3D SCANNING AND THE MASK INDUSTRY IN TAIWAN: A NEW BUSINESS PARADIGM

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ABSTRACT

This study outlines considerations of a 3D scanning technology applied in the mask industry in Taiwan. A new way of looking at the industry, i.e. an on-line mask industry, will then be presented that integrates 3D scanning technology, common geometric shape parameters of face or head, customer tailored mask manufacturing, and supply chain management. The safety regulations and/or health care, such as respiratory care, guidelines will be incorporated into the technique, and logistic support aspects of this industry. Based on the above outline, key questions are posed and answered regarding how the industry will move towards the new paradigm, what will be required in order to do so, what will be the nature of the companies that will get us there, and when this shift will or should occur. The conclusion of the study is that the application of 3D scanning technology in the mask industry will launch a shift in the business paradigm to which it currently ascribes.

Keywords: mask, 3D scanning, supply chain.

INTRODUCTION

In the hospital, the mask is the most usual equipment for the patients. It can be used or the interface to supply extra oxygen for maintaining the patient's life, and it can be also used to solve the problem of sleep handicap. Because the patients need to wear the mask for a certain period of time, the comfort-ness will be one of the main purposes to design a mask. The fitness between the interface of a mask and a patient face is the most payoff area of the mask design issue. If, we can design a face-fit mask, it will not only improve the comfort-ness, but also prevent the leakage of respiratory care gas such as the oxygen wastage [1]. How to deign a best face-fit mask? The customer-tailored mask for each patient is the direct way to tackle the problem. This study aims to construct an E-Business model of customer-tailored mask by integrating the techniques of 3D human scanning, facial analysis, database

management and web system. The following paragraphs will introduce the (1) mask supply chain model, (2) 3D facial scanning system, (3) 3D facial data management module, and (4) web database system.

MASK SUPPLY CHAIN MODEL

Today, for mask selection, some of the mask companies provide a set of mask selection guidelines to screen the company's products, and then under the medical personnel's help, a mask is chosen from the hospital storage [2]. But in our model (shown as figure 1), we have set up a 3D facial scanning system, which can scan the 3D surface data of the patient's face in a short time. By analysis of the facial data and compare to the information of local mask database, we can construct a really fitting test method to choose the best-fit mask form the mask storage. And the local mask database can be downloaded from the "Web Database Center". Beside the replace selection method, we also build up an alternative way to purchase a customer made mask by uploading the 3D facial and analyzed data to the Web Database Center. At the Web Database Center, we had build up some standard mask interface CAD models and their correspondent interface contours. After selection of the proper size of interface CAD model and mapping the correspondent contour on the 3D facial data, we can get the mapping contour. The mapping contour is then be used to modify the interface CAD model, then we can e-mail the digitized interface CAD model to the CNC factory to curve the mold. After the CNC factory has finished this work, the mold will be mailed back to Web Database Center by Express. Now, we will fill the container into the mold, and stitch it to the mask mold. Then the customer made mask is finished and mailed back to the hospital. All of the process can be managed by the database on the Web Database Center. We can collect a lot of 3D facial data and feedback the design information to the mask manufacturers. The manufactures also can supply new design mask into our database. We can also add the storage control on our web database, and develop the on-line order mechanism.

3D FACIAL SCANNING SYSTEM

The prototype system was developed by ITRI (Industrial Technology Research Institute), which was consisted of a laser slit 3D scanning head and a personal computer. The scanning range of the system is 350mm(H)*350mm(W)*370mm(D), the resolution is 0.3mm, and the scanning time is about 2~3 seconds, which is very satisfactory for the use of mask design. For the use in the hospital, the prototype system has been re-assembled on a cart, and the scanning head has been fixed on a hand-held robotic arm, which is shown as figure 2. Thus, we can move the cart to where needs facial scan in the hospital and adjust the scanning head manually by the robotic arm to scan the patient in any posture and direction. Further more, we also add the network connection on the back of car. From the network connection, we can upload the 3D facial data to the Web Database Center and download new style CAD model of mask for the selection of mask.

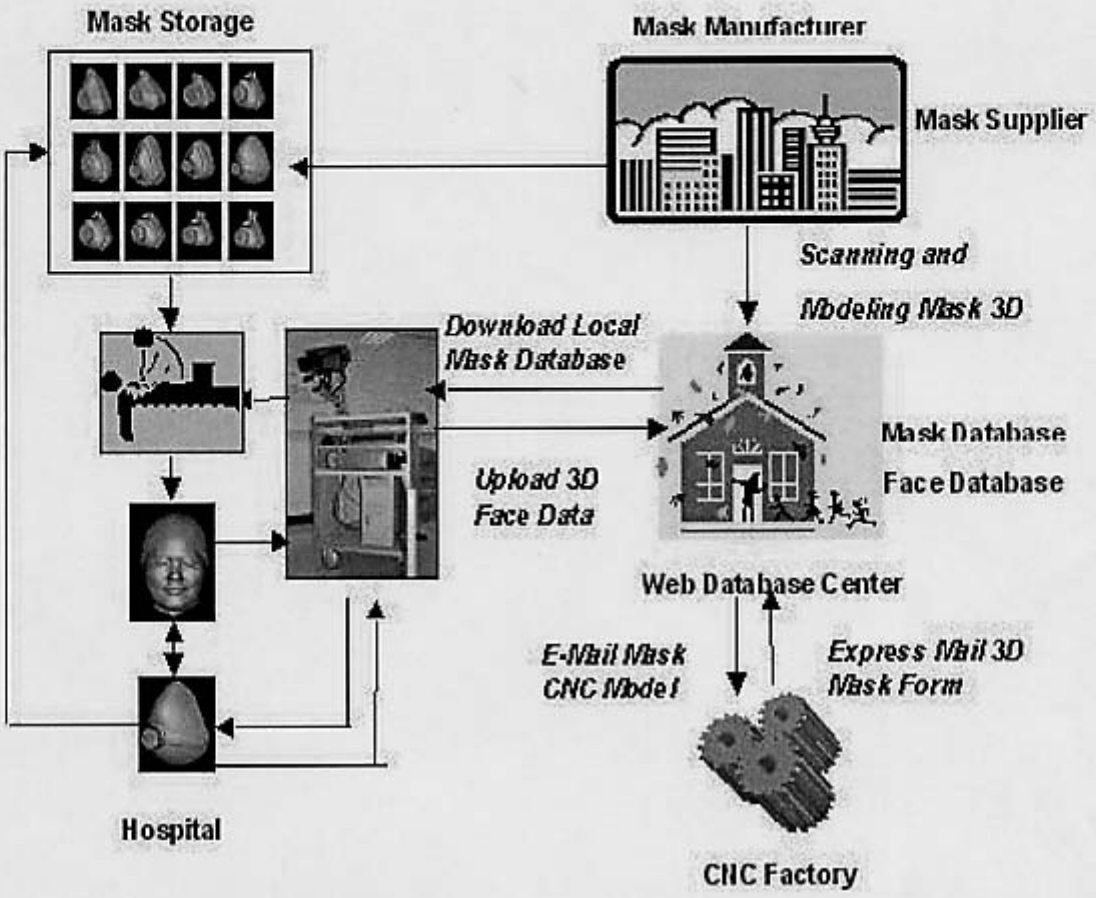


FIGURE 1. THE CUSTOMER-MADE MASK SUPPLY CHAIN MODEL

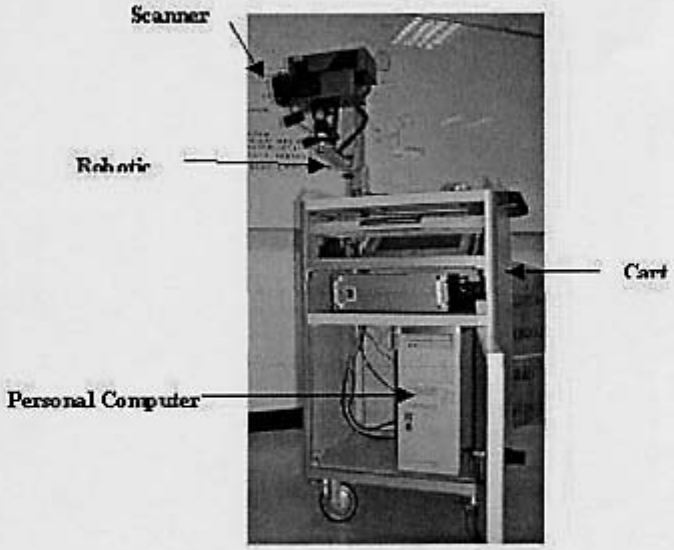
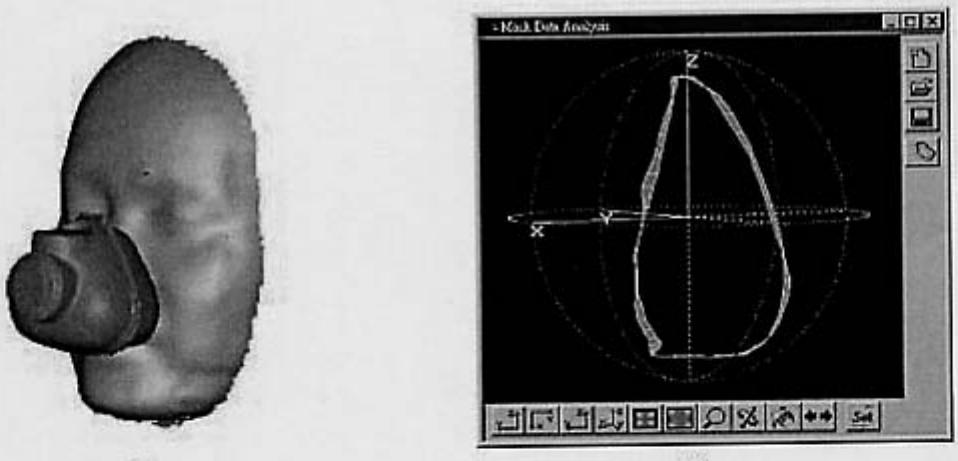


FIGURE 2. MOBILE 3D FACIAL SCANNER

3D FACIAL DATA MANAGEMENT MODULE

This module is to control the process of facial data analysis and management. After the facial data is scanned, the raw data will be transfer to the local database on the personal computer for later analysis. The module has set up a local database table to control the procedure of facial data analysis, and stored the results into the local database. The procedure of facial analysis has two stages [3], the first is to find the possible mask candidates from the local mask database, and the second is the do the shape comparison between the mask candidates and the face to find the best-fit mask. In the first step, eight landmarks were identified on the 3D facial data to calculate the facial size. The facial size was used to select the mask candidates by comparing it with the mask size, which is stored in the mask database. In the second step, the contours of the candidate masks were mapped on the facial data to generate the mapping contours. We can calculate the difference between the contour of mask and the corresponding mapping facial contour, and find out the least error one to be the best fit mask for the patient. Figure 3 shows the fitting result of the mask and the facial data. The raw data and result of analysis and selection will be upload to the Web Database Center for further application use. If the patient needs the customer made mask, the request will be sent to the Web Database Center for further process.



(a) (b)

FIGURE 3. Fitting result of the mask and the facial data: (a) The best fit mask has attached on the face, (b) the contour difference between the mask and the facial data, the blue area is the difference.

WEB DATABASE SYSTEM

The system was set up at the Web Database Center, which stored all the information about the facial data and mask data. The mask data were set up by collection of masks sold on the market, which were scanned by the 3D laser scanning system "ORION" produced by ITRI. The 3D scanning data have been analyzed to get the real dimension, identical fitting contour and wire frames of mask surface (shown as figure 4). The real dimension is used for candidate mask selection, the identical fitting contour is for the calculation of mask fitting error, and the wire frames are for the calculation of dead space in mask use. The face data were the scanning and analyzed data uploaded from the hospital, which can be used for further research, such as new style mask design, or goggle design.

The other main function of the system was to control the process flow of the customer made masks. It had a control flow database and a control mechanism to monitor the process. The control flow database record the process state and patient's information. When the order is sent to the center, the patient's information is added to the database and the process state is set to "waiting for CAD process." After the contour line retrieved from the patient's face and built up the CAD model, the process state is set to "wait for CAM process." Then, the center sends the CAD model to the CNC factory to process. After the CNC mold tooling is finished and sent back to the center for advanced stitched process, the state is set to "waiting for packing". When the mask is sent back to the hospital by express, the state is set to "Finished". All the process states can be monitored from the web page on the center.

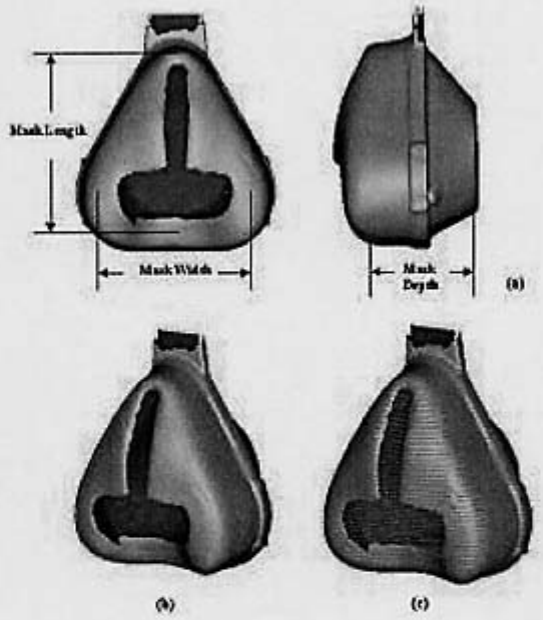


FIGURE 4. The analyzed data of mask: (a) size data, (b) fitting contour, and (c) wire frames

DISCUSSION AND CONCLUSION

The mask supply chain module is setting up now. Some of the system is well established and under testing, such as the facial scanning system and part of web database system. The supply chain of customer made mask is under construction and will be finished on December 2002. We expected to do the pilot test on the beginning of 2003.

After the system is set up, the key questions are posed and answered regarding how the industry will move towards the new paradigm, what will be required in order to do so, what will be the nature of the companies that will get us there, and when this shift will or should occur.

The customer made mask will be the trend. The application of 3D scanning technology in the mask industry will launch a shift in the business paradigm to which it currently ascribes.

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