2005 한국경영과학회/대한산업공학회 춘계공동학술대회
2005년 5월 13일~14일, 충북대학교

Design Process Improvement through the Integration of Commercial Software

상용 소프트웨어의 통합을 통한 설계 및 검증 시간 단축을 위한 연구

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초록

한국정부가 제조물책임법을 2002년 7월에 도입한 이래, 많은 제조업체가 설계해석 툴의 도입을 검토하고 있다. 또한, 원청업체의 요청에 의해 설계해석 툴을 도입하기도 한다. 일반적으로 설계 해석 툴들은 엄청나게 복잡하고 방대한 지식을 포함하고 있기 때문에, 이 툴을 사용하는 해석 전문가 역시 전문가는 설계 및 분야에 관한 방대한 지식을 터득해야 한다. 따라서, 중소기업에 이런 툴을 도입하기 위해서는, 도입비용 뿐 아니라, 운용 인력 확보에도 상당한 애로를 겪고 있다.

본 연구에서는, 신축관을 설계하는 업체를 대상으로 하여, 신축관의 특성을 이해하기만 하면 해석이 가능한 시스템을 구축하여, 해석 툴의 사용자 범위를 확대하고자 한다. 이 목표를 달성하기 위하여, MS-Excel, MDT, ANSYS를 통합하였으며, 이 연구결과로, 특별한 교육을 받지 않은 설계자도 이 통합 시스템을 운용할 수 있고, 설계 및 검증 시간을 획기적으로 단축할 수 있음을 확인하였다.

1. INtroduction

Up to now, Korean makers have many difficulties to manage their companies. These difficulties come from many reasons such as internationalization, the growth of China(Chosunilbo, 2004), difficulty of coming up with the advancedcountries, high cost and low productivity, many kinds of law restriction, hard to find workers etc.

Especially, the fact that the relation between maker and vendor has been changed makes the vendor more difficult. In traditional relation, the maker designed all system and analyzed their design. After design confirmation, they issued the drawings with their order. The design and analysis had been done by the maker who has more technical capacity than vendors. Accordingly, the main role of a vendor is to produce products as written in drawings and quality specification for their maker.

But after when the act of product liability(PL) was announced by the Korean government at July 2002, this act makes many vendor companies to prepare the analysis ability for their products. A maker asks the vendors to offer the analysis results when vendors bring their product to it.

Besides of this legal and relational situation, vendors have other basic problems. These problems were drawn from the interview which was done by design analysis tool distributor. One isthe lack of high level labor power. The worker who can control the design analysis tool is a kind of professional. This kind of designer usually takes graduate school education. It means their salary is very expensive for many small size vendors. And even the worker studied mechanical engineering in the graduate school, if he/she never used any kind of analysis tool, it needs about 6 months that he/she grows upa person who can understand and control the whole function of the design analysis software. But, because there are many companies that need such capable designers, these educated employees easily separate from his/her company. Actually there are high separation rate in this labor market. These situations make the vendor to hesitate to introduce design analysis software.

The other problem is that the introduction cost of design analysis software is very high.

Considering these problems, it is especially necessary to the small vendors that a research for making such basically complicate software easy to use should be done.

The objective of this research is to develop a method or circumstance that makes it easy to use the complicate design analysis tool. To do this, many design tools were integrated. As an evaluation example, we used U-type bellows that is a part of pipe system. Through this example, we can confirmthat this integration shows good effect as follows. (1) Design productivity improvement, (2) Design qualityimprovement, (3) Cost down through optimization, (4) Cost down for prototype, (5) Preparation for PL, (6) A vendor can eventually achieve high competitiveness.

2. Methodology

The object product of this research is bellows(Li etc, 1995, Tianxiang, 1998, Expansion Joint, 1998)) for the piping system of a ship. Figure 1 shows the movement of a bellows. Usually a bellows is a part that connects two separated pipes. The functions of bellows are to absorption of inner pressure, vibration, axial compression and tension. Figure 2 shows the section view and dimension of a bellows.

The important design factors of a bellows are number of thread(convolution), bellows height(w), bellows thickness(nt), pitch(q) and the length of sealing(tangent length, Lt). The design analysis of a bellows means to find out the optimal value of these factors.

2.1 Traditional Design Process

Before this research, the design process of this company was based on manual calculation. Design flow and approximated processing time is as follows. Figure 3 shows the traditional design process and processing time.

(1) get the constraint specification such as, the flange dimension, design pressure(internal, external), design temperature, axial compression(extension), lateral deflection, angular rotation etc.(2) input the bellows dimension and material (3) calculate the strength, stress and deformation(20 minutes with MS-Excel) (4) check the results (5) drawing(AutoCAD 2000, 6 hours, not include redesign time) (6) check drawing (7) make prototype(include 1 remanufacturing and assembling because of design or manufacturing error, 12 hour x 15 days = 180 hours) (8) test(include 1 extra test, 12 hours x 7days = 84 hours) (9) production. Usually total processing time is about 300 hours per one product. In this process, because of many reasons written in chapter 1, they could not consider the design analysis for their design results. It makes many trials and error process in design and manufacturing.

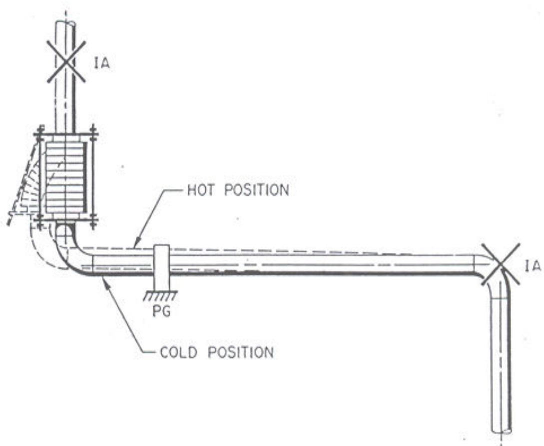

Figure 1. The movement of a bellows

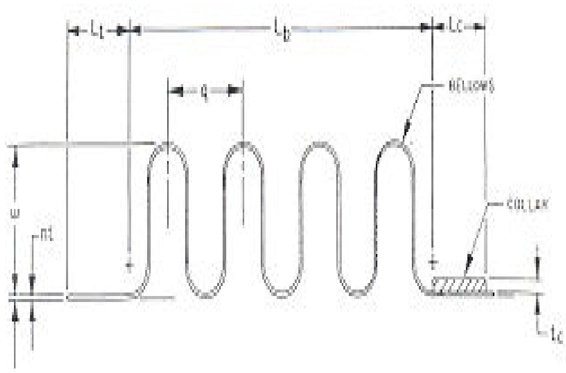

Figure 2. The section view of a bellows

Even though they have used the MS-Excel for calculation, it takes 300 hours per product. This is usual processing time in this bellows manufacturing field. After July 2002, companies that produce bellows were forced to analyze their product by makers. But the circumstances are not allowed for them to do so.

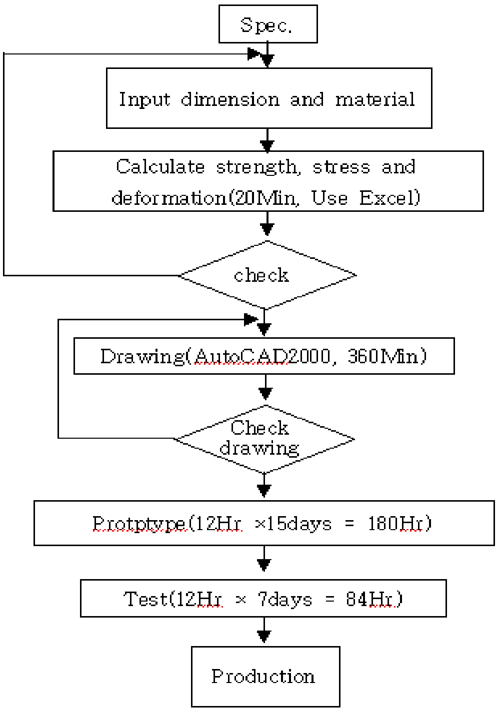

Figure 3. Traditional design process

2.2 Research Flow and New Design and Analysis Process

We tried to improve the design process and introduce the design analysis tool for the liability of design. As a tool for analysis, we decided to useANSYS. And in order to improve the usability of this ANSYS, we integrated MDT(Mechanical Desk Top) as 3D modeler, MS-Excel and ANSYS.

MDT is a 3D tool that is easy to learn for AutoCAD user. Designers are familiar with MS-Excel. Because of these reasons, the integration of these utility with ANSYS makes it easy to use the analysis tool. Additionally, this company has produced many kinds of bellows. We make astandard model, Worksheet, Log file for each type of product. This setup is one important step for the integration of design and analysis process. The process of integration was implemented as follow steps.

MS-Excel based process : (1) design a window for input constraint specifications and dimension data (2) design a windows for input material data (3)) design a window for input design equations (4) macro design between these 3 windows (5) design a report output window for the calculation (6) make worksheet connected with MDT.

MDT based process : Through these windows, one can efficiently make a 3D modelingon MDT.

ANSYS based process : The input(worksheet information)to the ANSYS should be manually done by worker using ANSYS log file. Then the ANSYS generates meshes and analyze the input data.
The analysis reports will be printed out.

Figure 4shows the improved design analysis process. The new process and processing time is as follows. (1) take specification from maker (2) input dimension and material (3) calculate the strength, stress and deformation(20 minutes with MS-Excel) (4) check the calculation result (5)transfer the product dimension data to MDT (6) generate 3D model(10 minutes with MDT) (7) make assembly drawing (8) check the interference between parts (9) transfer geometric data, load data, material data to ANSYS (10)generate FEM(Finite Element Method) model(6 hours) (11) analysis(6 hours) (12) evaluate the analyzed data (13) check the analyzed data and evaluated data (14) output reports (15) output 2D drawing and start to produce (16) output the result of analysis.

Through these processes, designer can generate various kinds of outputs without special knowledge about analysis. And it takes approximately 7 hours to complete all the design and analysis process for a product. In traditional process, the only design process takes approximately 6 hours. And if we include the manufacturing time and test time of prototype, it totally needs 300 hours.

Now, we can complete design and analysis tasks within 7 hours. Even if we have to make a prototype, we can process all the process within about 140 hours. And we can bring the analysis report with our product to the maker, without analysis expert. This ability makes a company more competitive.

3. Application example

We confirmed the effectiveness of this research through the design and analysis process of U-type bellows. Figure 5shows the input MS-Excel window of dimensional specification and design restrictions. Designer inputsall information from the maker to start his/her design task. Designer also inputsthe material(for example, SUS 304 or SS400 etc.) property data using another developed MS-Excel window. The third window can treats the design equations. It accepts several equations and calculates input data from former two windows. The designer makes a MDT worksheet for 3D modeling. This worksheet includes dimension data and material data.

If designer executes the MDT, then he/she can call a standard 3D model similar with a part that he just calculated. In the menu of MDT, he clicks "Part" – "Design Variable". And execute "Global" –"Setup". Next he clicks "Golbal Variable" – "Across". He gives a name to a Worksheet "MDT" and click "Link". Then he can link to the MS-Excel data. He inputs "Amupdate" in the command line of MDT, he can get 3D assembly drawing. Using this window, he can check the interference between parts. Figure 6 shows generated 3D model.

He open standard Log file on ANSYS and input MDTWorksheet data. He executes ANSYS and selects "File" – "Read Input Form" and clicksinput Log file. Then ANSYS generates 3D model and mesh, and design restriction will be loaded automatically. It analyses these data and prints out the results. Figure 7 shows the ANSYS 3D model. 2D drawing for manufacturing can be printed out as Figure 8.

4. Conclusions

Many small and medium manufacturing companies as vendors had suffered various kinds of difficulties. But the most important difficulties are productivity improvement and man power recruit. In this research, we solved these problems simultaneously. We can arrange the results of this research as follows.

(1) We improved the design and analysis process. As shown in the example, we can reduce the processing time for just design from 6 hours to 10 minutes. If we can reduce the number of times for manufacturing prototype and test, we can reduce total processing time from 300 hours to about 140 hours.

(2) Through the achievement of design and analysis automation, company can keep the delivery time.

(3) Designer needs no special knowledge for usingANSYS. It means company can easily supply other designers if needed.

(4) Through the analysis process, company can do the optimal design. It means a company can reduce the cost in the aspects of material.

And it is expected that using this integrated system for design and analysis, eventually, this company can get high competitiveness in this field.

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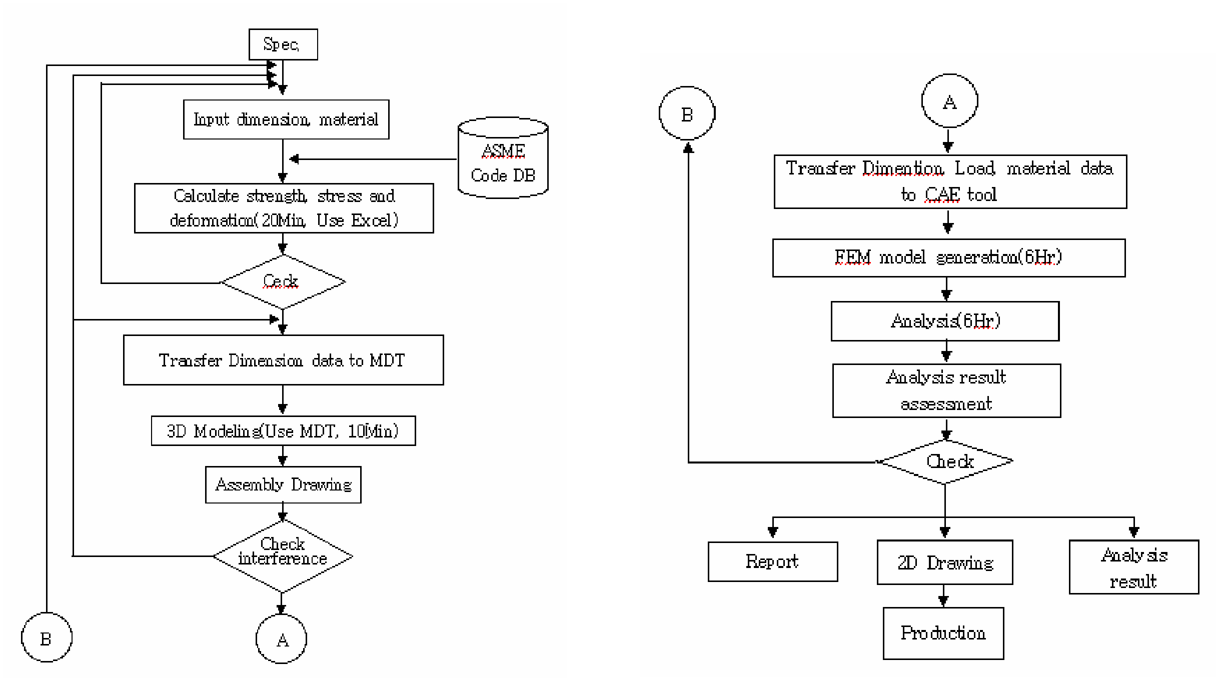

Figure 4. improved design and analysis process

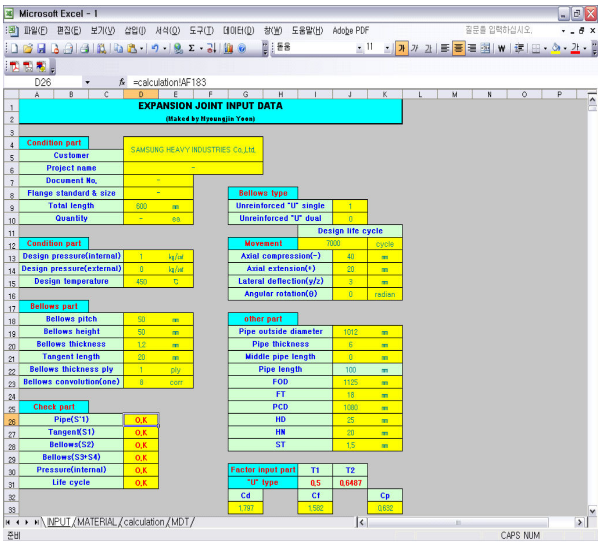

Figure 5. Dimension input window

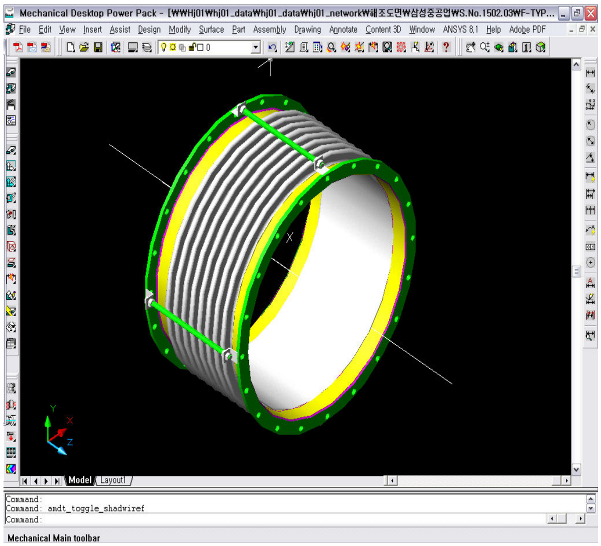

Figure 6. MDT 3D model

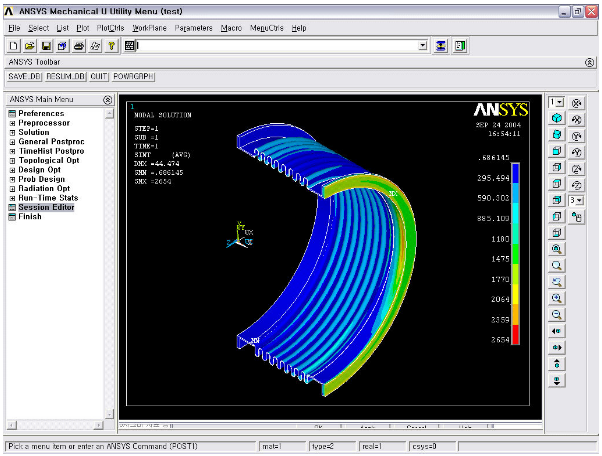

Figure 7. 3D model by ANSYS

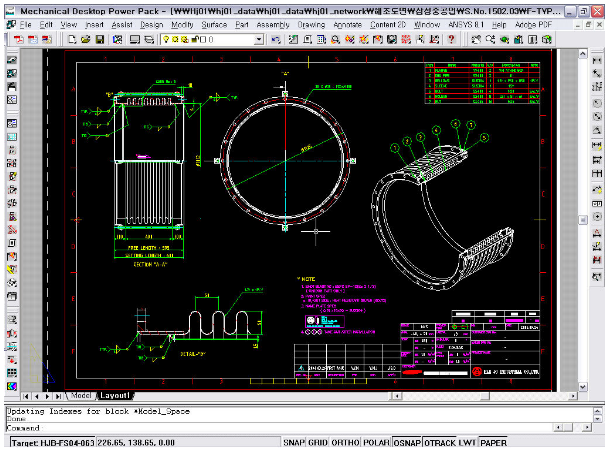

Figure 8. 2D Drawing for manufacturing