



YOUR  
TECHNOLOGY  
ADVISOR



## Customer References

Sizing motor bogie  
of a railway vehicle

Ing. Carmelo Siciliano

# Index

## ›01

Job Description

- ›The client
- ›The requirements

## ›02

## ›03

Why Mathcad?

## ›04

Input parameters

## ›05

Details of implementation

## ›06

Conclusions



# >01/02

## Job description

- >Creo Parametric Essentials
- >Creo AAX (Advanced Assembly Extension)
- >Simulation Advanced

### The client

Leading Italian company in the design, construction, renovation and maintenance of railway rolling stock

### The requirements

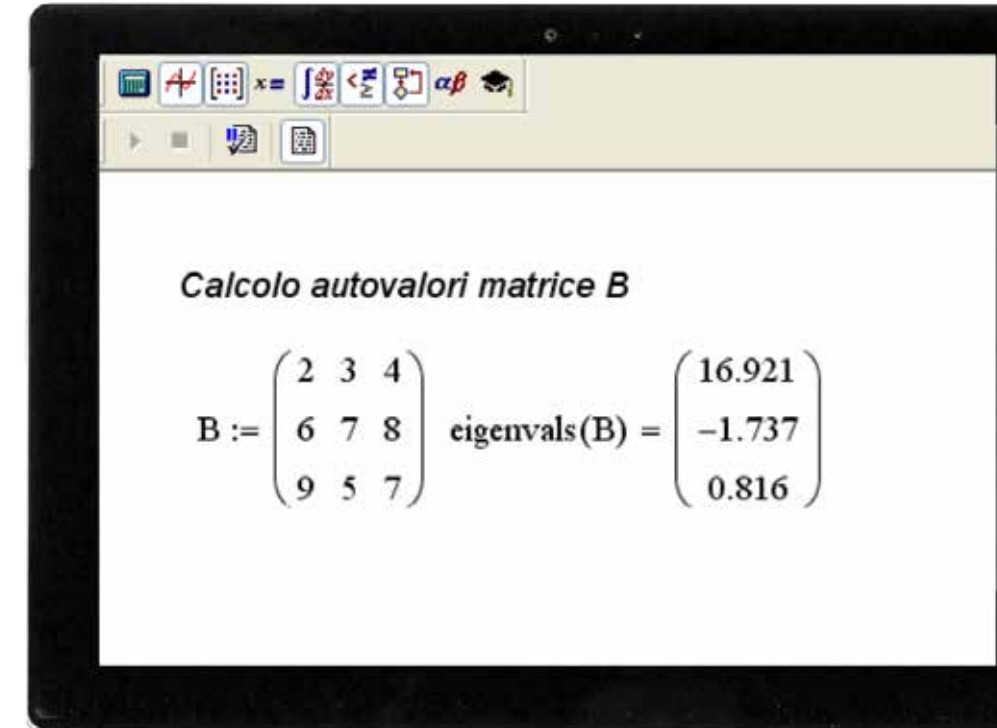
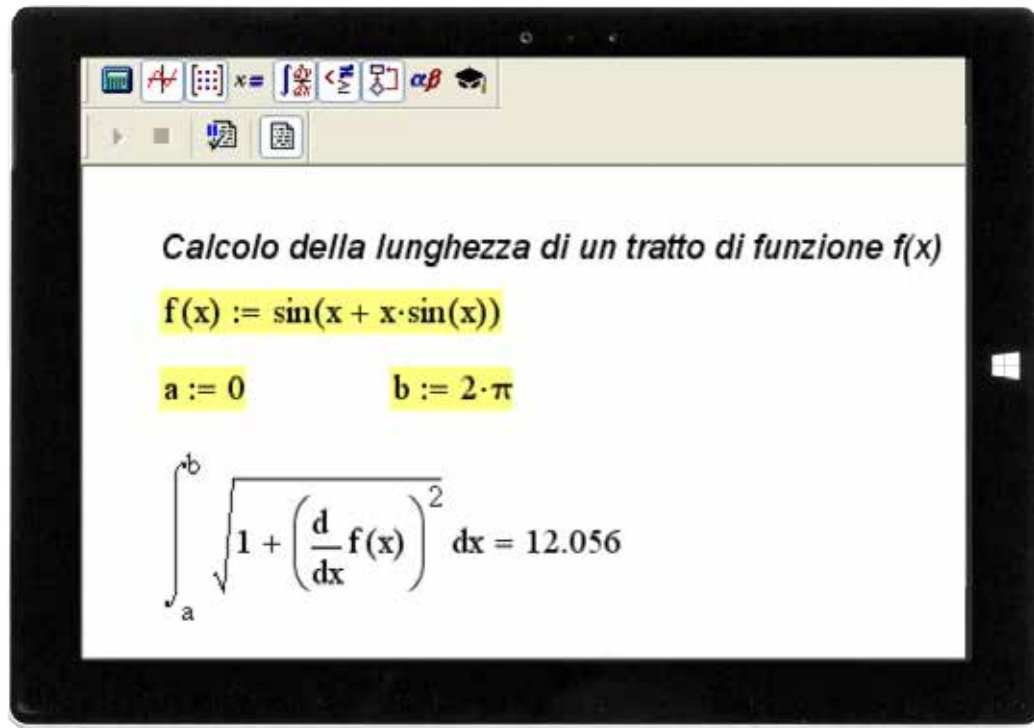
Determine, during the 'estimating' phase, the number of motor bogies required to equip a railway locomotive so as to satisfy given performance requirements in terms of its speed and acceleration

## ›03 Why Mathcad?

The only working environment integrated into a user-friendly interface:

›Differential calculations

›Matrix calculations

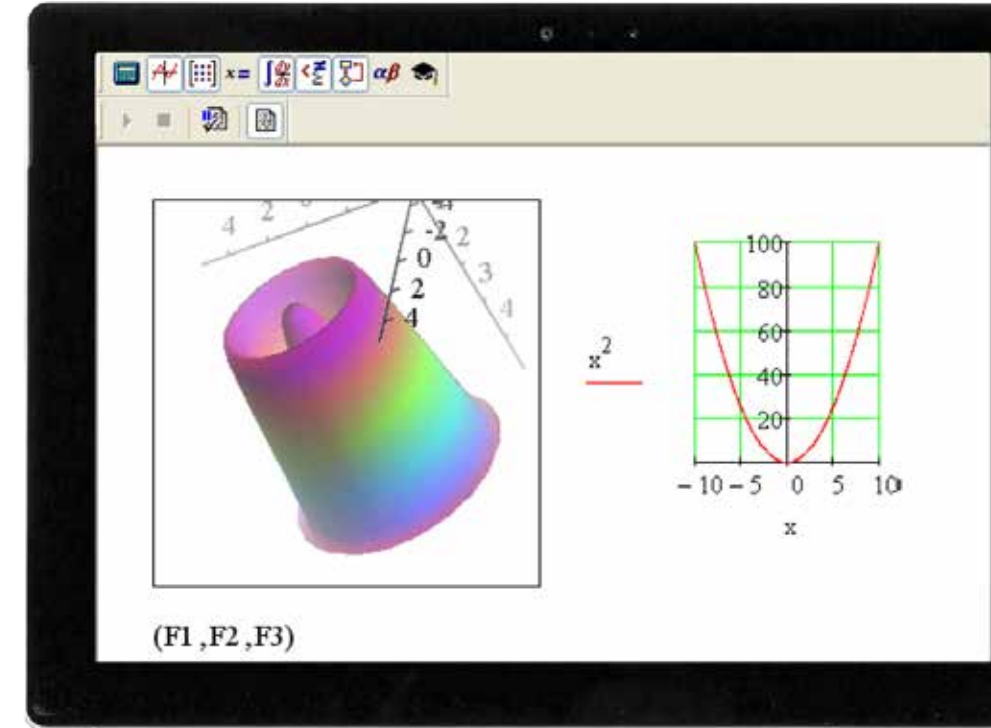
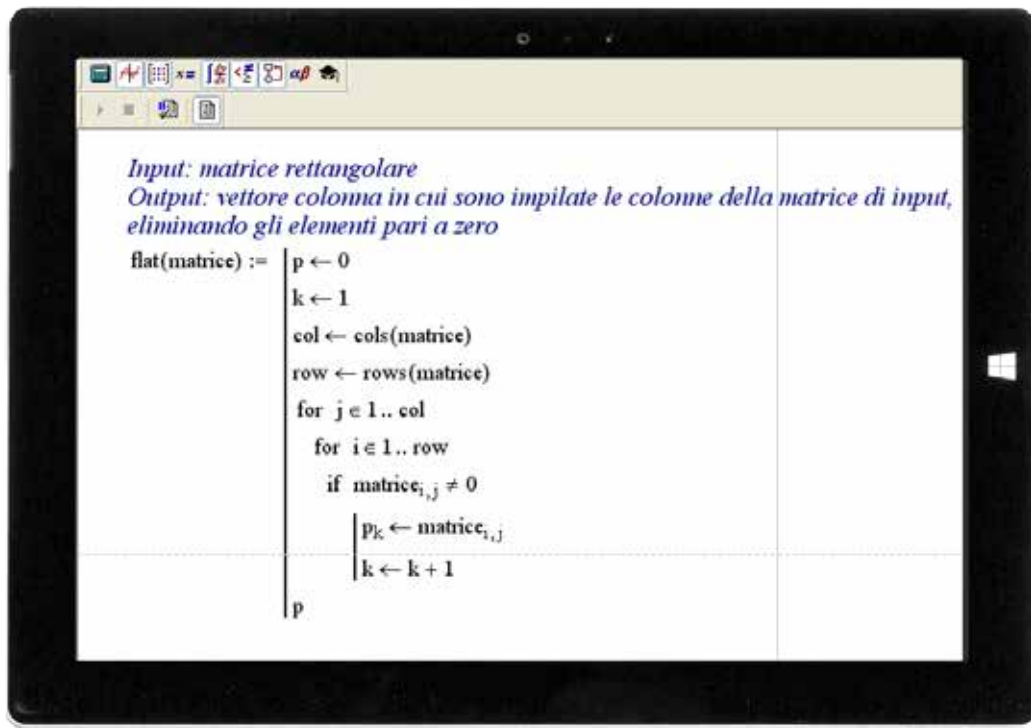


## ›03 Why Mathcad?

The only working environment integrated into a user-friendly interface:

›Programming tools

›2D and 3D Plotting

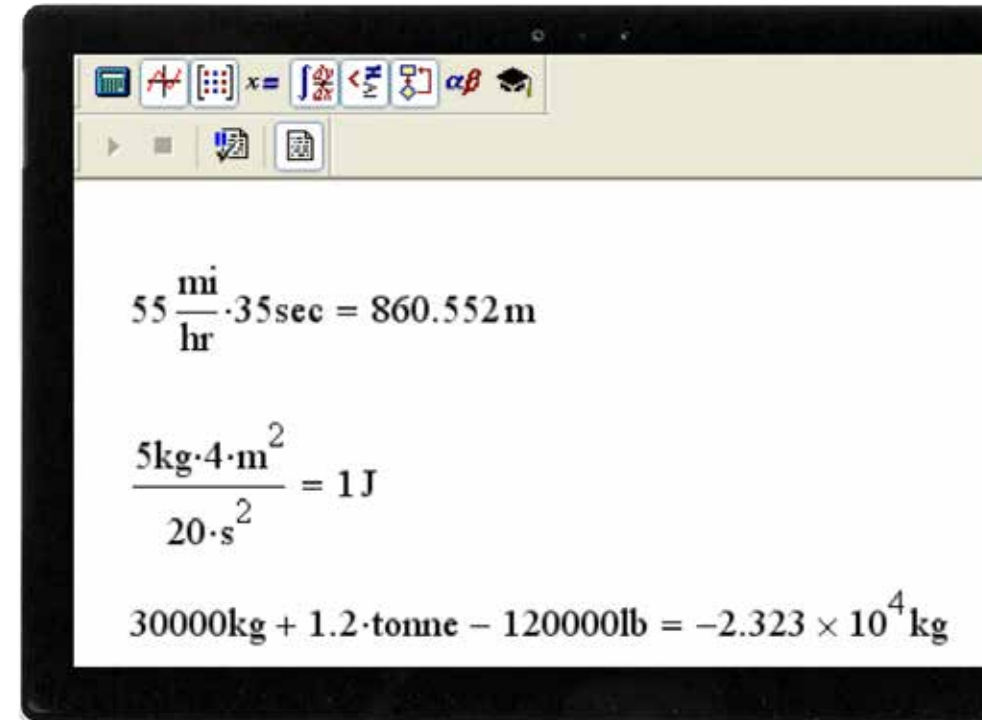
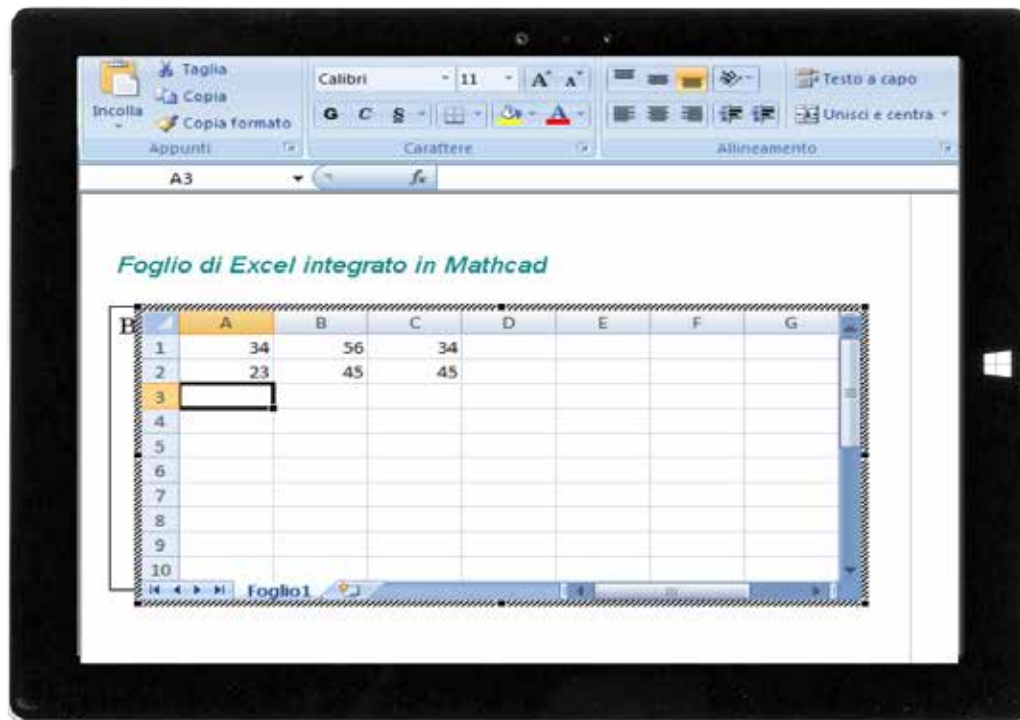


## ›03 Why Mathcad?

The only working environment integrated into a user-friendly interface:

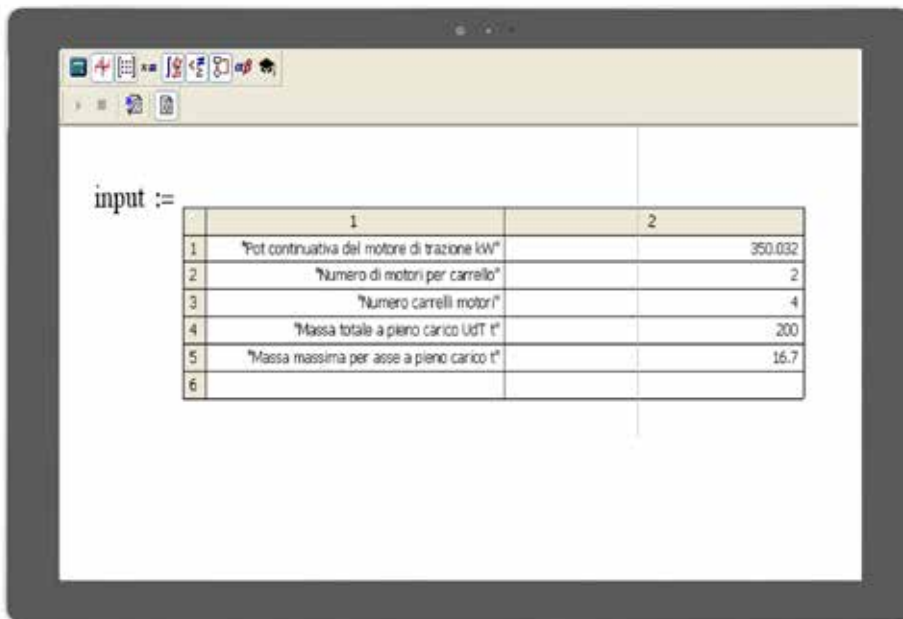
› Integration with external databases  
(Excel, ODBC...)(Excel, ODBC...)

› Manages units of measure



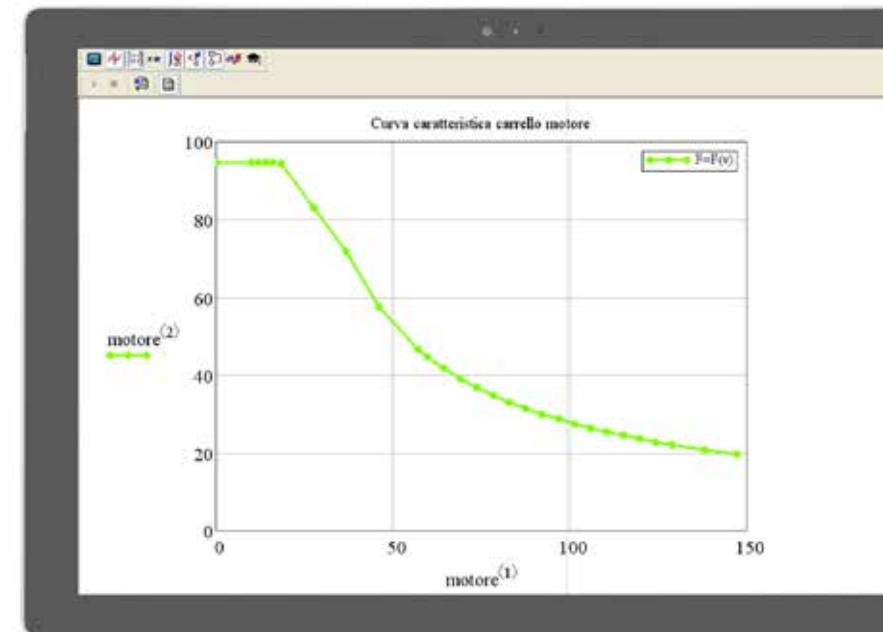
&gt;04

# Estimating the number of wheel-carriages: work plan

**Input**Overall parameters  
of locomotiveCharacteristic curves  
 $F=F(v)$ 

input :=

	1	2
1	"Pot continuaiva del motore di trazione kW"	350.032
2	"Numero di motori per carrello"	2
3	"Numero carrelli motori"	4
4	"Massa totale a pieno carico UD T t"	200
5	"Massa massima per asse a pieno carico t"	16.7
6		



&gt;04

# Estimating the number of wheel-carriages: work plan

## Calculation of Base Parameters

Resistance force

Resulting Force  
and instant acceleration

forza\_resistente :=  $\left( 2.5 + \text{pendenza} + \frac{\text{velocita}^2}{2500 \frac{\text{km}^2}{\text{hr}^2}} \right) \cdot g \cdot \text{massa\_equivalente} \cdot \text{kg}$

NUMERO DI ROTOLE PER CARRELLI	
3	"Numero carrelli motori"
4	"Massa totale a pieno carico UJT t"
5	"Massa massima per asse a pieno carico t"
6	

forza\_risultante := forza\_trazione\_totale - forza\_resistente

accelerazione\_istantanea =  $\frac{\text{m}}{\text{s}^2}$

1	
1	1.2
2	1.2
3	1.2
4	1.2
5	1.2
6	1.2
7	1.2
8	1.2
9	...



## &gt;05

Estimating the number of wheel-carriages:  
work plan

Implementation of  
algorithm for calculating  
time interval

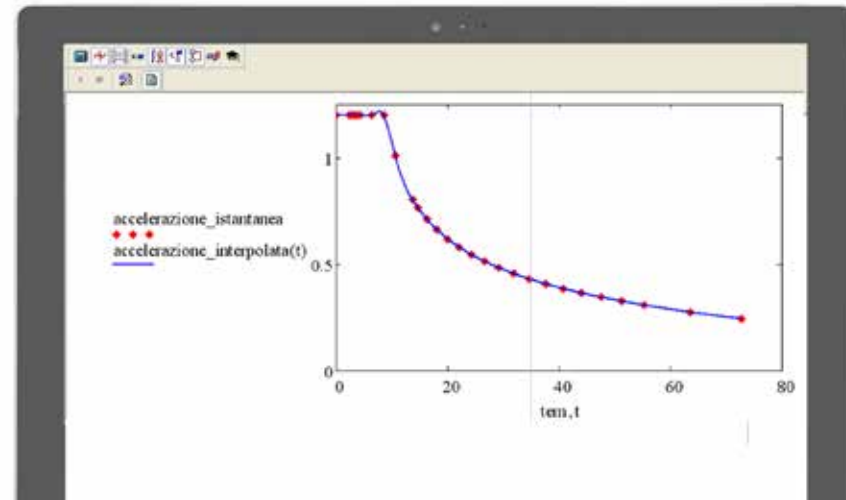


```
tem := | i ← 1
      | tempo1 ← 0
      | for i ∈ 1..rows(delta_t)
      |   tempoi+1 ← tempoi + delta_ti
```

	1
1	0
2	2.315
3	2.778
4	3.241
5	3.704
6	...

tem =

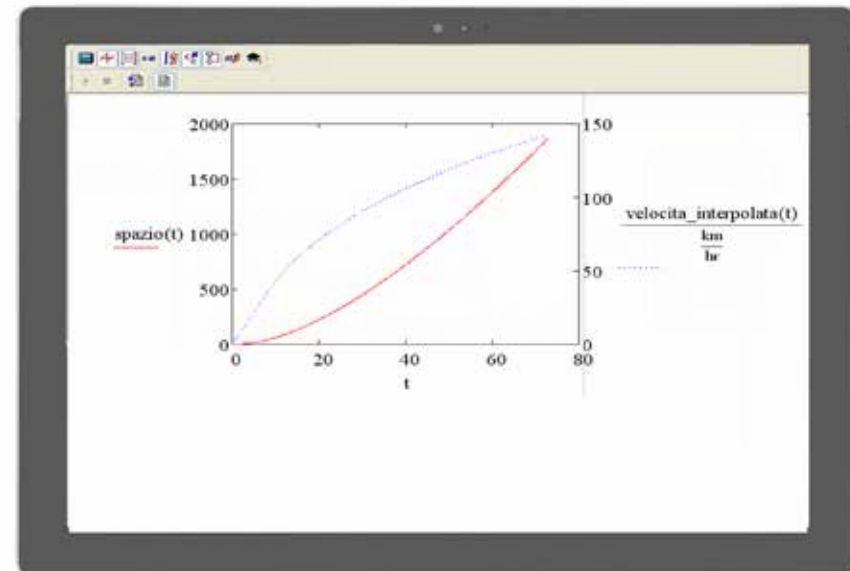
Implementation by cubic  
interpolation of function  
 $a=a(t)$ :



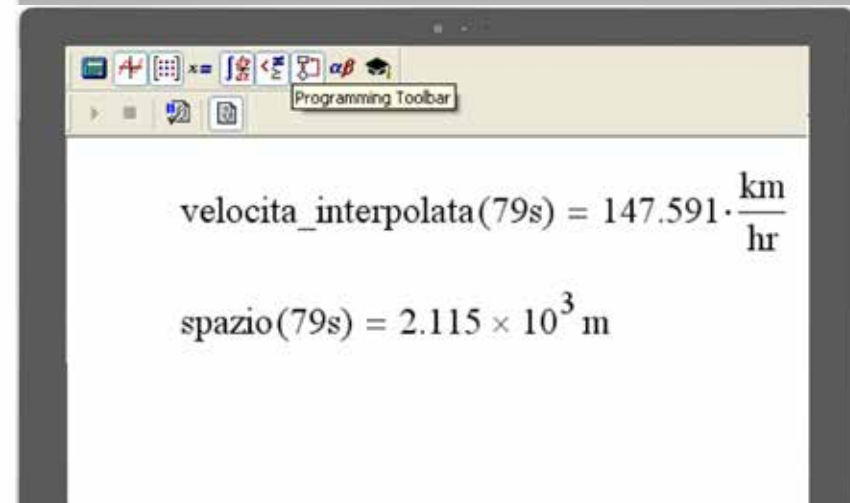
## &gt;05

## Estimating the number of wheel-carriages: work plan

Calculation by integration of velocity and space travelled by the motor carriage



Verification that the target requirements have been respected



## ›06 Conclusions

- › The spreadsheet developed in MathCad supplies technicians with a useful tool for rapid evaluation, in the pre-production phases, of the number of motor bogie undercarriages necessary to attain a given target
- › The spreadsheet is easy to read, with areas dedicated to introducing input data, areas dedicated to calculation and areas dedicated to presentation of results
- › Only the input areas are accessible to the spreadsheet user: the calculation area is password protected for know-how security and the area presenting results is read-only

Thank you!



YOUR  
TECHNOLOGY  
ADVISOR



Italian Operating Offices  
**Parametric Design S.r.l.**  
Piazza Corte Grande 24/25  
20060 Gessate (MI)  
+39 02 95384199  
+39 02 95382708

[info@parametricdesign.it](mailto:info@parametricdesign.it)

Swiss Operating Offices  
**Parametric Design Suisse Sagl**  
Corso San Gottardo 24  
6830 Chiasso (Ch)  
+41 91 945 31 40

[info@parametricdesign.ch](mailto:info@parametricdesign.ch)