part Version: v04 Directory: /home/magma/MAGMASoft/ALSTOM/GT13_CASING_Lower_Part/v04

Cast Alloy
GGG40MOHRA
Gating
GGG40MOHRA

[01/01]	Cast Alloy
[03/01]	Sand Mold
[05/01]	Chill
[10/01]	Inlet
[19/01]	Gating

Apply

View Geometry

MAGMA

Curves XYZ
Material S
Results X
Curves V

Project View Support

Help



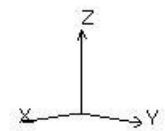
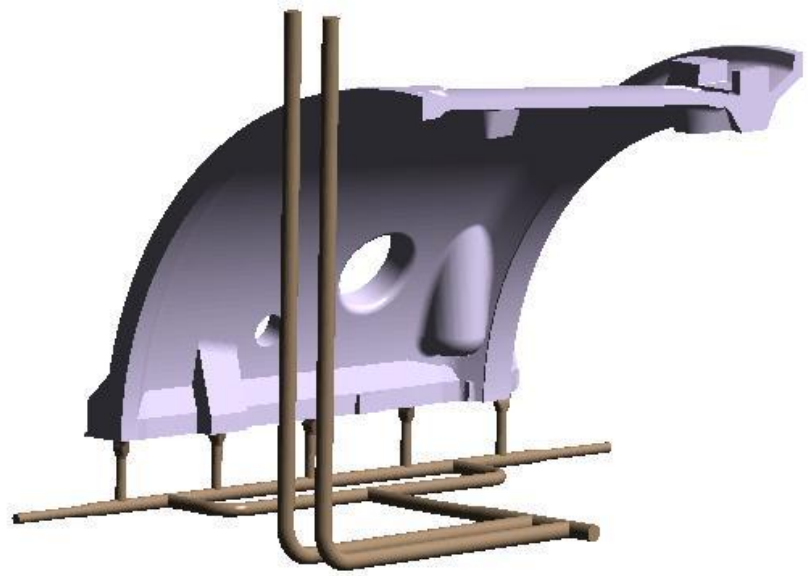
Anim
Light
ProcRot
Mesh

Project: GT13_CASING_Lower_Part Version: v04 Directory: /home/magma/MAGMASoft/ALSTOM/GT13_CASING_Lower_Part/v04

Result :
Group /R
Sw
Fi
G
S
ApI

Cast Alloy
GGG40MOHRA
Gating
GGG40MOHRA

-5362
-5362
2501
2791
2791



View Geometry



Curves XYZ Scr B Vec Slice X-Ray Vector Dist Anim

Material Scales Rotate Images Views Light
Results X-Ray Clipping Animation Distortion ProcRot
Curves Vector Slicing Tracer Print Mesh

Options

Resolution : 800x600 Format : jpeg

Directory : result File spec. : number

Match mode: Exact

Result selection

Group /Results/Solidification/Criteria

Switch to Compact Mode Deselect

Results	Name
Pressure	GRADIENT
Tempera	COOLRATE
Velocity	LIQTOSOL
Geometry	SOLTIME
Solidification	FEEDMOD
Criteria	NIYAMA
Fraction_	FEEDING
Tempera	POROSITY

Name

Add Result Remove Selected Clear List

Save Load Generate Player

Curves XYZ Scr B Vec Slice X-Ray Vector Dist Anim

Material Scales Rotate Images Views Light
Results X-Ray Clipping Animation Distortion ProcRot
Curves Vector Slicing Tracer Print Mesh

Printer

Paper size : A4 (210 x 297mm)

Orientation
Portrait Landscape

File

Save to File

Save as : jpeg

Filename : picture_001

Apply

Save Load Generate Player

Curves XYZ Scr B Vec Slice X-Ray Vector Dist Anim

Material Scales Rotate Images Views Light
Results X-Ray Clipping Animation Distortion ProcRot
Curves Vector Slicing Tracer Print Mesh

Options

Resolution : 800x600 Format : jpeg

Directory : result File spec. : number

Match mode: Exact

Result selection

Group /Results/Filling/Temperature

Switch to Compact Mode Deselect

Results	Name	Time
Pressure	Fill_Temp_190	94.990s
Criteria	Fill_Temp_191	95.490s
Pressure	Fill_Temp_192	95.990s
Tempera	Fill_Temp_193	96.490s
Velocity	Fill_Temp_194	96.990s
Geometry	Fill_Temp_195	97.490s
Solidification	Fill_Temp_196	97.990s
Criteria	Fill_Temp_197	100.000s

Name	Time	Percent	Cast only
Fill_Temp_001	0.492s	0.49%	no
Fill_Temp_002	0.992s	0.99%	no
Fill_Temp_003	1.491s	1.49%	no
Fill_Temp_004	1.992s	1.99%	no

Add Result Remove Selected Clear List

Save Load Generate Player

Curves	XYZ	Scr	β	Vec	Slice	X-Ray	Vector	Dist	Anim	
Material	Scales	Rotate	Images	Views	Light					
Results	X-Ray	Clipping	Animation	Distortion	ProcRot					
Curves	Vector	Slicing	Tracer	Print	Mesh					

Display mode:

- geometry
- mesh
 - no grid lines
 - show characteristic grid lines
 - show grid lines

Results can be displayed on mesh:

```
[03/01] Sand Mold
[05/01] Chill
```