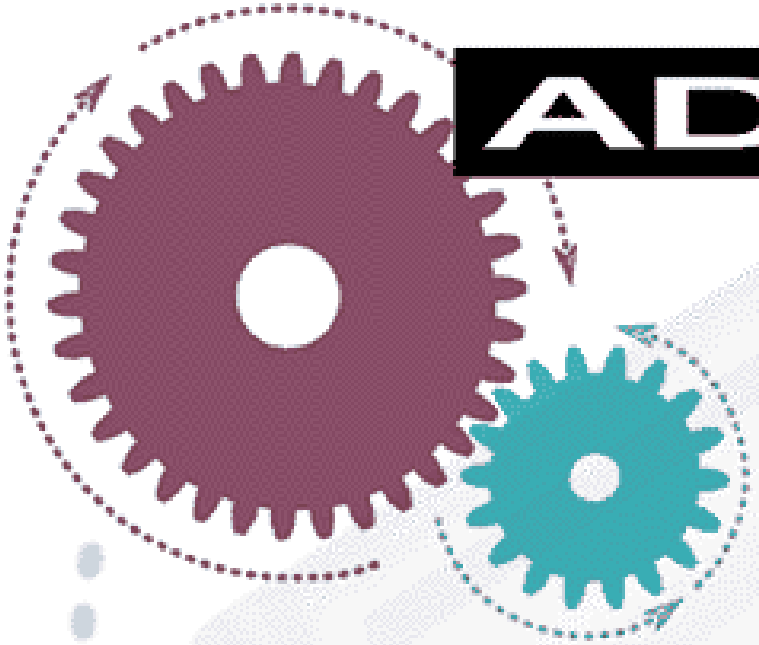

ADAMS

Useful Techniques for Complex Models

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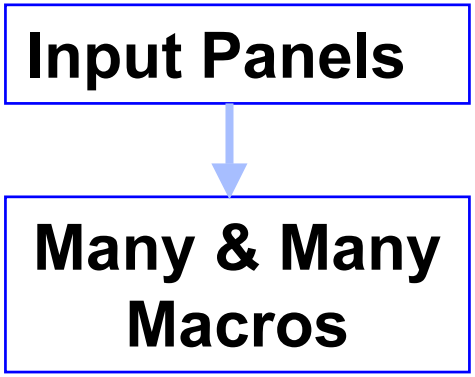
Table of Contents:

Mechanical Dynamics

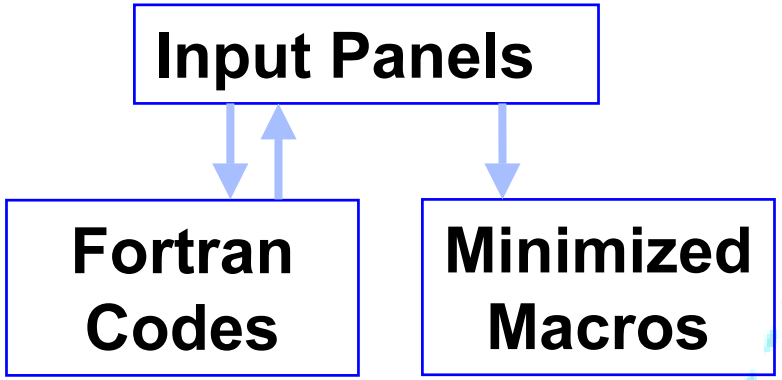
Combined Use of CMD files & Fortran codes

What is it?

Conventional approach (cmd files only)



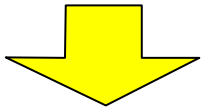
Suggested approach (cmd + Fortran)



Mechanical Dynamics

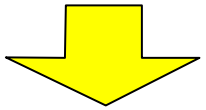
Advantages?

Conventional approach



- hard to debug
- runs slower

Suggested approach

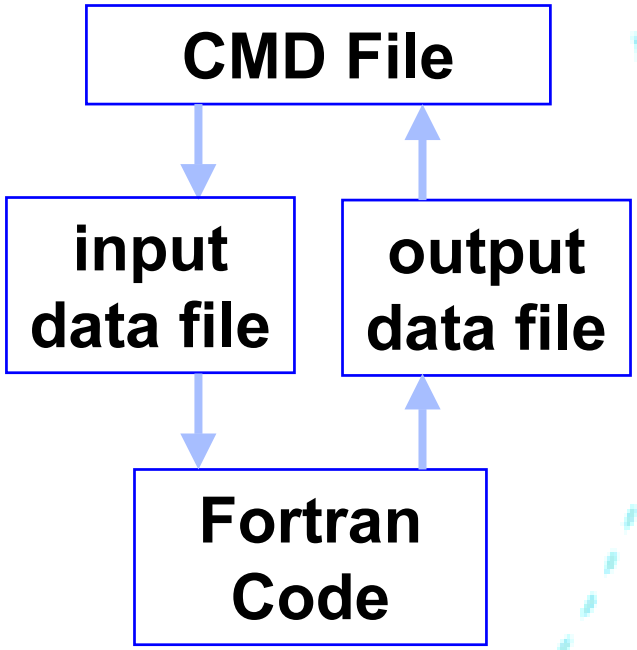


- easy to debug
- runs faster
- facilitates complex calculations

Mechanical Dynamics

How is it done?

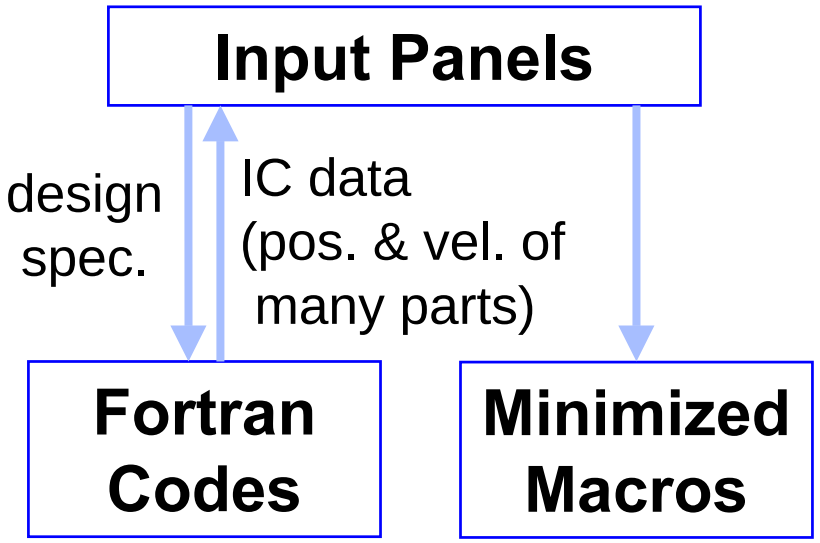
```
execution_commands = "var modify var=.cv.allow_stress  real=$f_input_1",  &
    "file text open open_mode=append fi=\"cross.dat\" ",  &
    "   file text write values_for_output=(.cv.cv_bn)          format_for_output=\"%d\" newline=yes",  &
    "   file text write values_for_output=(.cv.cv_grb)         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.l_output_1_2'  &",  &
    "   'text = (eval(locx[1]))'", "",  &
    "interface label modify  &",  &
    "   'label_name = .gui.design_check.l_output_2_2'  &",  &
    "   'text = (eval(locx[2]))'", "",  &
    "interface label modify  &",  &
    "   'label_name = .gui.design_check.l_output_3_2'  &",  &
    "   'text = (eval(locx[3]))'", "",  &
    " ",  &
    "var del var=locx", &
    "ana del ana=results" &
```



Mechanical Dynamics

Example 1

(Preprocessor for Complex Belt & Pulley System)

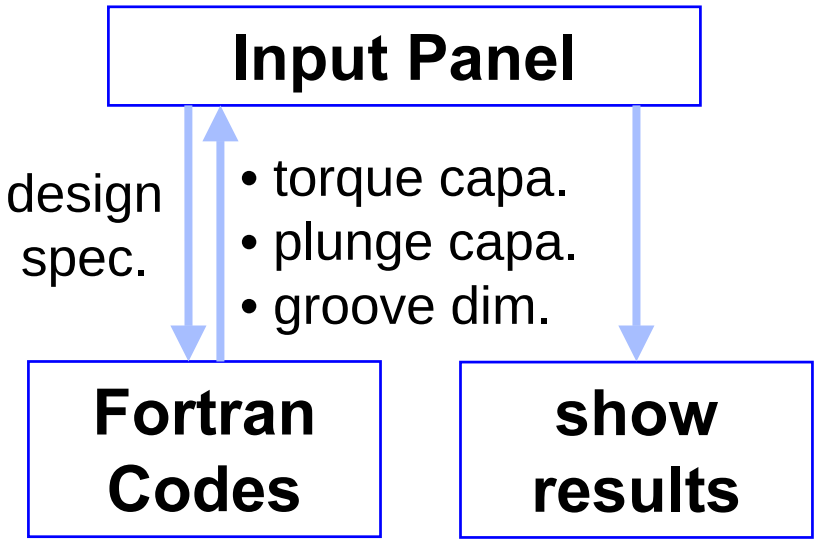


- cmd only preprocessor → 2 hours for model generation
- cmd + fortran preproc. → 30 min. for model generation
  + it allows precision modeling

Mechanical Dynamics

Example 2

(Design Check for CV-Joint Model)

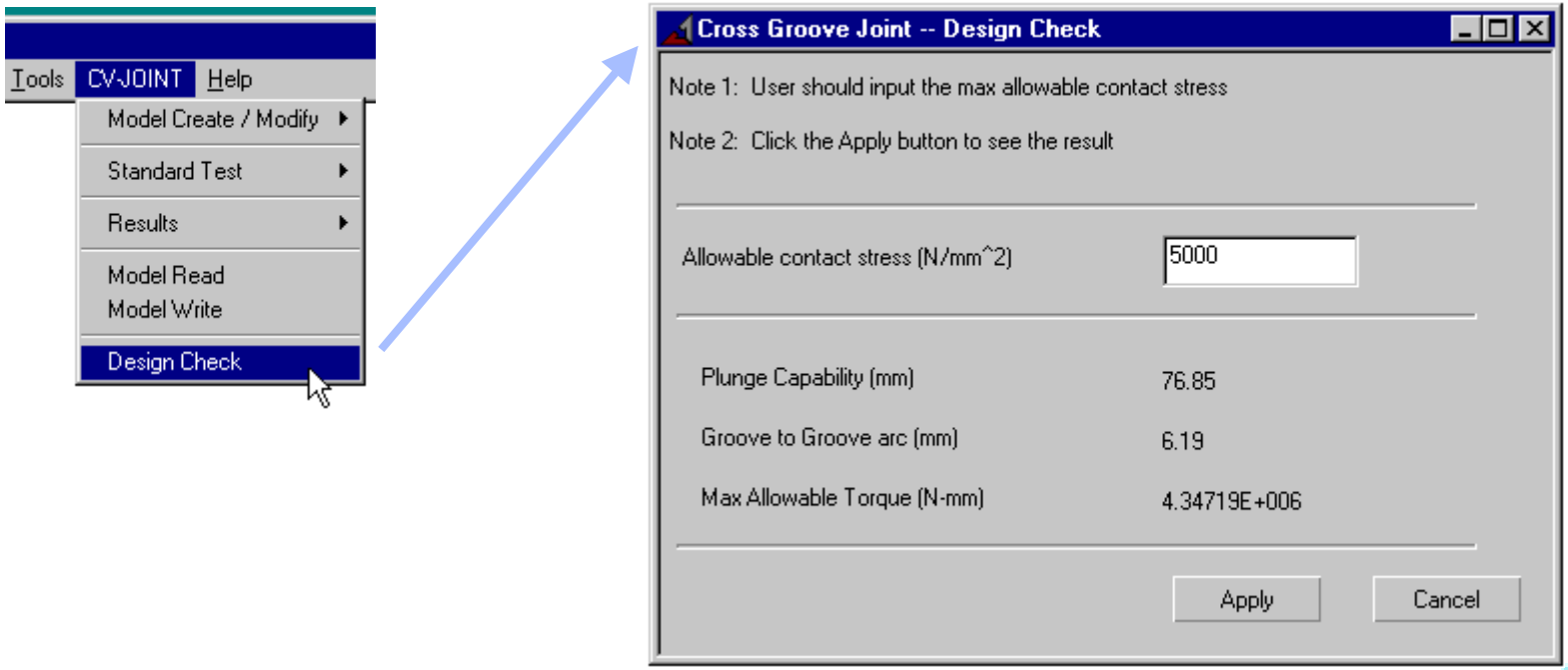


- cmd only preprocessor → practically difficult to implement
- cmd + fortran preproc. → allows extremely complex calculations that involve Newton Raphson iteration & Hertzian stress calcuations

Mechanical Dynamics

Example 2--continued

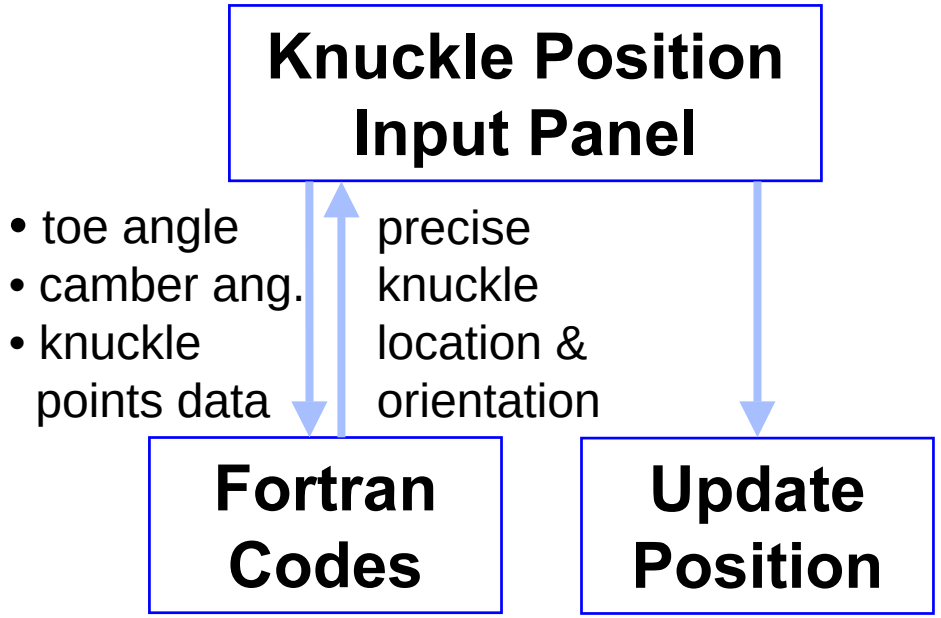
(Input Panel for Design Check)



Mechanical Dynamics

Example 3

(Precision Positioning of Knuckle)

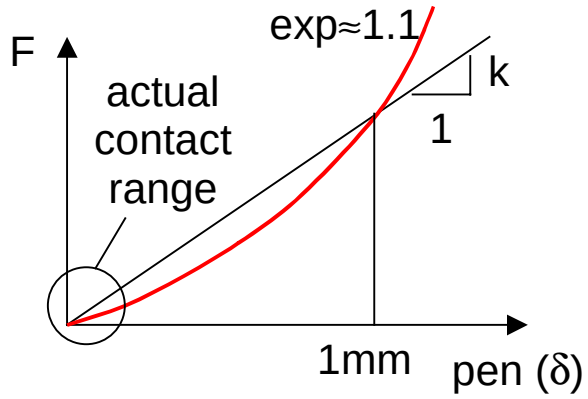


- cmd only preprocessor → practically difficult to implement
- cmd + fortran preproc. → allows extremely complex calculations that involve Newton Raphson iteration & complex coordinate transformations

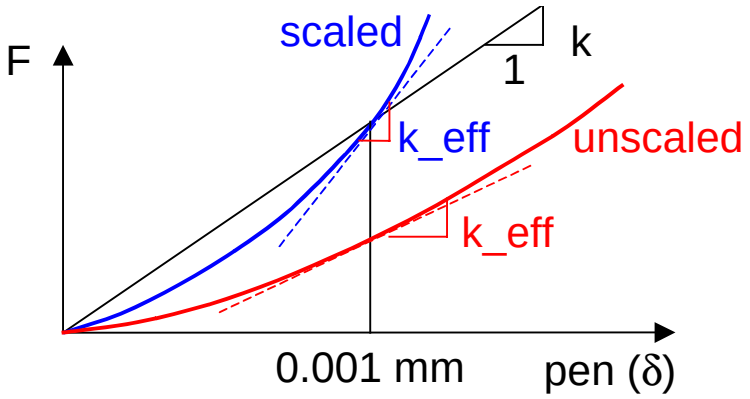
Mechanical Dynamics

Rediscovery of Impact (New Impact)

Conventional Impact



(unscaled impact)

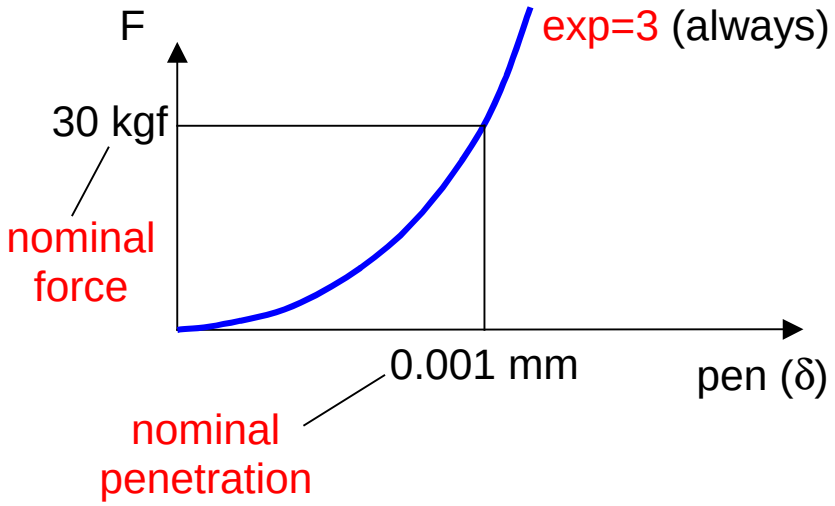


(scaled impact)

- scaling or exponent_value → affects the effective stiffness
- realistic value of effective stiffness → often times cause simul. failure

Mechanical Dynamics

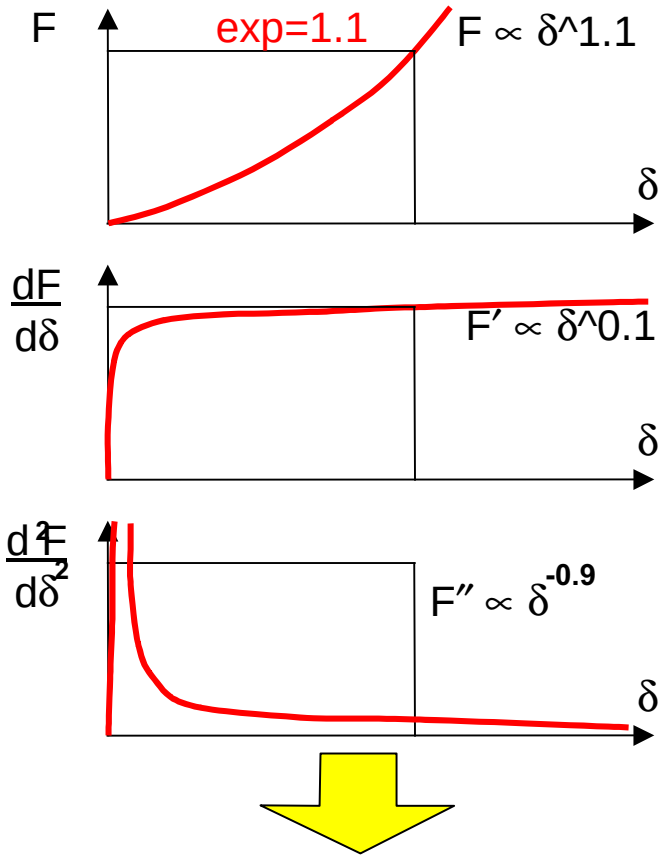
New Impact

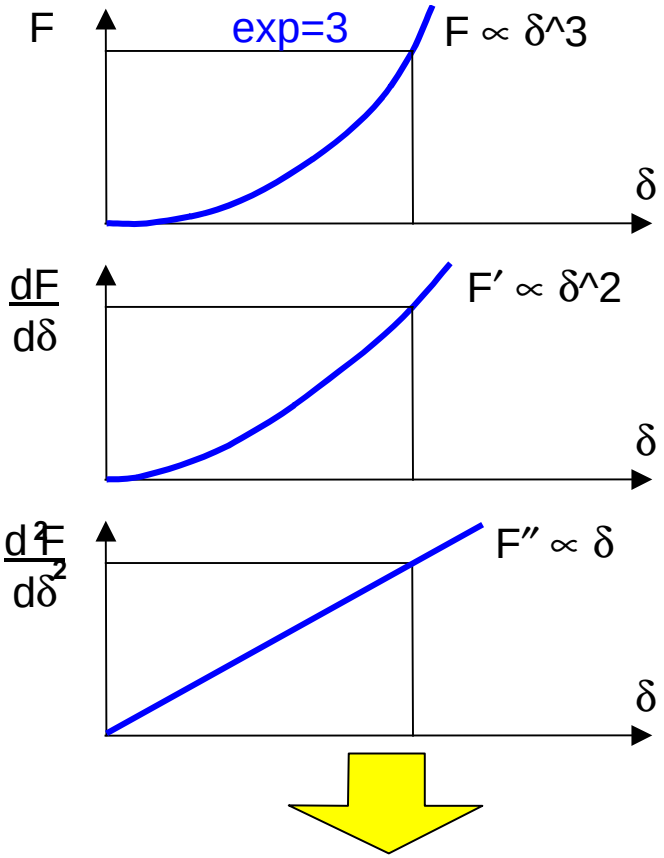


- discard stiffness & exponent concepts
  - ➔ which affects the effective stiffness
- adopt nominal force & penetration concept
  - ➔ simple & intuitive to users
- exponent is fixed to 3
  - ➔ magic number for numerical integration!

New Impact--continued

(Why is exp=3 magic number?)





F′ & F″ are virtually discontinuous near δ=0 → bad for integrator

F, F′ & F″ are continuous → good for integrator

Mechanical Dynamics

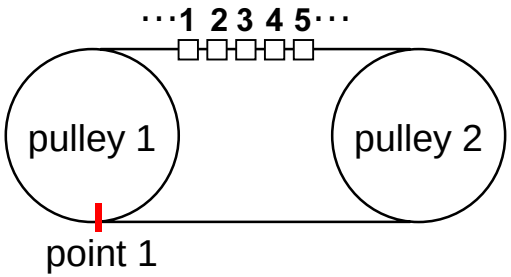
New Impact--continued

(Advantages?)

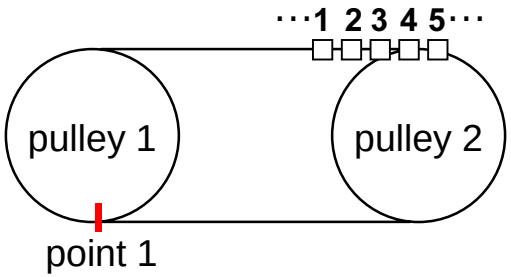
Applications	Old Impact	New Impact
CV Joints: • Rzeppa • Cross Groove • Double Offset	3 hrs 40 min. N/A N/A	3.8 min. 5 min. 7 min
Belt & Pulley System (including CVT)	x hours with softer-than-actual stiffness	x/2 hours with realistic stiffness

Snap Shot Technique

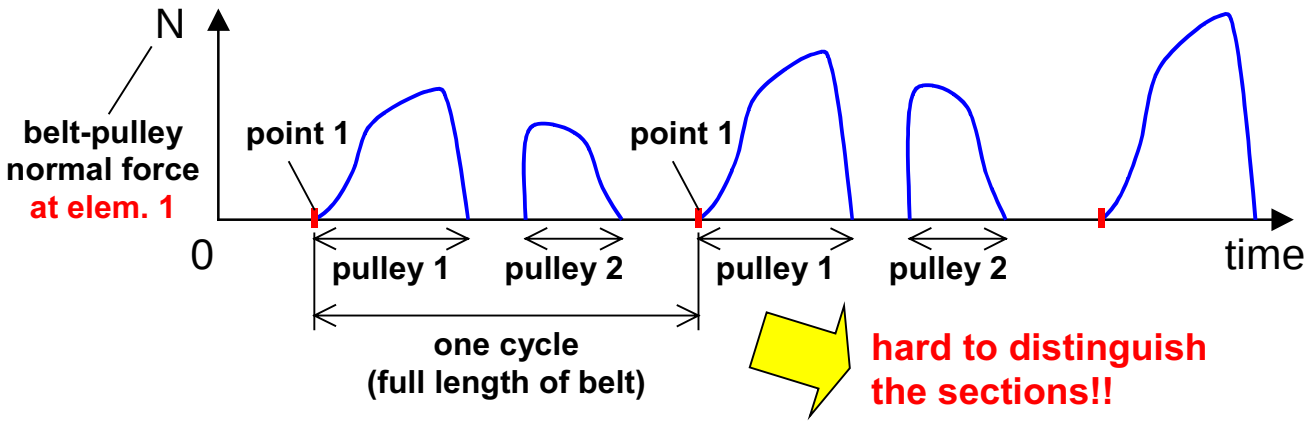
Conventional Time-Domain Output



Belt system at time = t1

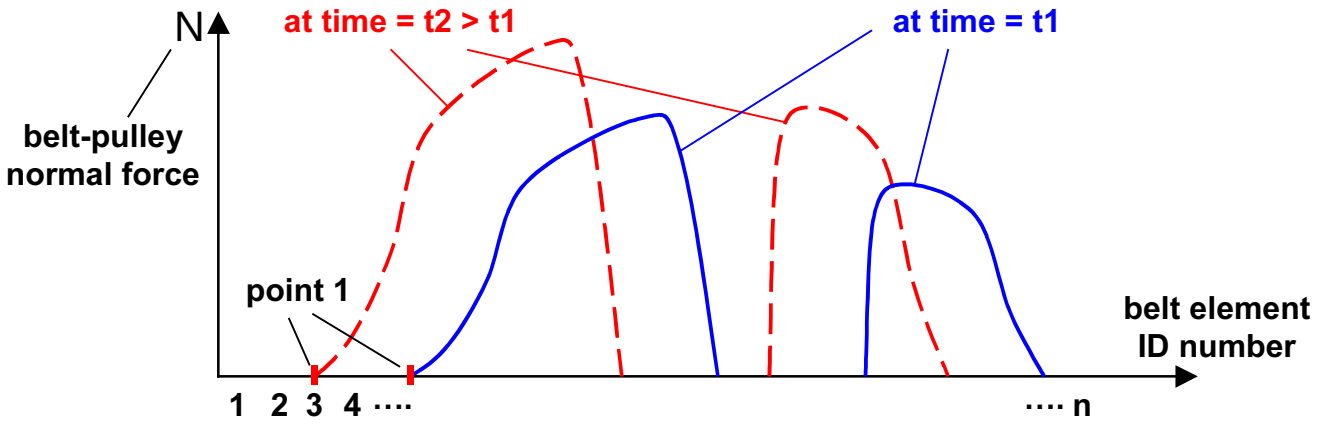


Belt system at time = t2 (> t1)



Mechanical Dynamics

Suggested Plot → (profile along the belt)



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

Solution?

Mechanical Dynamics

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	
⋮	⋮	⋮	⋮	

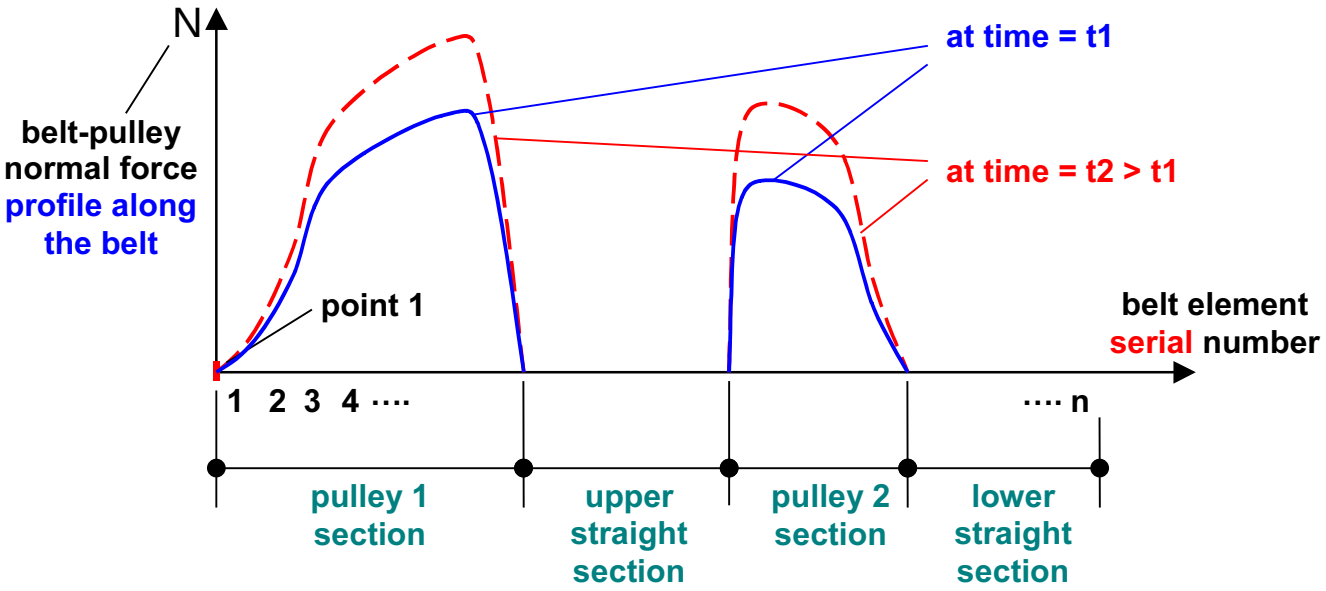
original data at each reporting time step

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 spap-shot data at each reporting time step

Mechanical Dynamics

Snap Shot Output

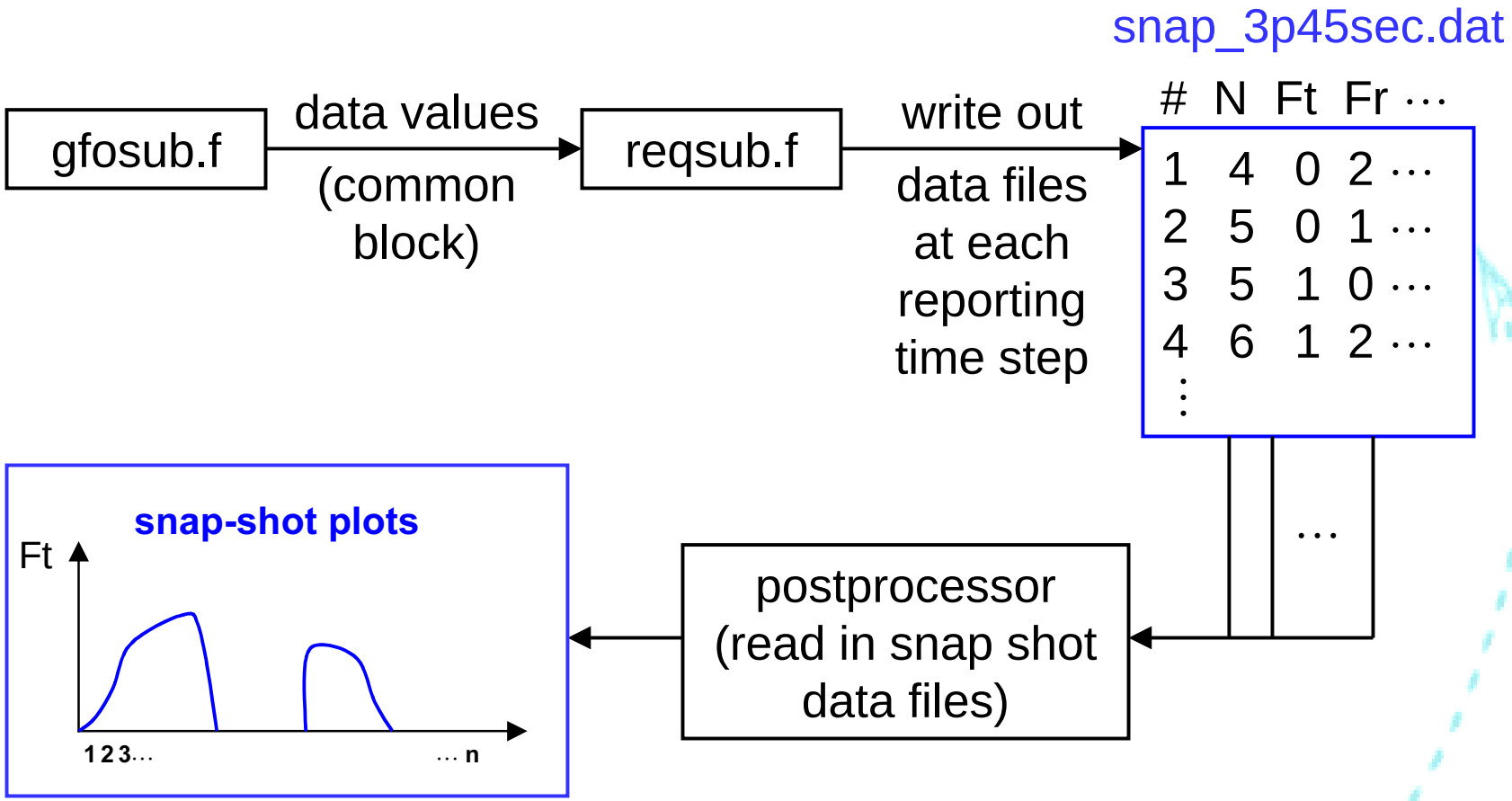


Advantages:

- 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

Mechanical Dynamics

How to implement Snap Shot Output



Mechanical Dynamics

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!