Applications of LS-DYNA in Electronics Products

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Introduction:

Portable electronic devices have become smaller and lighter but they are also easily damaged during accidentally drop situation. Therefore, new electronic products are usually needed to pass requirements of shock and drop test before actually delivering to customers. FEM simulation provides engineers a useful and powerful approach to identify the potential weakness of products before the prototype is even made. The report will introduce the applications of the Ls-dyna in a virtual lab which simulates the experiment conditions of shock and drop tests in computers. It also shows Ls-dyna can be a very effective tool for engineers to improve the performance of their design in the shock and drop test.

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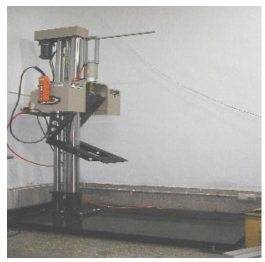
Types of experiments

Introduce how to simulate drop/shock test by using the LS-DYNA according to different types of experiments. Three types of experiment equipments are widely used in electronic industries.

- Free drop
- Shock table
- Shaker

} One group

acceleration gage



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- Based on different types of inputs in experiments, they can be divided into two groups.
  - First group → Free drop test → input: height
    - According to the weight of products, height of the free drop test can be determined. Once the H is decided the velocity before the impact can be defined as

$$V = \sqrt{2gh}$$

      - The direction of performing the free drop test are, One corner, three edges, six faces

Normally, the free drop tests are with foam or sort of packing solution.

  - Second group → Shock table and shaker → shock waves
    - The types of input waves for the shock table are half sine, square and triangular. To perform a shock test, a peak, duration and shapes of the acceleration wave shall be determined first.

Normally, this experiment has direction impact on the products.

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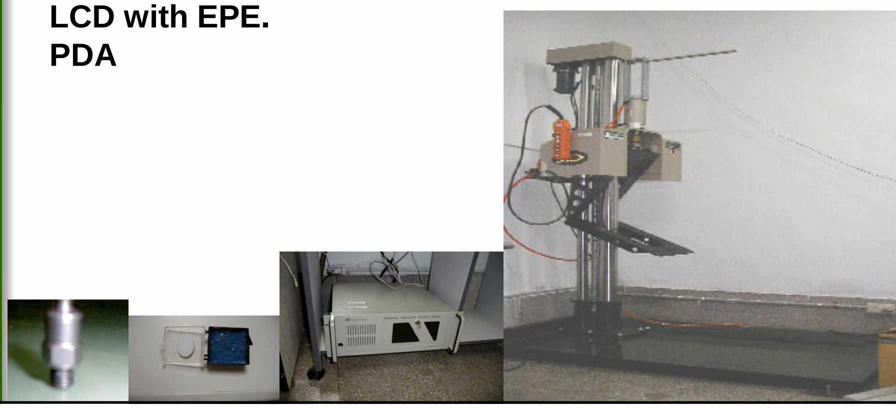
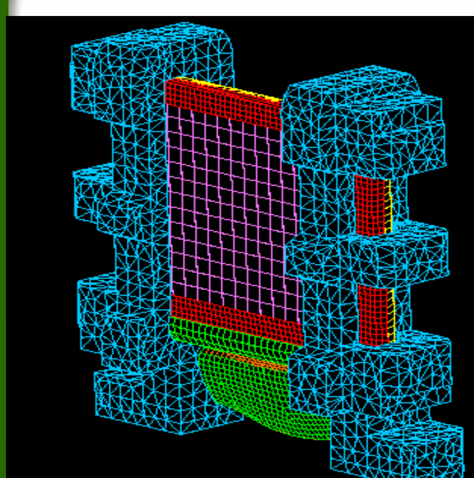
Free Drop Simulation

LCD with EPE.
PDA



Fem model and the actually LCD



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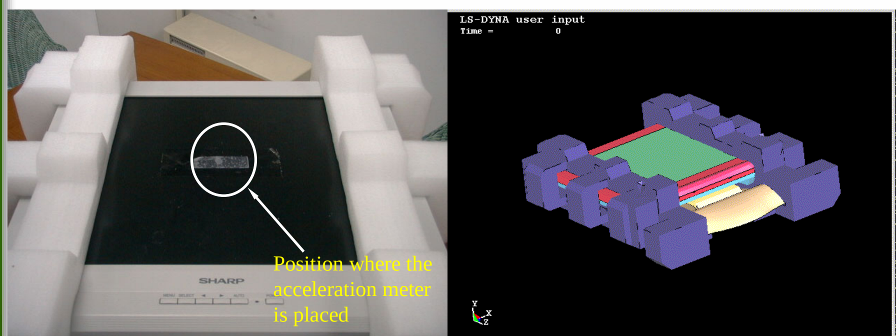
Pictures of LCD with EPE

- The animation on the right hand side shows direction of the impact for a LCD with EPE package. The other picture shows where the acceleration meter is located.



Picture provided by Mitac

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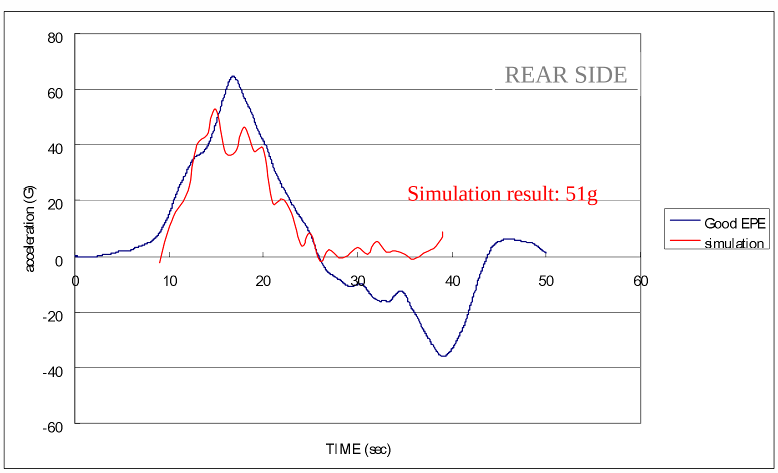
Drop Simulation and Experiment Results



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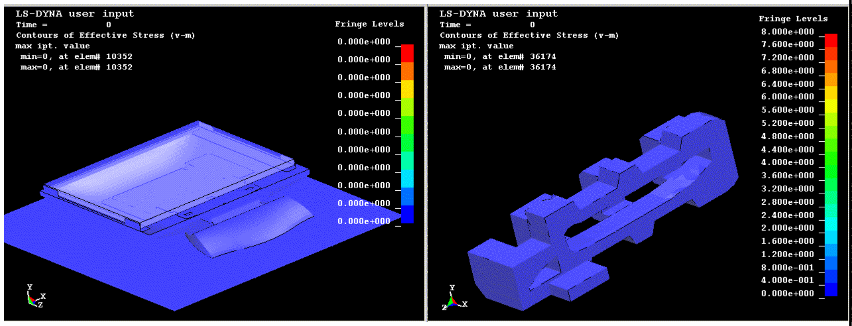
Approach to reduce the usage of EPE

Information for the entire model is ready for engineers to obtain after the simulation is done. Virtually, the physical responses for all components are kept inside simulation results.



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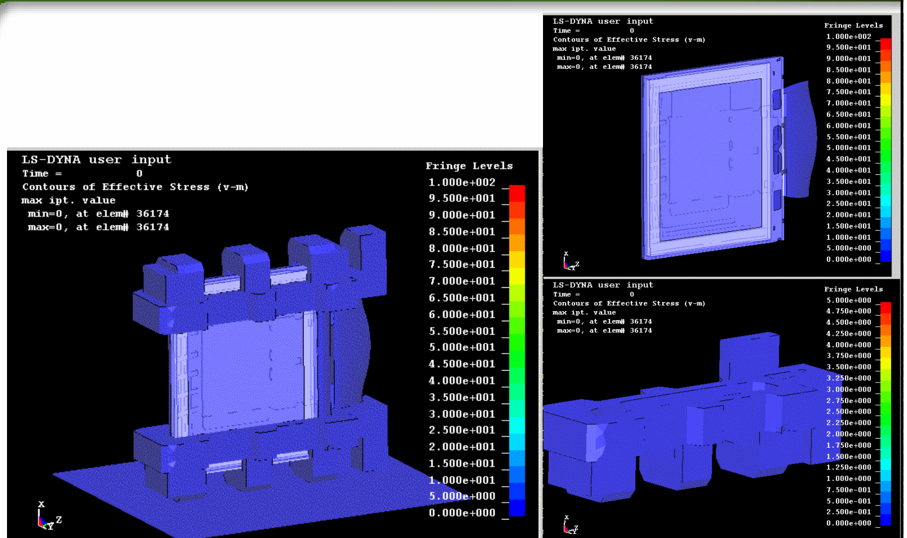

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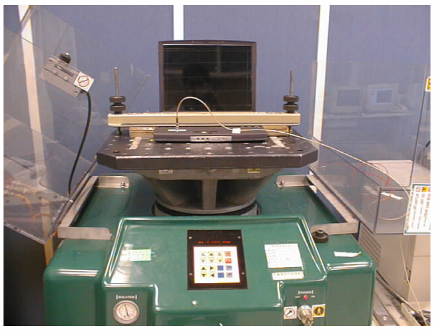
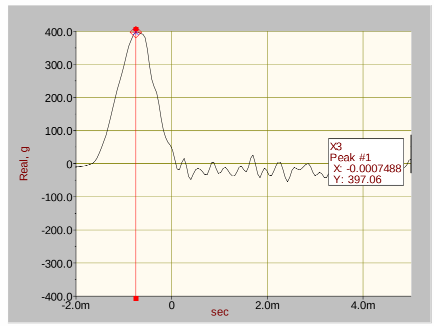
Shock table

- Shock table: shown as below
- Accelerometer: Dyan 3200B5 (acc. limit: 5000G) located at HDD center
- Shock input: 400 G/ 2 ms





Pictures provided by Kevin, Wistron

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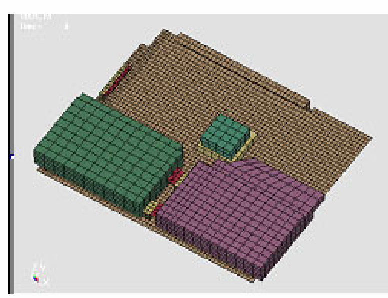
FEA Shock Simulation

- Software: LS-DYNA (non-linear finite element solver), FEMB (Pre-processor)
- CAD model was simplified to create FE model



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Weight Analysis and mesh summary

	Machine		Simulation
LCD Module	720		720
Keyboard	103		103
CD-ROM 178	178.5		
Battery	394		393.5
Daughter board	22.5		25.2
Mother board	204		205
middle cover	10.5		
heat sink 42			
Fan	24.5		
audio in/out cover	21.5		
Lower case	212	=310.5	311
speaker +cover (R) 9.5			
speaker +cover (L)	10		
mouse pad	8.5		
Upper case	105	= 133	134
HDD	111.5		112
HDD cover	5		8
Total	2181.5		2191

HDD cushion		1080	solids
HDD		5850	solids
Battery		2320	solids
Other hexa components		1770	solids
Total numbers of solid elements	11020	solids	
Ribs (Support HDD)	278	shells	
HDD Holder		160	shells
Lower case		3029	shells
Upper case		3174	shells
Motherboard		1216	shells
CD-ROM shells			1424
Other Shell Components		92	shells
Total numbers of shell elements	9373	shells	
Rigid Link Elements	102		
Mass elements		2	
Total elements		20497	

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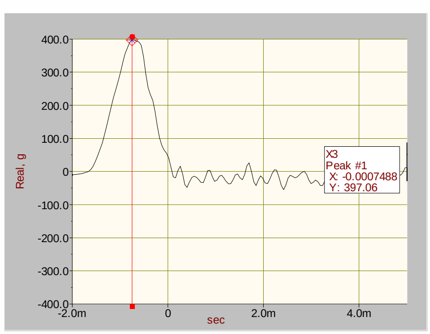
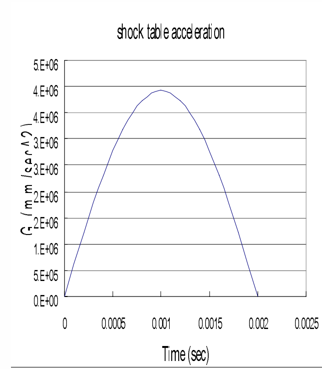
Acceleration Pulses

- The figure on the left hand side shows acceleration v.s. time used during a shock test. The curve is also used as an input for the simulation.





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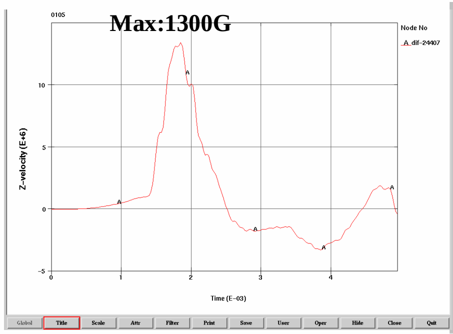
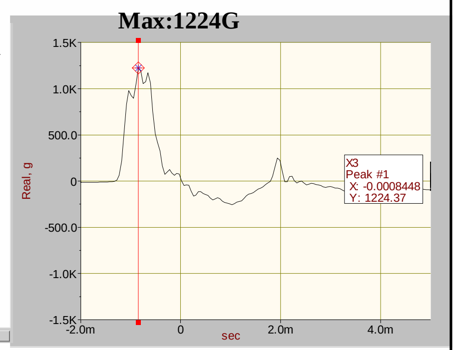
Simulation results Correlates with experiment results





Shock test results (provided by Kevin, Wistron)

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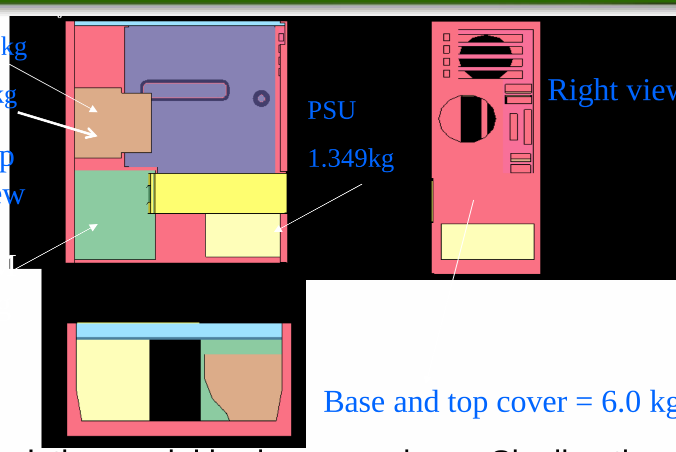
Modeling information



- The simulation model is shown as above. Six directions of shock tests are all simulated. The objective of this simulation is to investigate the model will survive the shock test.

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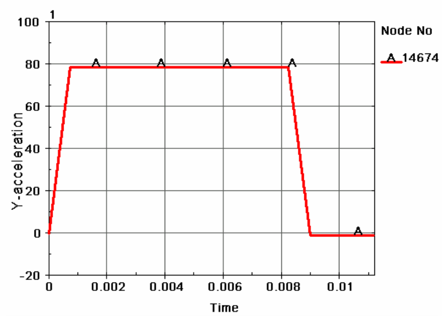
Pc Enclosures in Shock test

- A half sine wave of acceleration input was introduced in the previous simulation. In this case, a square wave of acceleration is used as an input of simulations and experiments.



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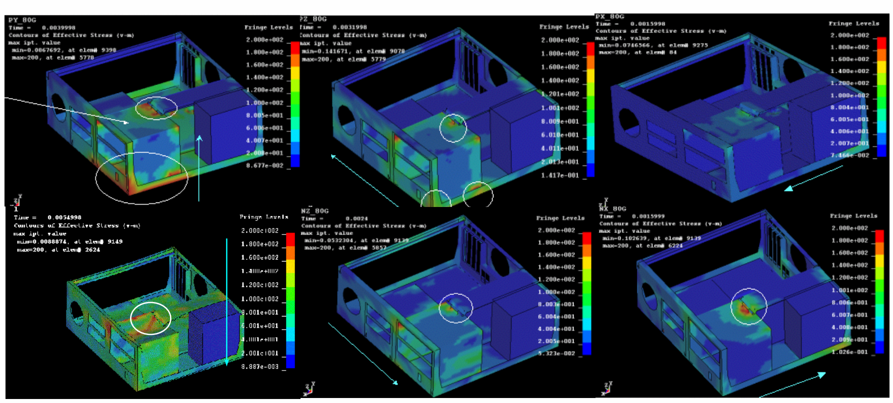
Simulation results for all directions of impacts



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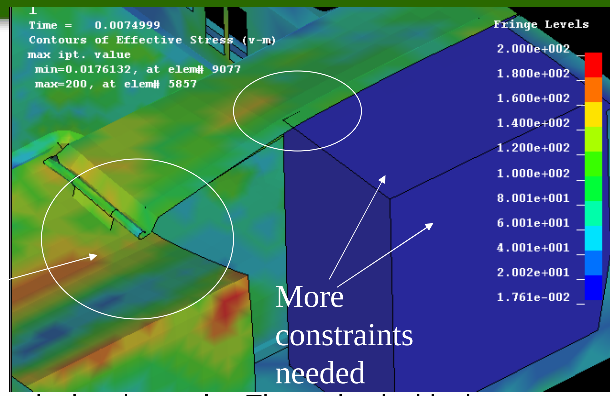

The twisted bar is shown in the above plot. The region inside the circle is where the contact occurred between the bar and PSU. The reason causes these two objects to collide is the PSU does not have enough constraints. The solution is to add more supports to provide extra constraints for the PSU. That will fix the PSU where it is, therefore reduce the upwards forces to the added bar.

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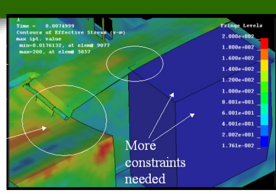
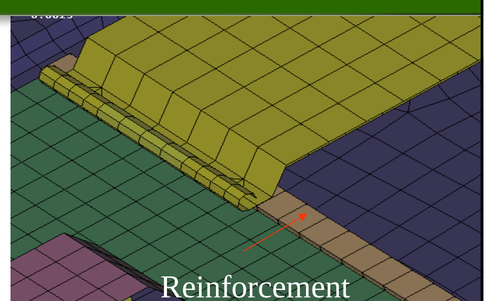
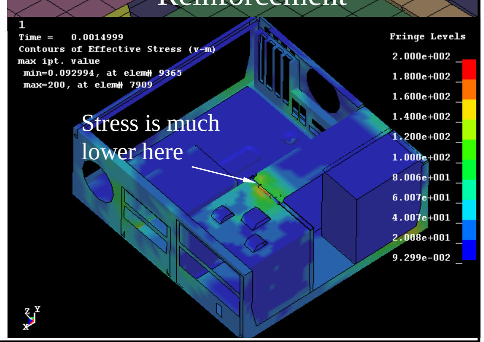
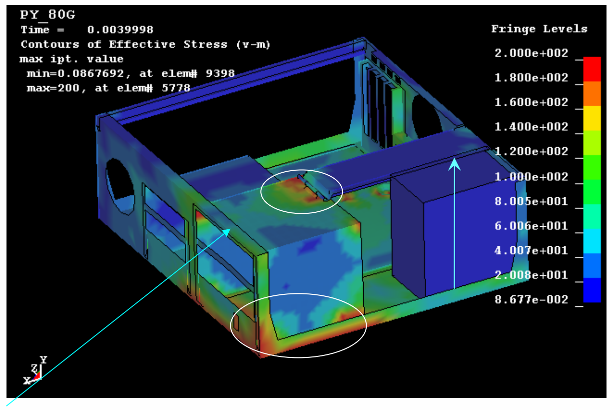


In the previous plot the hinge connection is failed in the simulation. A reinforcement bar is added to the CD tray to spread out the stress. The peak stress around the hinge is now much less in the new design.







There is no support on top of the CD tray. It is the main reason that bottom of the chassis has high stresses. An extra support on the top surface will help to share the impact force.

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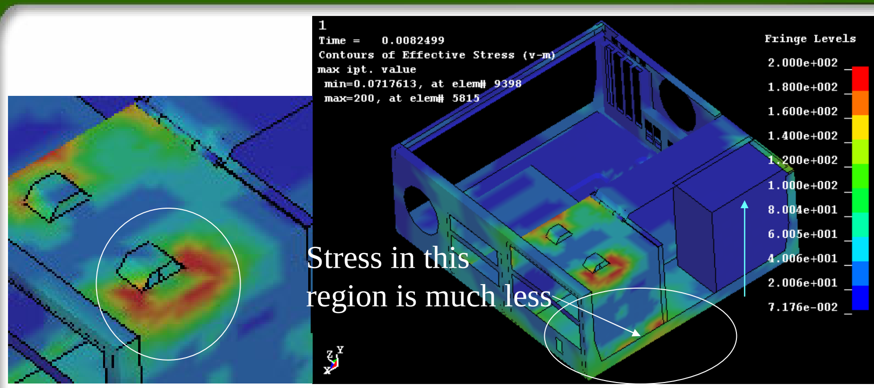

- Two small extrusions are formed as extra supports in this direction. The stress at the bottom of CD tray is less than the original design. However, regions of stress concentration are now shifted to the top of CD tray.

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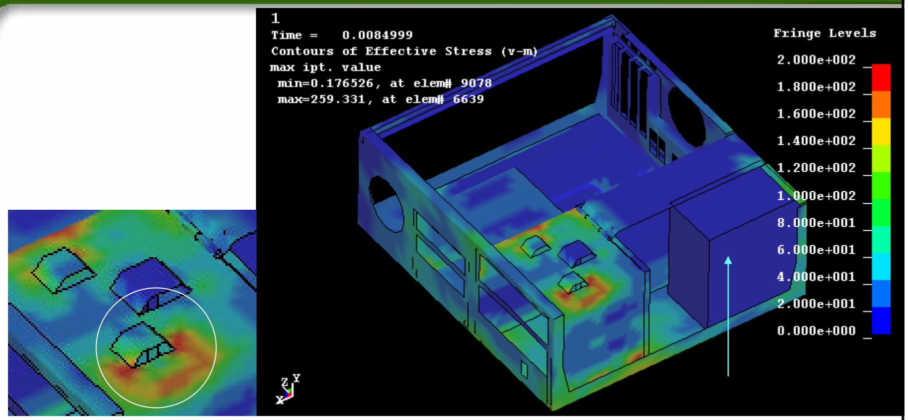

The third extrusion is added to reduce the stress concentration on the top surface. It does work very well in sharing the stress.

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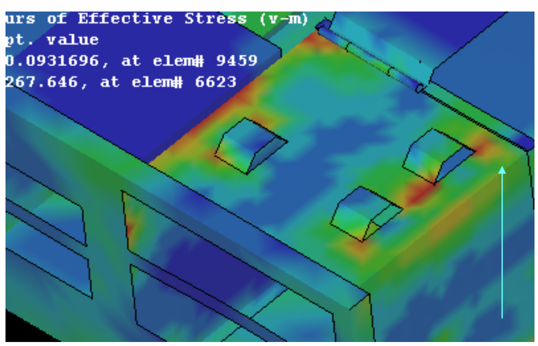

- The third extrusion is moved to new location. The stress contours in this design is better that the previous designs. If more supports are added to the top surface, the peak stress will be reduced.

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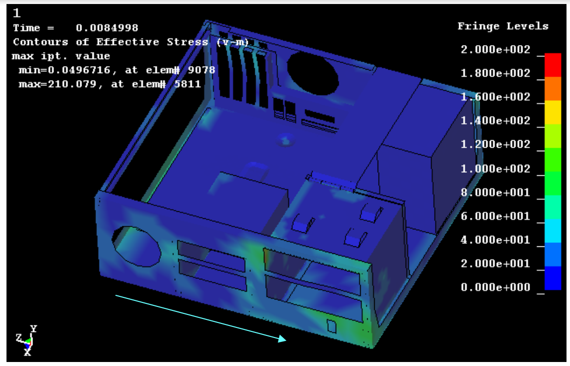

The stress distribution near the hinge is improve by the reinforced bar added before. One more riveted joint is added on the each side of the CD ROM tray to share the shear force.

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Experiments in a Virtual Lab

- A FEA model has built and analyzed in the computer(virtual Lab). The results are then compared with those from experiments. Once the simulation and experiment has good coloration with each other, the model can be treated as a good representation of real object in the Virtual Lad. Based on the good agreement between simulations and experiments, we can rely on the feedbacks of possible design changes in the virtual lab to make engineer judgments. Different structures can be tested until a satisfied conclusion is reached.

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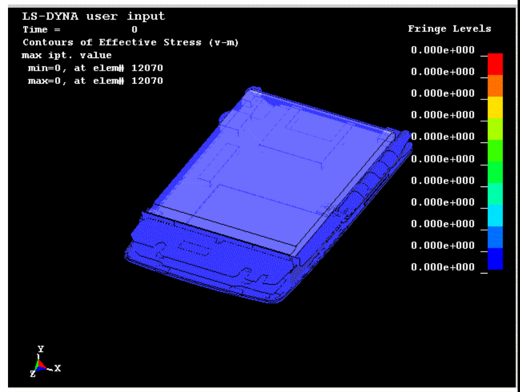
Modeling information for the analysis

Quad. Elements	11137
Tria elements	681
Hexa elements	3544
Wedge elements	123
Spot weld	24
Total No of elements	14896
Simulation time MSec	30

Cpu time required12 hours

On a K7 1.2 GHz



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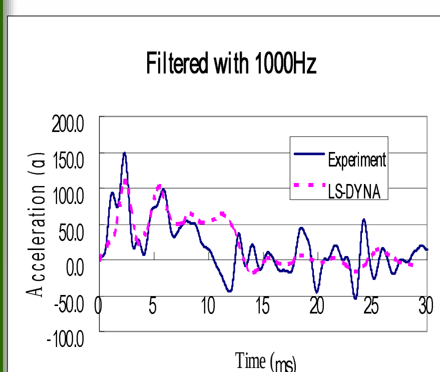
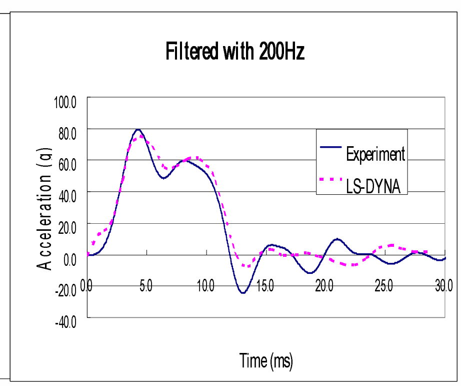
Experiment and Simulation Result





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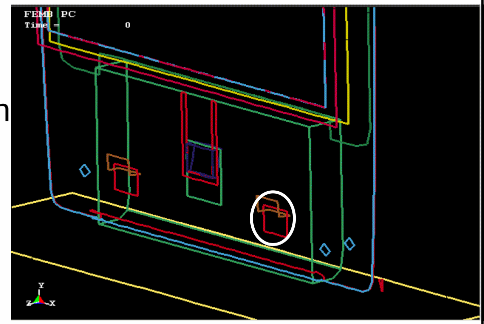
Snap Fit design in PDA

- Objective: snap fit connections are one of the most comment connector used in electrical products.

Using advantage of simulation to investigate the response of snap fit during the collusion. Snap fit will vibrate violently after the collusion with floor.



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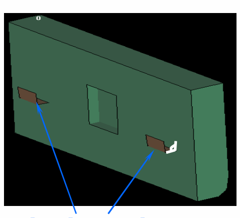
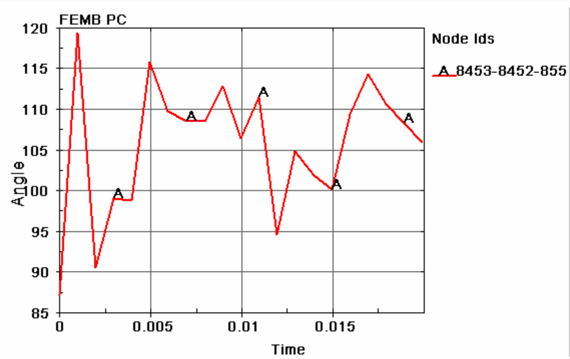
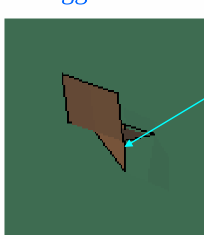


Ribs that make structure stiffer are suggested.





- A small rib is suggested to add at the root of snap fits. Its function is to reduce the movement of the snap fits during the impact.

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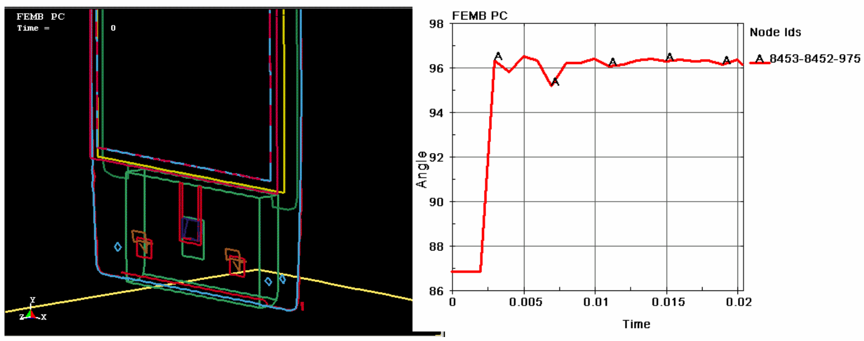
The same angle between the snap fit and the wall is plotted. It shows clearly that small ribs are very effective in reducing oscillations at the snap fits .



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- The change of angles for both structures are listed in the following table. As we can see, the structure with small ribs certainly perform much better than the original design.

	Original angle	Largest angle	Angle variation
Without ribs	87	120	23
With ribs	87	96	9

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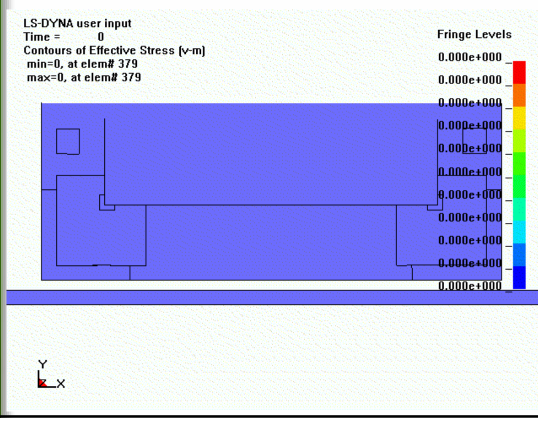
A failure of structure is located

- The rib with thickness of 1 mm is not strong enough to support the LCD in a free drop test.



Picture provided by Mitac

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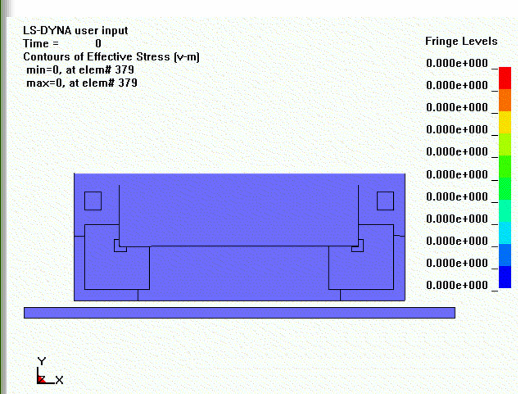
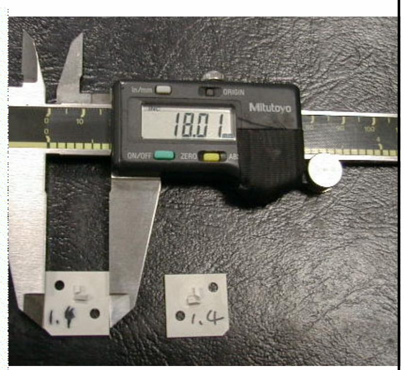
- Thicker ribs with 1.4 mm in thickness are used. Again, they still fail during the process of impact.





Picture provided by Mitac

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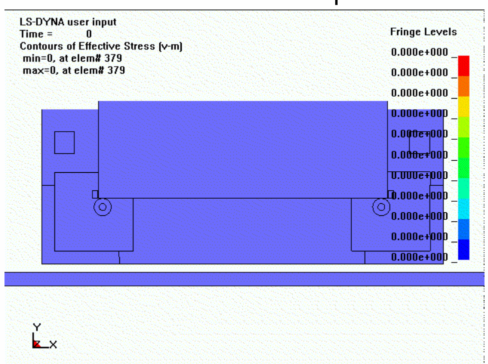
Final design

- Cylinders with outer diameter of 4mm and inner diameter of 2.6mm are built. They survive in the process of impact in the simulation. The later experiment confirms that.



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Conclusion

- The report demonstrates clearly that the concept of virtual Lab can be very a powerful and useful tool for engineer to improve their design as early as in stages of concept design. Changing geometry at this stage is virtual free. In addition, different features and ideas can be tested in the virtual lab with just few finger clicks. Eventually, better and stiffer products can be manufactured with the help of virtual simulation.

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