

# Modeling Pantograph Dynamics

## *An ADAMS Macro Toolkit*

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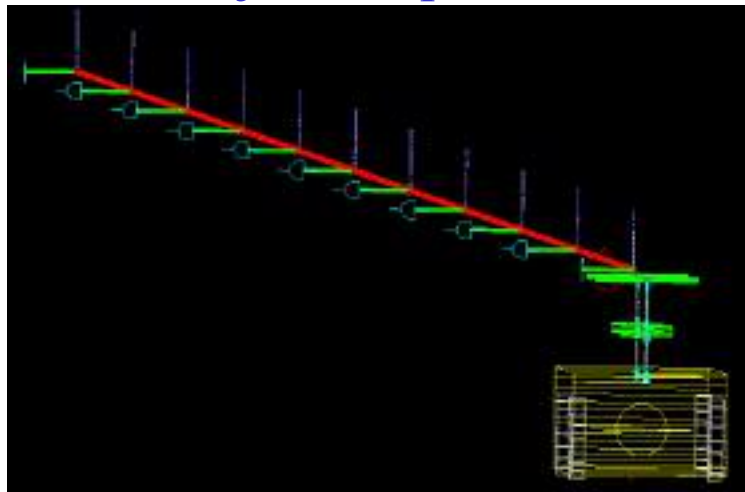
Nedtrain Consulting & SayField International

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## Project Purpose



Modeling toolbox for Pantograph systems in high speed trains

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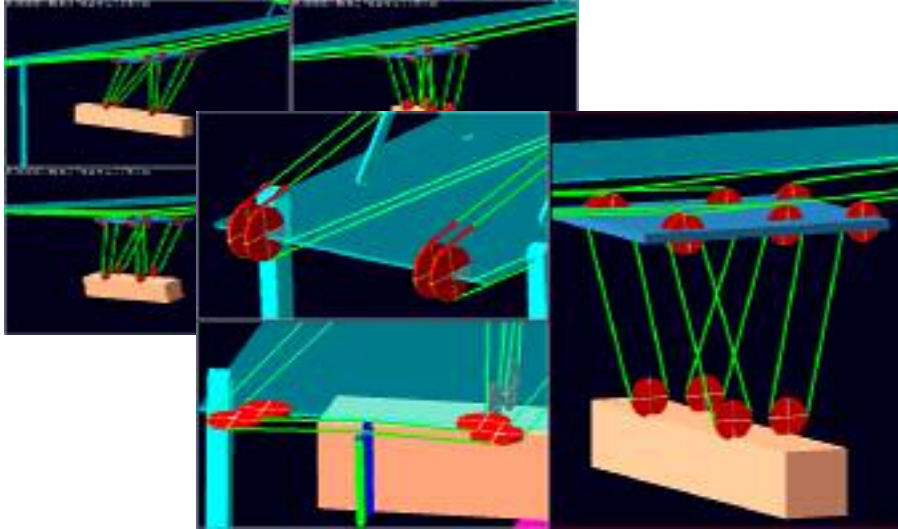
## Historical Overview (I)

- **Nedtrain Consulting:** co-developer of ADAMS/Rail
- Currently using ADAMS/Rail + ADAMS/View for consultancies
- Nedtrain has 4 to 5 regular ADAMS users
- Need for simulations of pantograph /catenary dynamics
- Existing (competing) software is mainly FEM Based

## Historical Overview (II)

- **SayField International:**
  - MSC.ADAMS competence center for Benelux,
  - Pre/post sales support, user support, consultancy, ADAMS courses (MSC & Uni's)
  - ADAMS agency in Netherlands since 1996
  - Key ambition: *demonstrating to users how rapid they can be productive with ADAMS multi-body simulations*
  - Core activities: ADAMS customization & toolkits

## Samples: Cable systems

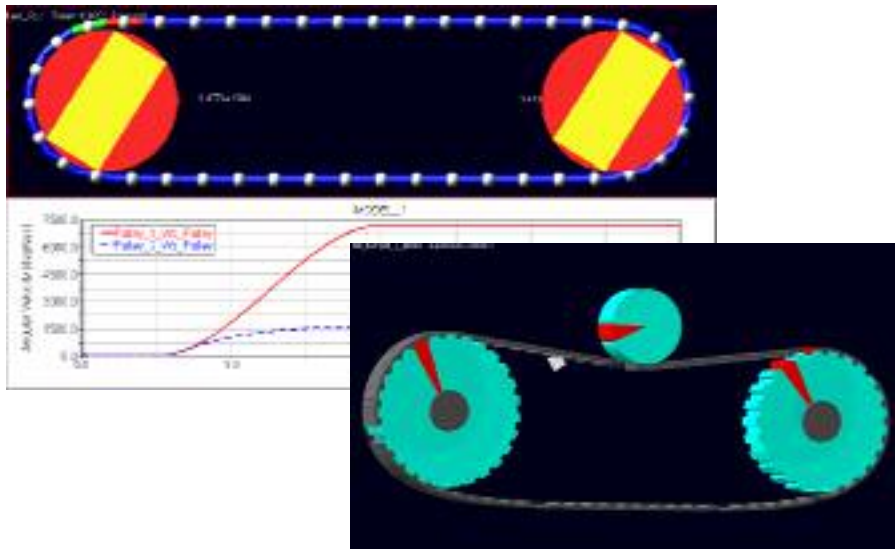


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## Samples: Discrete Cable systems

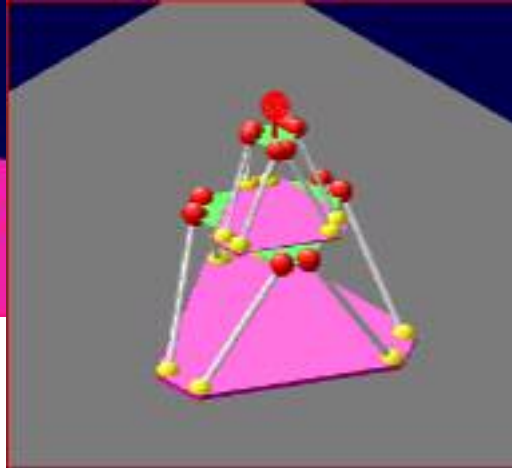
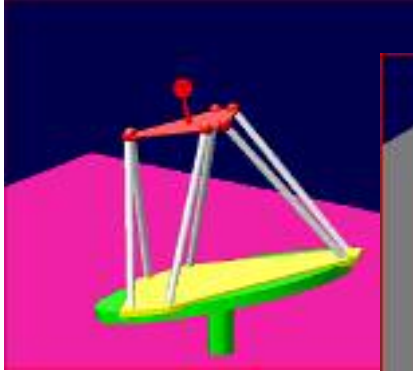


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## Samples: Hexapod Platforms

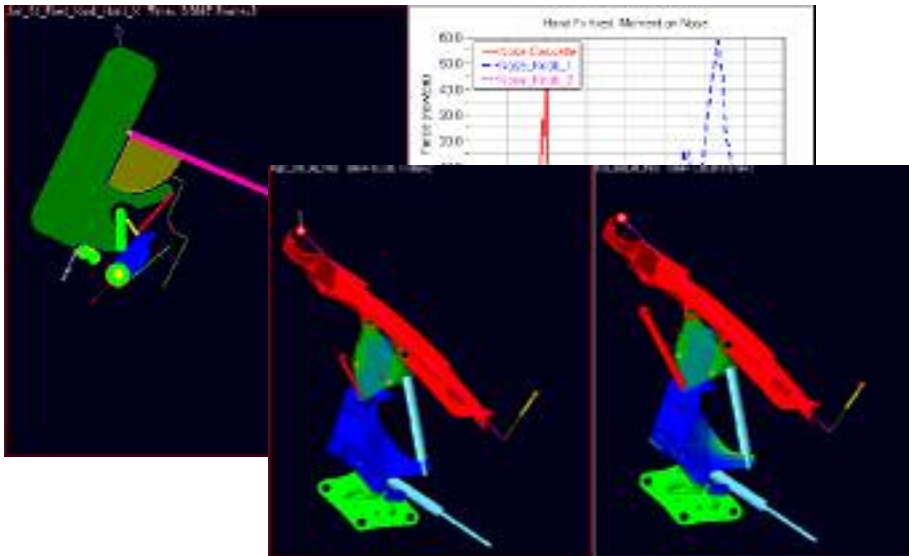


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## Samples: Citroen Pluriel Roof



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## Recent Work with Prospects

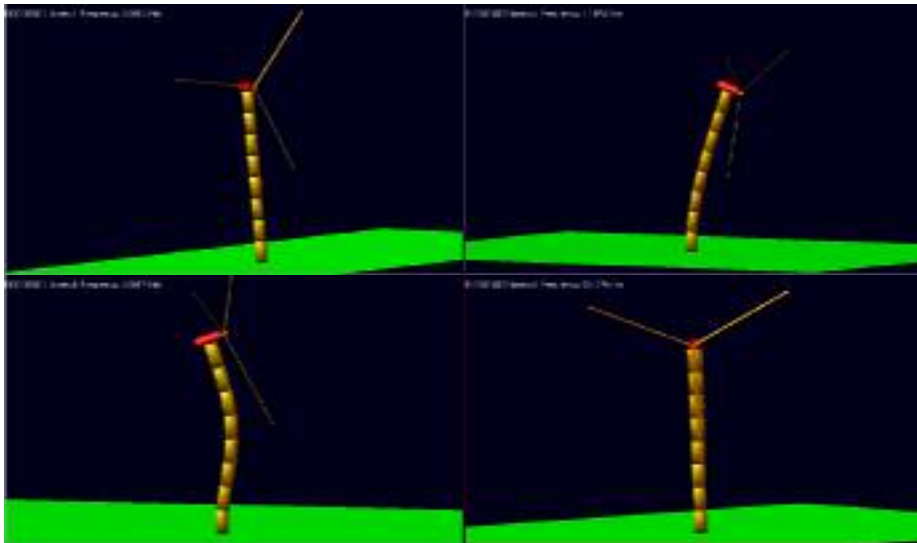
- Task for Vortech Engineering + ECN:  
*Finding a suitable simulation tool for describing wind dynamics effects in wind turbines using User Code*
- MSC.Software offered flying start license: ADAMS Course + trial period to use software.
- For Vortech & ECN: evaluation of suitability of ADAMS code

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## After 2 days course & 4 days modeling



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## Pantographs: Project Challenge

- Creating a toolkit in MSC.ADAMS
- Must work in ADAMS/View (+ in A/Rail)
- Must enable easy modeling and extension of functionality
- Interaction through *state-of-the-art* GUI
- Modeling Contact wire dynamics: Catenary-Wire contact and flexibility of wires:
  - Apply discrete flexibility first,
  - later also ADAMS/Flex modal description of wires

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## Modeling Approach (i)

- Component Macros with support of:
  - Exchange of models and macros
  - Easy macro adaption for support of knowledge development and use of model level of detail
  - Model storage: *known* user entities (UDE concept)
  - ADAMS can be made to *speak the users language*
- Graphical support in ADAMS GUI
  - Generic dialogs for each component macro
    - only 2 dialogs to maintain: 1) Macro 2) Data

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## Modeling Approach (ii)

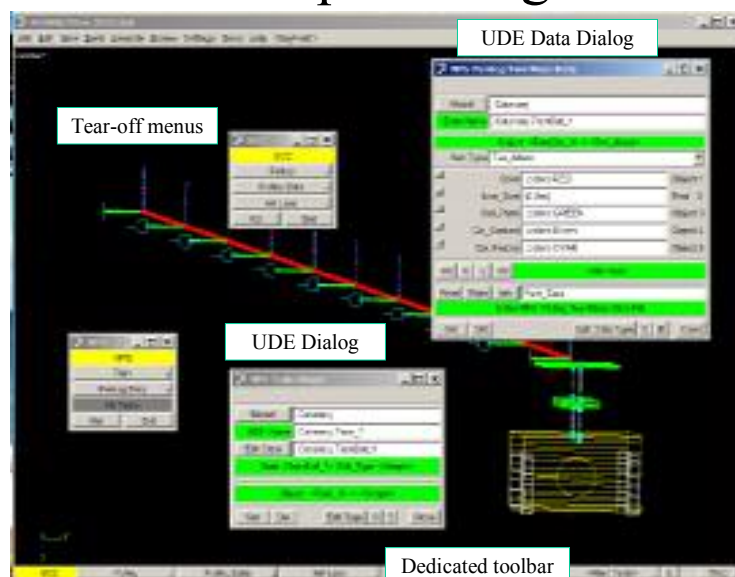
- Component Data:
  - Parametrised model components
  - Fully prepared for design study/optimization
  - Stored in documented ASCII files
  - User only creates component Macros, GUI is generic and adjusts to user data.
  - Method applies ADAMS UDE's: User Defined Entities
  - Toolkit Basics:
    - UDE Types for component equations: i.e NPS\_Pantograph
      - UDE Sub Types for multiple versions: (simple, two\_mass, etc.)
      - Each Sub Type defined unique Data Structure (stored in UDE)
    - Toolkit Tools to manipulate models using dedicated dialogs

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## Example dialogs



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## Complete toolkit definition is stored as property lines in ASCII File

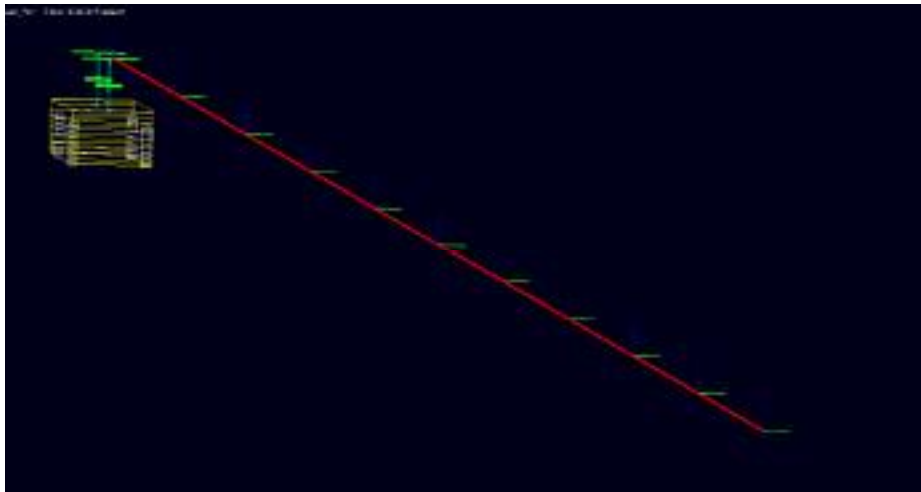
```
!  
BEGIN_GROUP TOOLKIT = NPS  
VERSION = "Version 1.0"  
ALIAS = "Pantographs"  
COMMENT = "NedTrain Pantograph System Toolkit"  
DATA_DIR = ".\\_TKC_Data"  
UDE_TYPES = "NPS_Train", "NPS_Pantog", "NPS_Catenary"  
!  
BEGIN_GROUP UDE_TYPE = NPS_Train  
COMMENT = "Train to support Pantographs"  
DATA_UDE = "NPS_Train"  
UDE_NAMES = "Train", "TrainDat"  
UDE_EXT = "train"  
ICON_REF = "[U]_body.cm"  
ICON_DEF = 1.0, 1.0, 0.5, 1.0  
SUB_TYPES = "Simple"  
!  
BEGIN_GROUP SUB_TYPE = NPS_Train_Simple  
COMMENT = "Train with fixed wheel susp."  
DATA_EXT = "Train_Sm"  
END_GROUP SUB_TYPE = NPS_Train_Simple  
END_GROUP UDE_TYPE = NPS_Train
```

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## Simulation Results



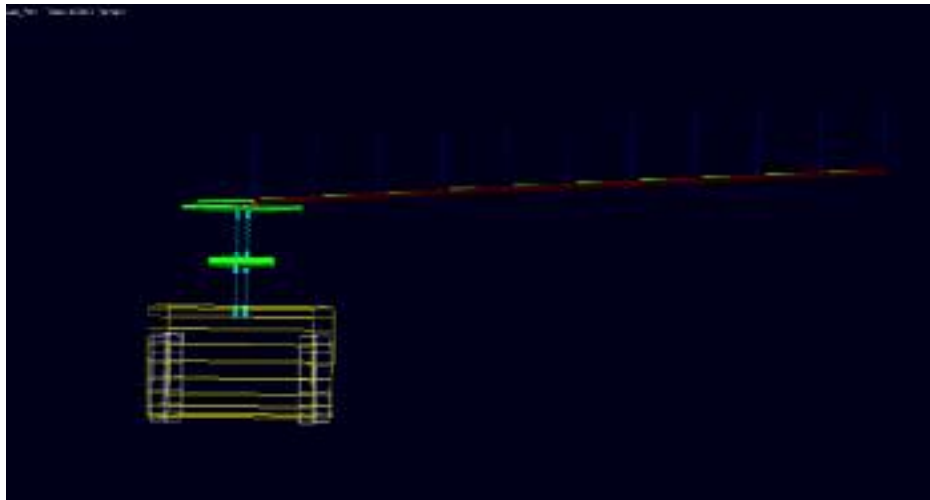
Time domain, 10 secs, fixed camera front view

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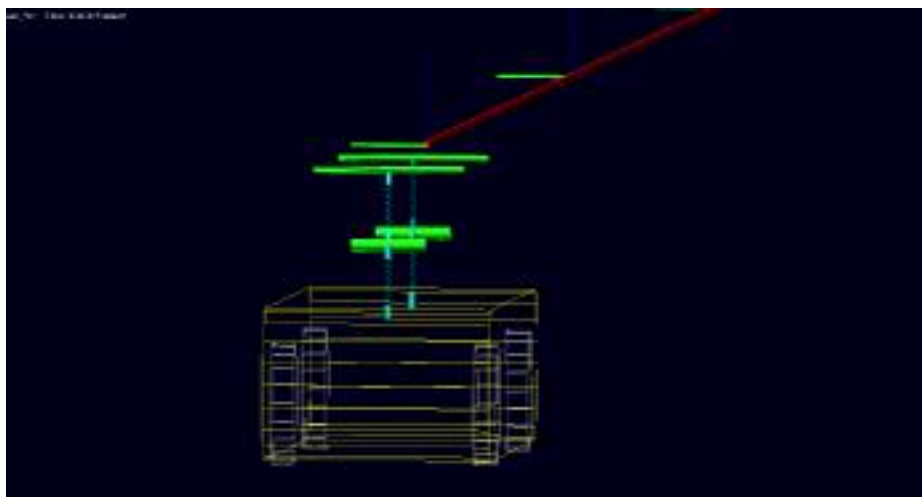


Time domain, 10 secs, fixed camera rear view

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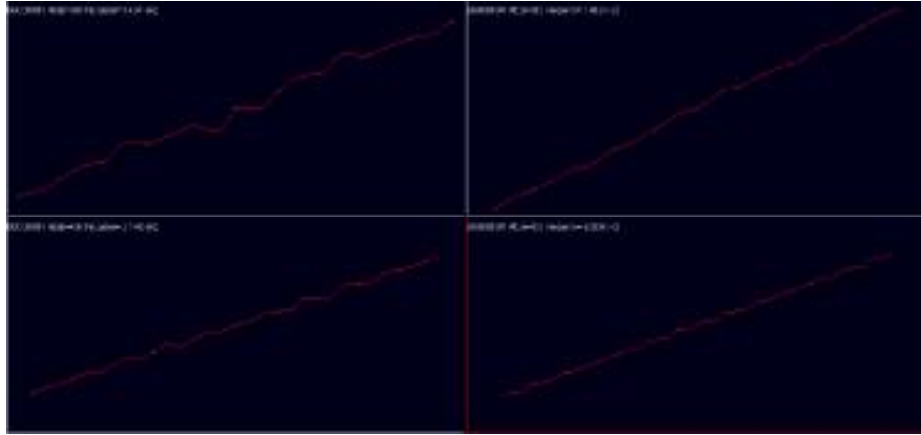


Time domain, 10 secs, moving camera rear view

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### Catenary system vibration analysis

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## Current Status

- Macros functioning and stable
- Pantograph models not yet completed
- F77 contact subroutine to be implemented
- First test runs with 10 span catenary (600 meters, 100 discrete parts) show fast runs (few minutes)
- Feedback from Nedtrain will be processed.

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## Toolbox Creator: Work to be done

- Further testing of GUI elements
- Model *rebuild* functionality:
  - Script like model storage (1 page full model)
  - Build file created from hand-built model
  - Parametrized model building: level of complexity
- Embedding of other toolboxes
- Testing with current & new customers

Thank You