An Analysis of the Benefits of DDM Processes for The Exoskeleton

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Safety in sporting is of utmost importance in this day and age. We must preserve our youth, in mind and body, all the while allowing them to enjoy their youth with sports such as football or hockey. The Exoskeleton is designed to do exactly that. There have been countless studies directed toward the optimization of helmets in football due to the consistent impact to the head. These studies are instrumental in preventing the likelihood of Alzheimer's or other mental diseases in players as they grow older, however another crucial part of the body that is often overlooked is the neck. Anatomically speaking, the neck is the "soft spot" of the body. If any significant impact is made to the neck in a sporting event, it can cause immediate, irreversible damage. When there are over than one million players in high school football alone in the United States, every step towards safety must be taken in order to maximize the chances of avoiding that irreversible damage.

Firstly, let's address the benefits of DDM processes. Since a neck brace such as The Exoskeleton is such a custom piece of hardware, this type of manufacturing is extremely useful as an actual image of the player themself can be used to generate an Exoskeleton using software such as Autodesk Fusion 360. An image of the players head can be scanned and turned into an stl file, and a mesh can be modeled around it. For this process to occur, DDM is required so as to allow for customization. In addition to the usefulness of customization, the channels inside the interior of The Exoskeleton can be manufactured quite efficiently when using this process. A

liquid such as a non-Newtonian fluid would be sealed within these channels to distribute the pressure around the neck, rather than in a localized position. A dual AM machine would be used to create this structure, while adding this fluid into the channels it creates, that way a sealed mesh results. DDM processes are vital to the production of such a structure due to its geometric complexity. A Voronoi pattern was used in order to simulate a honeycomb pattern, which was determined through simulation to adequately distribute pressure. Since the material would be 3D printed, there is no need for molding of any kind, which would cut down on manufacturing costs when considering the waste material used to mold each individual unit. The "primitive" stage of 3D printing only allowed for printing in hard plastics, however we now may use softer and more flexible plastics which are ideal for this application. A few top contenders to be considered for The Exoskeleton are TangoPlus FLX 973 (Shore 27A), TangoBlackPlus FLX 980 (Shore 27A), Agilus30 FLX935 (Shore 30A), and Agilus30 Black FLX 985 (Shore 30A). Each of these have a flexible composition that provides maximum shock and vibration absorption.

In the current market, TangoPlus FLX 973 may be purchased at a rate of 3.6 kg for $1,086. With a polymerized density of 1.14 g/cm^3, and each neck mesh using approximately 6.76 cubic centimeters of material, we may assume that each neck mesh should cost roughly $2.30. The material cost for manufacturing this material is astoundingly low. Mass production would only favor even lower costs for production as ordering higher quantities of material would almost assuredly lower the overall price. Therefore, it is safe to say that this method of manufacturing is quite cost effective as the only major investments are into the printing machine itself, the materials, shipping, and time to create the models. As far as environmental impact is concerned, there would be a very minimal effect on the pollution of the environment due to the total lack of production materials. The ability to print the product without use of a mold is

instrumental in cutting down on production costs and time, as well as limiting the amount of material used to create The Exoskeleton.

In an ideal world, the scale of this production would be huge; it should service the entirety of the United States and eventually even the world. Therefore, it would be safe to say that many printing devices would be used, and there would be a team of designers working constantly to improve the design, and customize it to the exact dimensions of every customer. If we are dealing with absolute ideal conditions, the optimum number of units to be manufactured would be in the millions. On a scale such as this, average unit prices would most likely reduce to at most 80% of the original unit price. Such low pricing could make a monumental impact toward the safety of our youth in playing sports requiring physical contact, and DDM processes afford this goal the chance to come to its fruition.