



# ADAMS

## Useful Techniques for Complex Models

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- Combined Use of CMD files and Fortran codes
- Rediscovery of Impact
- Snap-Shot Plot Technique



## Combined Use of CMD files & Fortran codes

### What is it?

**Conventional approach  
(cmd files only)**

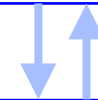
Input Panels



Many & Many  
Macros

**Suggested approach  
(cmd + Fortran)**

Input Panels



Fortran  
Codes



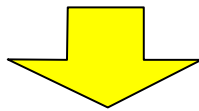
Minimized  
Macros



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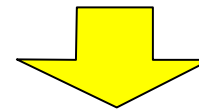
## Advantages?

### Conventional approach

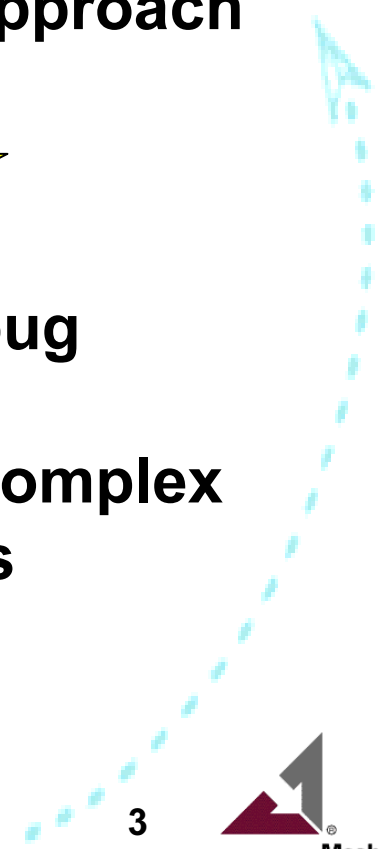


- hard to debug
- runs slower

### Suggested approach



- easy to debug
- runs faster
- facilitates complex calculations



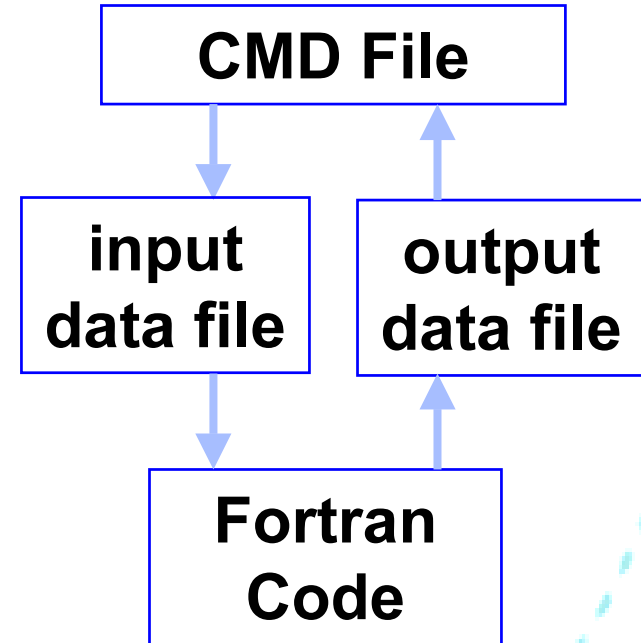


## How is it done?

```

execution_commands = "var modify var=.cv.allow_stress real=$f_input_1", &
  "file text open open_mode=append fi=\"cross.dat\" ", &
  "  file text write values_for_output=(.cv.cv_bn)          format_for_output=\"%d\" newline=yes", &
  "  file text write values_for_output=(.cv.cv_grb)         format_for_output=\"%d\" newline=yes", &
  "  file text write values_for_output=(.cv.cv_cwl)         format_for_output=\"%d\" newline=yes", &
  "  file text write values_for_output=(.cv.cv_sri)         format_for_output=\"%d\" newline=yes", &
  "  file text write values_for_output=(.cv.allow_stress)   format_for_output=\"%d\" newline=yes", &
  "file text close file=\"cross.dat\" ", &
  " ", &
  "sys command_text=\"./bin/run.exe\" sen=off", &
  "sys command_text=\"rm cross.dat\" sen=off", &
  " ", &
  "ana cre ana=results", &
  "num read new=junk.x file=\"result.dat\" ", &
  "var cre var=locx real=(eval(junk.x))", &
  "sys command_text=\"rm result.dat\" sen=off", &
  " ", &
  "interface label modify &", &
  "  `label_name = .gui.design_check.1_output_1_2` &", &
  "  `text = (eval(locx[1]))`", "", &
  "interface label modify &", &
  "  `label_name = .gui.design_check.1_output_2_2` &", &
  "  `text = (eval(locx[2]))`", "", &
  "interface label modify &", &
  "  `label_name = .gui.design_check.1_output_3_2` &", &
  "  `text = (eval(locx[3]))`", "", &
  " ", &
  "var del var=locx", &
  "ana del ana=results" &

```

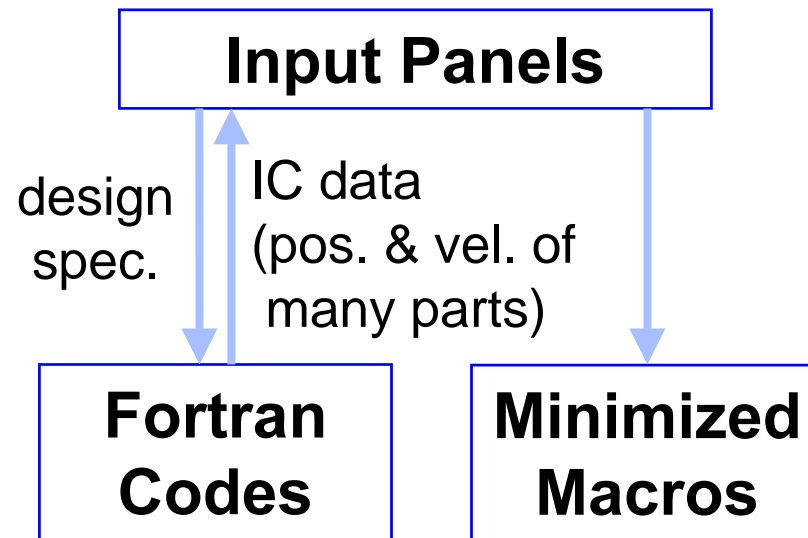




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## Example 1

(Preprocessor for **Complex Belt & Pulley System**)



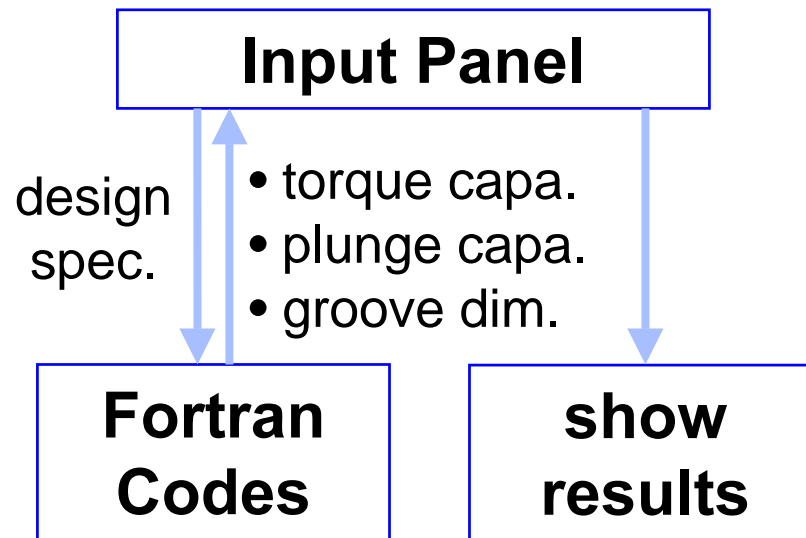
- cmd only preprocessor → **2 hours** for model generation
- cmd + fortran preproc. → **30 min.** for model generation + it allows **precision modeling**



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## Example 2

(Design Check for CV-Joint Model)



- cmd only preprocessor → practically **difficult to implement**
- cmd + fortran preproc. → **allows** extremely **complex calculations** that involve Newton Raphson iteration & Hertzian stress calculations



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## Example 2--continued

(Input Panel for Design Check)

The screenshot shows the ADAMS software interface. On the left, the 'Tools' menu is open, with 'Design Check' highlighted. A blue arrow points from the 'Design Check' menu item to the 'Cross Groove Joint -- Design Check' dialog box on the right. The dialog box contains the following information:

Note 1: User should input the max allowable contact stress  
Note 2: Click the Apply button to see the result

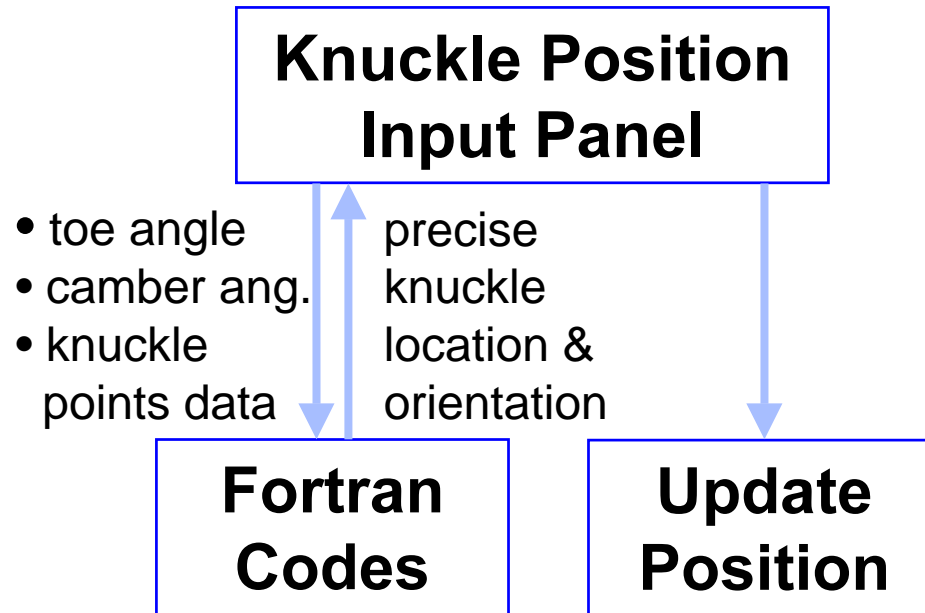
Allowable contact stress (N/mm <sup>2</sup> )	5000
Plunge Capability (mm)	76.85
Groove to Groove arc (mm)	6.19
Max Allowable Torque (N-mm)	4.34719E+006

At the bottom of the dialog box are 'Apply' and 'Cancel' buttons. A dashed blue arrow points from the 'Apply' button towards the bottom right corner of the slide.



## Example 3

(Precision Positioning of Knuckle)

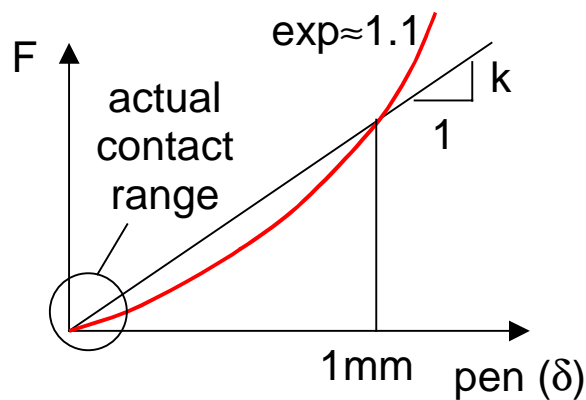


- cmd only preprocessor → practically **difficult to implement**
- cmd + fortran preproc. → **allows** extremely **complex calculations** that involve Newton Raphson iteration & complex coordinate transformations

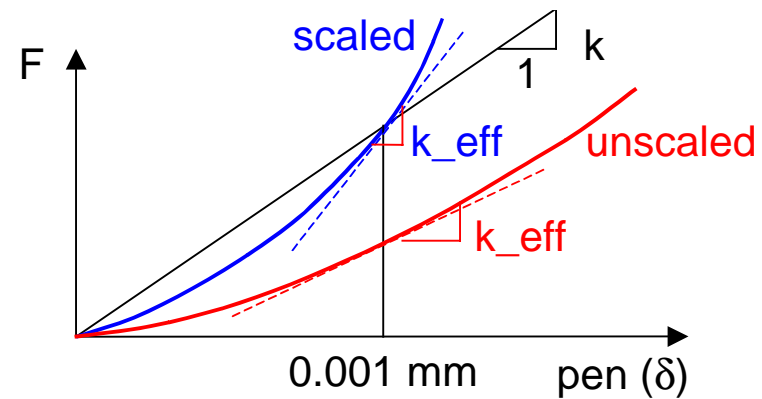


## Rediscovery of Impact (New Impact)

### Conventional Impact



(unscaled impact)



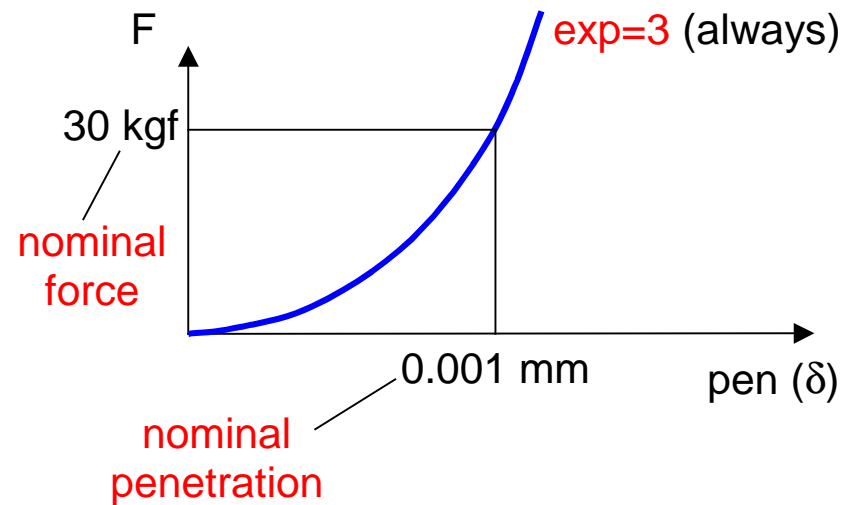
(scaled impact)

- **scaling** or **exponent\_value** → **affects** the effective stiffness
- **realistic value** of effective stiffness → often times **cause simul. failure**



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## New Impact



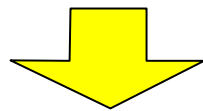
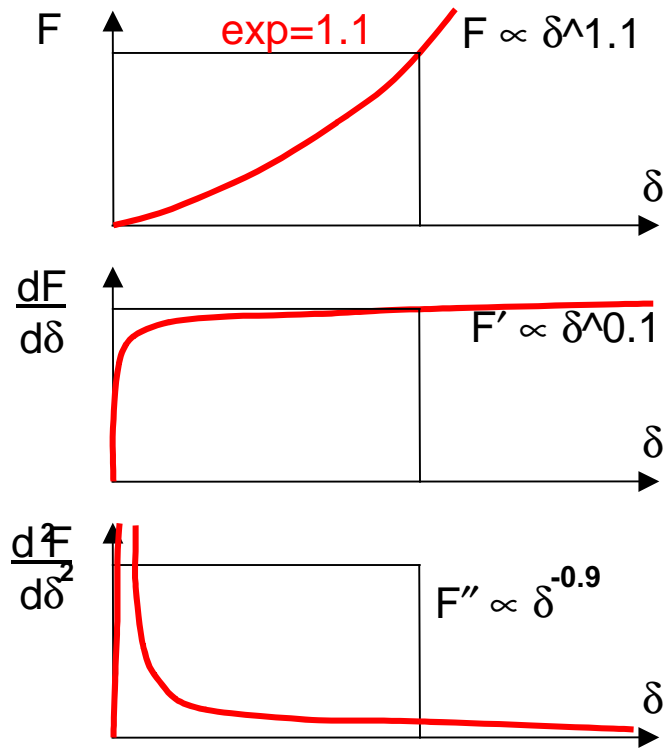
- **discard** stiffness & exponent concepts
  - which affects the effective stiffness
- adopt **nominal force & penetration** concept
  - simple & intuitive to users
- exponent is fixed to **3**
  - **magic number** for numerical integration!



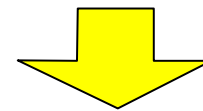
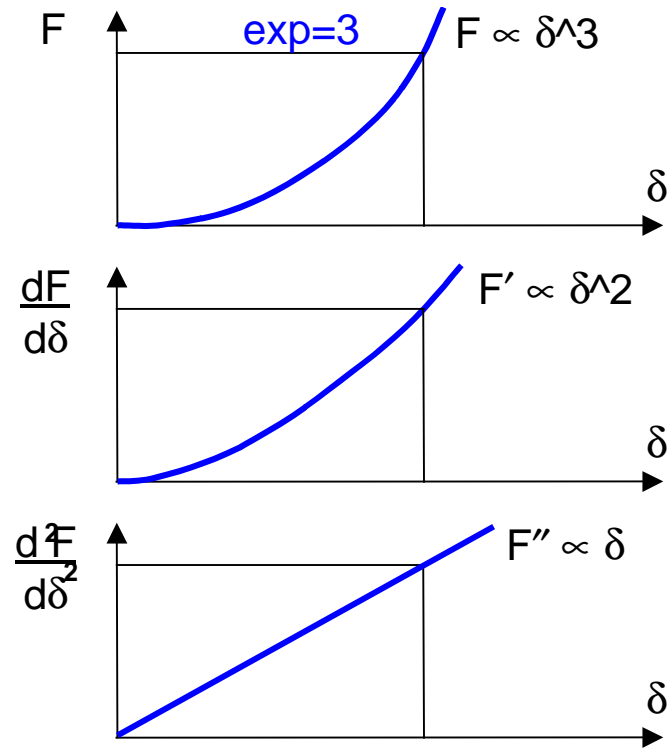
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# New Impact--continued

## (Why is exp=3 magic number?)



$F'$  &  $F''$  are virtually **dis**continuous near  $\delta=0$  → **bad** for integrator



$F$ ,  $F'$  &  $F''$  are continuous → **good** for integrator



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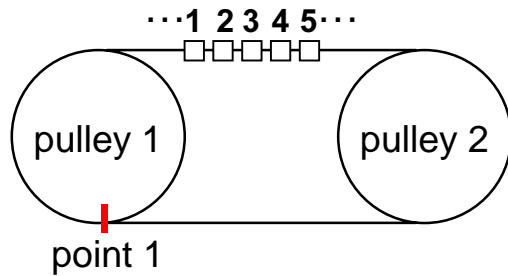
## New Impact--continued (Advantages?)

Applications	Old Impact	New Impact
CV Joints: <ul style="list-style-type: none"><li>• Rzeppa</li><li>• Cross Groove</li><li>• Double Offset</li></ul>	3 hrs 40 min. N/A N/A	3.8 min. 5 min. 7 min
Belt & Pulley System (including CVT)	x hours with softer-than-actual stiffness	x/2 hours with realistic stiffness

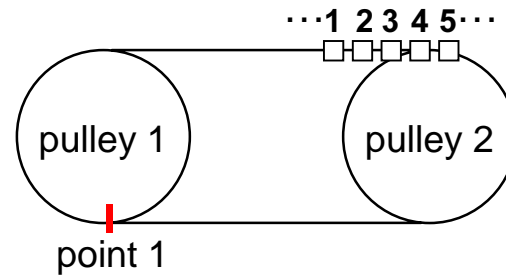


## Snap Shot Technique

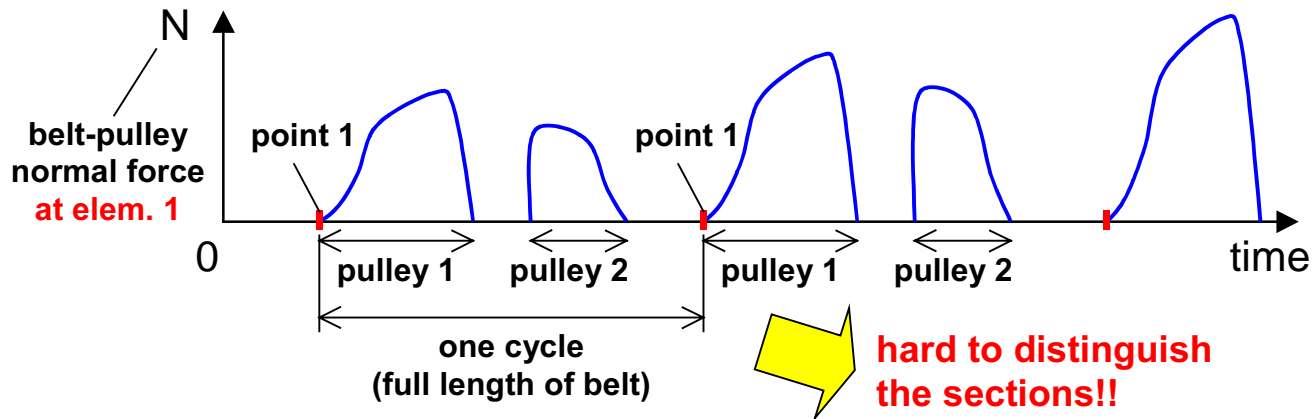
### Conventional Time-Domain Output



Belt system at time =  $t_1$

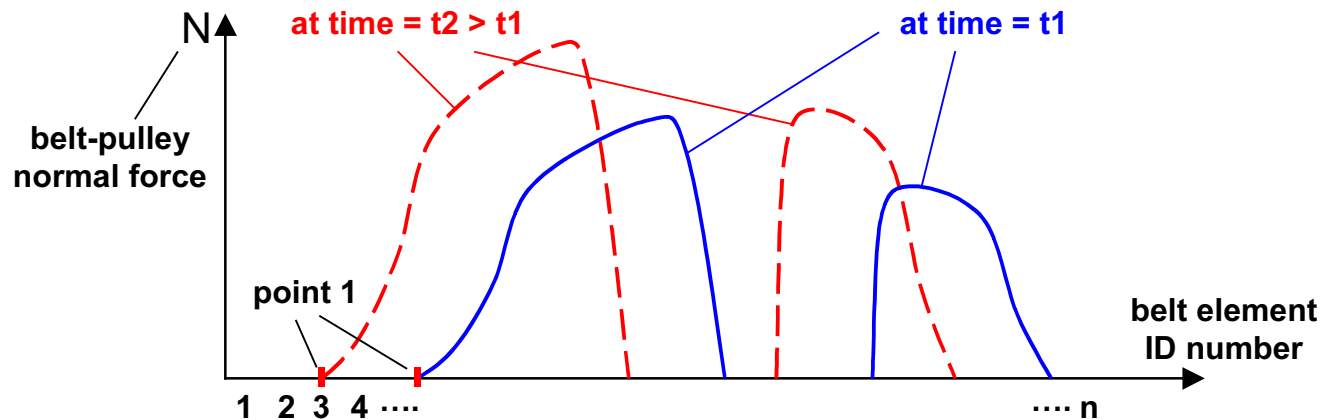


Belt system at time =  $t_2 (> t_1)$

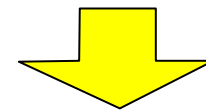




## Suggested Plot → (profile along the belt)



**Problem** → the **plot** keeps on **shifting** to the left direction as time increases



**Solution?**



## Snap Shot Output

**Re-shuffle** the (belt elem. ID # vs N)-data such that the **point 1** (the element that first hits the pulley 1) **comes first!**

elem. ID #	N	Fr	Ft	...
1	0	2	0	
2	0	3	0	
3	0	4	1	
4	0	4	1	
5	2	5	2	
6	3	4	5	
⋮	⋮	⋮	⋮	

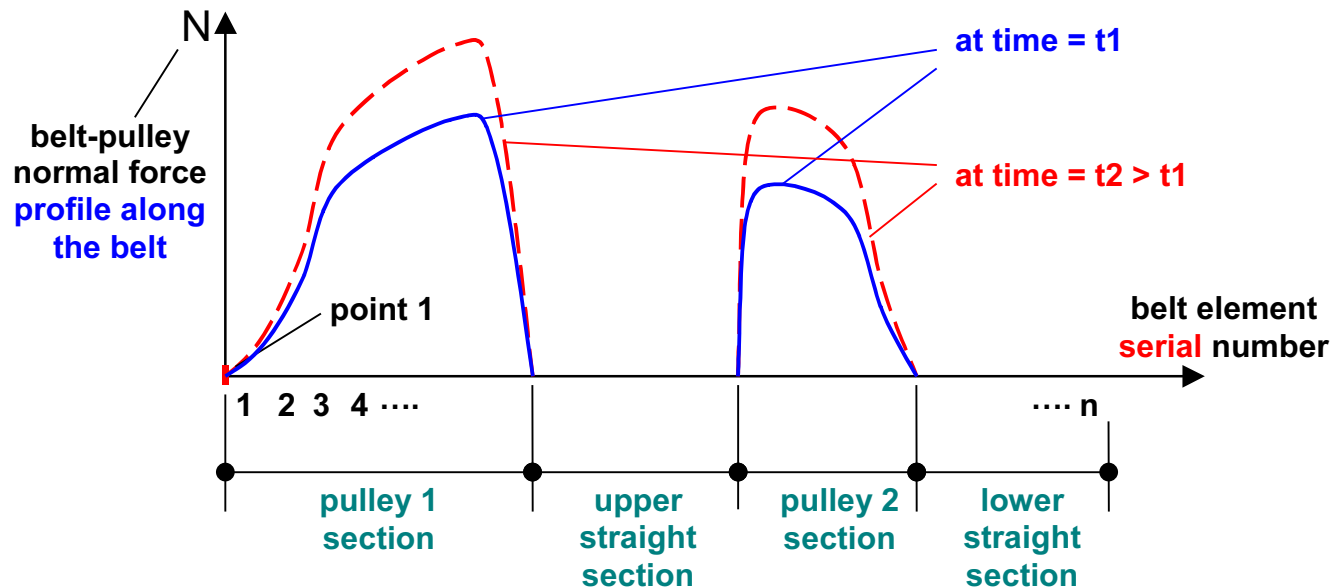
original data at each reporting time step

serial #	N	Fr	Ft	...
1	2	5	2	
2	3	4	5	
3	4	4	7	
4	5	5	7	
5	5	5	6	
6	4	6	3	
⋮	⋮	⋮	⋮	

**Re-shuffled** snap-shot data at each reporting time step



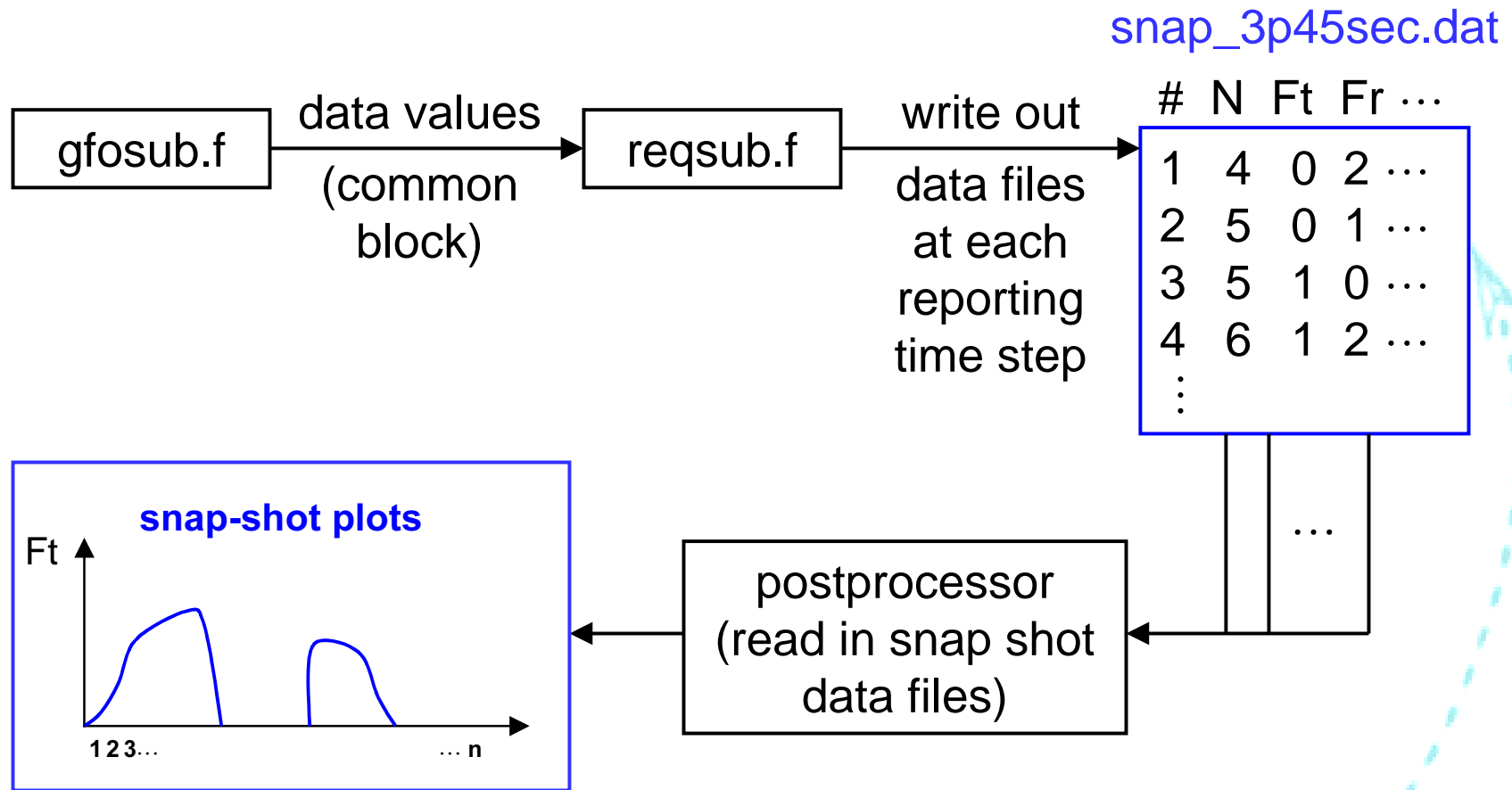
## Snap Shot Output

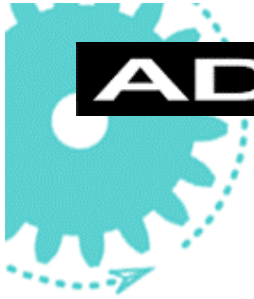


- Advantages:**
- provides **at-a-glance plot** (profile)
  - allows to see the **time-history in one plot**
  - help **reduce the simul. time** because the snap shots are available as soon as the system reached the steady-state



## How to implement Snap Shot Output





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## Applicable Areas of Snap Shot Technique

- Serpentine belt system
- Cam belt system
- Roller chain system
- Silent chain system
- Any other belt/chain system (including CVT)
- Leaf spring system

*Thank You!*